Field Evaluation of a Commercial Feeder to Control Wild Pigs

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Abstract: Wild pig (*Sus scrofa*) populations have exploded across much of the southeastern United States. In order to combat increasing wild pig numbers in an effort to reduce both ecological and economic damage caused by wild pigs, toxicant baits are being investigated as a possible method to reduce wild pig numbers at the local scale. In fall 2017, we tested the HogStopper® feeder to ascertain if this feeder design would deliver bait to wild pigs while preventing non-target species from accessing bait. We examined visitation rates at feeders for wild pigs and non-target species using both digital and video cameras. We had a three-week acclimation period (feeder doors remained open allowing free access to bait) followed by a three-week activation period (feeders were closed). Wild pigs visited eight of 10 feeders but fed from only one of these feeders during the activation period. With the exception of the Louisiana black bear (*Ursus americanus luteolus*), non-target species were effectively prevented from accessing feeders. Wild pigs frequently (95% of the time) spilled corn while feeding during the activation period. Due to the potential for wild pigs to spill toxicants when feeding, spill rates should be addressed during research and development of feeders and their associated toxicants in order to minimize non-target species exposure. We recommend manufacturers carefully consider bait load capacities and feed spillage when designing feeders to deliver toxicants to wild pigs.

Key words: toxicant, feed, bait, spillage, non-target, warfarin

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Since the introduction of wild pigs (*Sus scrofa*) by Spanish explorers to North America in the 1500s, their population has rapidly expanded. Wild pigs have expanded into most U.S. states, Mexico, and parts of Canada (Ditchkoff et al. 2017), with greater population densities in the south and southwest United States (West et al. 2009). Wild pigs are predators of reptiles, amphibians, ground-nesting bird eggs, and mammals including white-tailed deer fawns (*Odocoileus virginianus*; Mayer and Brisbin 2008). They also are a source of *E. coli* contamination in aquatic ecosystems (Kaller et al. 2007) and carry numerous diseases including influenza A, *Leptospira* spp., *Trichinell* spp., *Toxoplasma* spp., and *Brucella* spp. (Pedersen et al. 2014, 2017). Rooting from wild pigs can destabilize surface soils and increase soil erosion (Lucas 1977), threaten endangered plants (Chavarria et al. 2007), damage native plant communities (Engeman et al. 2007), and damage crops, pastures, and timber (Jerrolds et al. 2014). Damage to vegetation has been shown to parallel increases in wild pig abundance (Chavarria et al. 2007).

Wild pigs have the highest reproductive rate among ungulates (Taylor et al. 1998, Massei et al. 2011) and depending on environmental conditions may produce up to two litters per year (Barber and Coblentz 1987, Taylor et al. 1998, Ditchkoff et al. 2012) with mean litter size ranging from 4–6 piglets (Taylor et al. 1998, Ditchkoff et al. 2012). Because wild pigs have such a high reproductive rate and low natural mortality (Sweitzer et al. 2000, Adkins and Harveson 2007, Hayes et al. 2009), it can be difficult to control their populations and thus minimize the ecological and economic damages they cause. Bieber and Ruf (2005) suggested that during years of good environmental conditions (i.e., good mast years) survival of juvenile wild pigs would need to be reduced to approximately 15% in order to control wild pig populations. Other studies (e.g., Katahira et al. 1993, Sweitzer et al. 2000) have also indicated the need to remove a significant proportion of the population to control wild pig numbers.

Many different methods have been employed to try to reduce wild pig populations. Opportunistic shooting (Hanson et al. 2009, Hayes et al. 2009, Sparklin et al. 2009), night shooting (McCann and Garcelon 2008), aerial shooting (Cowled et al. 2006, Massei et al. 2011), hunting with dogs (Katahira et al. 1993, McCann and Garcelon 2008), trapping (Sweitzer et al. 1997, Williams et al. 2011, Smith et al. 2014), and poisoning (Hone and Pedersen 1980, Massei et al. 2011) have all been used with varying levels of success. Despite varied and intensive measures, landscape-scale control of wild pigs has not been achieved.

Toxic bait is considered a potential option for reducing wild pig abundance (Choquenot et al. 1990, Poché et al. 2018). Only one toxic bait is registered for use on wild pigs in the United States (Kaput®; Scimetrics Ltd. Corp., Wellington, Colorado), a warfarin-based toxic bait. A prototype toxic bait, Hoggone® (Animal Control Technologies Australia Pty. Ltd., Somerton, Victoria, Australia) containing the active ingredient sodium nitrite is being evaluated for registration in the United States as a toxic bait for wild pigs (Snow et al. 2017). A major concern of using toxicants to control wild pigs, however, is the potential impacts on non-target species (Leopold et al. 1964, Allen et al. 1996, Stone et al. 1999, Wobeser et al. 2004).

The manufacturer recommends that Kaput® Feral Hog Bait be delivered to wild pigs via the use of a specialized feeder, the HogStopper® feeder, that allows wild pigs to access the bait but excludes non-target species. Although specialized feeders may exclude non-target species from accessing bait, there may be little to prevent spilling by target species thereby making toxic baits available to non-target species. Access by Louisiana black bears (*Ursus americanus luteolus*) to feeders designed to deliver toxicants to wild pigs is of particular concern to the Louisiana Department of Wildlife and Fisheries. The species was listed under the Endangered Species Act as threatened from 1992 until its recent removal from the list in 2016 (U.S. Fish and Wildlife Service 2016), and continued recovery is a management priority.

The goal of this study was to test HogStopper® feeders (hereafter feeders) in the field to ascertain if 1) wild pigs are able to access bait within these feeders, 2) non-target species are able to access bait at these feeders, and 3) bait is spilled outside the feeder by feeding wild pigs and therefore would be accessible to non-target species.

Study Area

Ten different sites in black bear populated areas were selected on private lands in Louisiana within two primary study areas. The five northern-most sites were centered around the town of Livonia in Pointe Coupee Parish and the five southern-most sites were located south of Iberia in Iberia and St. Mary parishes. The Pointe Coupee study sites consisted of two tracts of land totaling 1,902 ha. Both sites were bottomland hardwood forest composed of oaks (*Quercus* spp.), hickory (*Carya* spp.), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), baldcypress (*Taxodium distichum*), and water tupelo (*Nyssa aquatic*) with agricultural crops comprised of soybeans, rice, and corn on adjacent properties. The Iberia and St. Mary parish sites consisted of four tracts of land totaling 3,490 ha. These sites averaged 70% bottomland hardwood forest composed of water oak (*Quercus nigra*), sugarberry (*Celtis laevigata*), red maple, sweet gum, and camphor tree (*Cinnamomum camphora*), 25% marsh dominated by *Panicum* spp., cattail (*Typha* spp.), and *Sagittaria* spp., and 5% agriculture composed of sugarcane. Average daily temperature during this study ranged from 26.1° to 26.9° C at the study sites. Average precipitation during this study ranged from 21.6 cm in Pointe Coupee Parish to 44.3 cm in Iberia and St. Mary parishes (NCEI 2019). Wild pigs were hunted normally during the hunting season at all study sites, otherwise no wild pig management occurred at our study sites.

Methods

In August 2017, we placed one HogStopper feeder on each of 10 sites (five feeders of heavy gauge [12 gauge] steel and five feeders of light gauge [16 gauge] steel). Overall feeder dimensions were 0.81 m wide x 0.71 m high x 0.85 m deep. Total feeder mass for the heavy gauge steel feeders was 89.8 kg and the feeder door had a mass of 11.2 kg. The total feeder mass for the light gauge steel feeders was 57.2 kg and the feeder door had a mass of 8.4 kg. The minimum distance between any two feeders was 1.2 km and the greatest distance was 49.3 km.

The feeders had two guillotine-style weighted doors, each with a lift bar, on opposing sides; animals had to lift the doors vertically to access the feeder contents. We staked the feeders down with four t-posts driven approximately 0.61 m into the ground, one on each corner through existing brackets on the feeder. As we installed the feeders, we loaded them with corn through a hinged lid which was secured shut with a pin. Kaput Feral Hog Bait, which the manufacturer recommends be used in the feeders for the activation period, consists of a paraffin wafer. Our study used corn for the acclimatization period as well as for the activation period. The feeders are capable of holding 90.7 kg of corn, which is the amount we placed in the feeders on a weekly basis. Although the manufacturer recommends using 11.3 to 22.7 kg of non-toxic feed during the acclimation period, a representative from the manufacturer assisting in setting up and baiting the HogStopper feeder had our field technicians fill the feeders to capacity. This suggests that users will fill them to capacity.

We set up one still digital camera (Bushnell Trophy Cam) and one video camera (Bushnell Trophy Cam) 1.5 m from each feeder mounted 0.9 m above the ground on a t-post. The cameras were placed so that both feeder doors would be captured when images were taken. Still cameras were motion activated; there was a two-minute minimum delay between activations. Video cameras were also motion activated; they filmed for 15 seconds which was then followed by a minimum two-minute delay.

Feeder doors remained open (acclimation period) for the first three weeks to condition animals to feed from them, after which we closed the doors (activation period) for the additional three weeks. During the initial acclimation period, raspberry-scented

Bear Scents attractant (Bear Scents LLC, Lake Mills, Wisconsin) was used to increase the likelihood of both wild pigs and bears locating the feeders.

We monitored feeders and checked cameras once weekly for six consecutive weeks. Bait was replenished to 90.7 kg of corn during the weekly checks. SD cards were collected each week. Images were examined to determine: 1) what species of wildlife fed at the feeders, 2) whether corn was spilled outside of the feeders by feeding wildlife, 3) whether wildlife fed on any spilled corn, and 4) whether wildlife were able to gain access to feeders once the doors were closed. We only considered corn to be spilled if we could observe it falling from the mouth of wildlife and there was additional corn on the ground in the next consecutive photo frame or video clip or if we observed wildlife removing corn from the feeder and there was corn on the ground in the next consecutive photo frame or video clip.

We used descriptive statistics to describe feeding events at feeders by encounter rather than by number of individual animals. This was done because an encounter often consisted of multiple photo frames or video clips with several animals and it was often not possible to distinguish individual animals. We considered pictures and recordings separated by <10 minutes to be the same encounter at a feeder. Digital pictures and video recordings separated by >10 minutes were considered to be different encounters at a feeder. An encounter could consist of one animal or several animals.

Although it is likely the same individual visited a feeder for more than one encounter this is not a concern since certain toxicants (e.g., warfarin-based toxicants; Poché et al. 2019) need to be consumed over several days by the same individual to be effective. We combined encounters from both still and video cameras and calculated overall encounter rate. We did this because the number of encounters by species did not differ between digital and video cameras ($P \geq 0.80$; one-way ANOVA) for either the acclimation or activation periods for our three most abundant species detected (wild pig, bear, raccoon). We report species-specific encounter statistics of all detected species relative to accessing feeders, spilling feed, feeding at feeders, and feeding on spilled feed. For every defined encounter, we identified the maximum number of each species present during the encounter by identifying the image(s) with the greatest number of each species. We used the general linear models procedure (one-way ANOVA; Proc GLM, SAS 2013) to test for differences in maximum number of individuals per feeder per encounter between the acclimation and activation periods for wild pigs, bears, and raccoons.

Results

During the acclimation period there were two digital cameras (one week each) and four video cameras (one week each) that malfunctioned and did not record data. There was one digital camera (one week) that malfunctioned during the activation period and did not record data. We recorded a total of 2,870 encounters. Wild pigs visited 8 of 10 feeders (523 total encounters; range 9–280 encounters per feeder) and bears visited all 10 feeders (581 total encounters; range 25–179 encounters per feeder).

Table 1. Number of encounters by species recorded feeding from feeders and feeding on spillage at feeders for both the acclimation and activation periods August to September 2017 in Pointe Coupee, Iberia, and St. Mary parishes, Louisiana.

	Acclimation period		Activation period	
Species	*n* encounters feeding from feeder	*n* encounters feeding on ground	*n* encounters feeding from feeder	*n* encounters feeding on ground
Wild pig	116	207	39	236
Louisiana black bear	82	350	72	208
Raccoon	250	445	161[a]	613
White-tailed deer	45	87		43
Sciurus spp.				30
Virginia opossum	1	2		1
Nine-banded armadillo		1		2
Sylvilagus spp.		1		1
Rattus spp.		1		
Peromyscus spp.		1		
Northern cardinal				1
Common grackle				1
Blackbird				1
Corvus spp.				1

a. All encounters were a result of bears making access.

During the acclimation period we recorded five species of wildlife feeding from feeders for 368 encounters (Table 1). Nine species of wildlife for 1,091 encounters were recorded feeding on corn on the ground during the acclimation period (Table 1). During the activation period, we recorded three species (wild pig, black bear, raccoon [*Procyon lotor*]) feeding from feeders (271 encounters). Wild pigs spilled corn most frequently when feeding from feeders (95% of encounters; Table 2). Twelve wildlife species for 1,134 encounters were recorded feeding on spilled corn during the activation period (Table 1). The maximum number of wild pigs visiting feeders per encounter was greater during the acclimation ($\bar{x}$ = 4.2 ± 0.2) than activation ($\bar{x}$ = 1.7 ± 0.1) period (F = 197.69, df = 1, 1043; $P < 0.0001$). The maximum number of bears (F = 3.08, df = 1, 1610; P = 0.08) and raccoons (F = 0.33, df = 1, 2769; P = 0.57) visiting feeders per encounter did not differ between the acclimation (bear $\bar{x}$ = 1.15, raccoon $\bar{x}$ = 1.97) and activation (bear $\bar{x}$ = 1.11, $\bar{x}$ raccoon, $\bar{x}$ = 1.99) periods.

Table 2. Number of encounters and spill rate by species recorded feeding from feeders during the activation periods August to September 2017 in Pointe Coupee, Iberia, and St. Mary parishes, Louisiana.

Species	*n* encounters feeding from feeder	*n* encounters not spilling feed	*n* encounters spilling feed	*n* encounters unknown if feed was spilled	% spill rate
Wild pig	39	2	37	0	94.9
Louisiana black bear	72	42	26	4	36.1
Raccoon	161	124	30	7	18.6

Figure 1. Louisiana black bear opening guillotine style door on a HogStopper® feeder during a pilot study in Pointe Coupee Parish, Louisiana

Discussion

This study examined feeders under field conditions to determine if wild pigs were able to access bait once the feeders were activated, if non-target species were able to access bait within feeders, and if bait was spilled by wild pigs. Both visitation and access to feeders by wild pigs was reduced once the feeder doors were closed. Wild pigs did not visit the feeders as frequently and the maximum number of wild pigs per feeder per encounter decreased from the acclimation to activation period. Wild pigs only attempted to access one of eight feeders (HS7) that they visited during the activation period and every time it was a single large male. We never observed an unsuccessful attempt to access a feeder by wild pigs. Wild pigs in our study were, however, observed rooting in front of the door at feeders without attempting to lift the door. Lavelle et al. (2018) and Snow et al. (2017) found that some, but not all, wild pigs attempted to lift a bait station lid to access bait. Campbell et al. (2013) also found wild pigs in their study did not attempt to access some of the feeders during the activation period that they had visited during the acclimation period. It is unclear why wild pigs at our study only attempted to access one of eight feeders during the activation period and why it was only a large male that attempted to access the feeder. We were not able to determine if there was more than one large male that accessed the feeder or if it was the same male every time. Although warfarin bait may effectively reduce wild pig numbers (Choquenot et al. 1990, Poché et al. 2018), they need to consume enough of the toxicant for it to be lethal. Indeed, Poché et al. (2019) stated lower concentrations of warfarin can be efficacious against wild pigs if feeding occurs over consecutive days. With a reduction in the number of wild pigs visiting feeders and few of these wild pigs accessing feeders once feeder doors are closed it's unlikely that toxicants alone will greatly reduce wild pig densities across the landscape.

The number of encounters by non-target species was reduced once the feeder doors were closed. Fewer species of wildlife visited feeders once the feeder doors were closed. Bears and raccoons were the primary non-target species that removed bait during the acclimation period, each visiting nine of 10 feeders during this time. Other studies have shown raccoons (Campbell et al. 2011, 2013, Lavelle et al. 2018) and white-tailed deer (Lavelle et al. 2018) to be the primary non-target species removing bait from wild pig feed systems. Unlike other studies testing the efficacy of wild pig bait delivery systems, we intentionally placed our feeders in black bear populated areas.

With the exception of bears, non-target species were effectively prevented from accessing feeders during the activation period. Bears were able to bend back the lid on the light gauge model as well as remove the pin holding the lid closed on the heavy gauge model, thereby allowing them access to feeders. Once access was gained by bears, raccoons were then able to access feeders through the opening created by bears from bending back the lid or by raccoons lifting the lid once bears had removed the pin. We did not observe raccoons gaining access to the activated feeders without bears having facilitated that access. No other species of wildlife gained access to the feeders once the feeder doors were close. Neither bears nor raccoons were observed attempting to lift the guillotine style door. However, in a pilot study conducted by LDWF bears were recorded by video camera lifting the guillotine style door on the light gauge feeders (Figure 1).

It's likely that the feeders we tested could be modified to prevent bears from accessing feed via the lid. However, something that needs to be considered when using toxicants in feeders is the manner in which wild pigs feed. We found that wild pigs spilled corn from the feeders 95% of the time while feeding once the feeder doors were closed. Although spill rates with corn do not provide information on potential spill rates when toxicants are used, this does indicate that attention to spill rates is warranted when developing both feeders and toxicants.

We recorded 39 encounters of wild pigs feeding from a feeder (HS7) during the activation period. In 37 of the 39 encounters (95%) wild pigs spilled corn. We identified wild pigs feeding from feeders in three manners during the activation period: 1) they would lift the door and eat corn in the feeder, 2) they would lift the door repeatedly and let it fall until corn spilled, then feed on spilled corn, 3) they would lift the door and sweep corn out with their snout, then feed on spilled corn. Feeding methods two and three, resulting in spilled corn, make feed available to non-target species. If wild pigs fed in the same manner on toxic baits, then these toxicants would potentially be available to non-target species. Like other studies (Campbell et al. 2011), we found that although wild pigs fed on spilled corn, they did not always consume all of the spilled corn. We recorded six non-target species (nine-banded armadillo [*Dasypus novemcinctus*], Louisiana black bear, white-tailed deer, Virginia opossum [*Didelphis virginiana*], raccoon, squirrel [*Sciurus* spp.]) and wild pigs feeding on corn spilled by wild pigs feeding from this feeder during the activation period. Competitive interactions with wild pigs could reduce or eliminate raccoon visitation rates at feeders (Campbell et al. 2013), but we observed wild pigs and raccoons simultaneously feeding at feeders. Although bears visited this feeder, they did not attempt to gain access to it.

Management Implications

The feasibility of using toxic baits to reduce wild pig numbers depends partly on maximizing bait consumption by wild pigs and minimizing risk to other species. We did observe wild pigs rooting in front of feeder doors during the activation period. Residue could decrease wild pig access (feeding under the door as opposed to lifting it) and increase non-target risk. We therefore recommend that residue be removed whenever feeders are visited. We also found that once the feeders were activated wild pig access and visitation rates declined. Since the goal of using feeders is to reduce wild pig numbers across the landscape this is problematic. Our study was conducted during the summer months in Louisiana. It is possible that during other times of the year or in different geographic locations that pig visitation rates and access could differ from our study; this is something that warrants further investigation. Due to the potential for non-target species to gain access to toxic baits we recommend that any bait and delivery system being considered for use first undergo rigorous field testing. Field testing should examine both the potential for non-target species to access bait within the bait delivery system and spill rates by wild pigs feeding at the bait delivery system. Furthermore, considering bait formation dictates feeder type it is important to use the proper delivery system with its associated bait to obtain the most relevant results.

Feeders placed in bear populated areas should be designed in such a way that bears cannot access them. We found bears were able to access the feeders through the lid. Lids should be designed so that bears cannot lift or bend them. Mechanisms such as hot wires or steel bars over the lid should be tested prior to the feeders being placed in areas with bears.

In order to reduce manpower needs, it's possible that users of feeders will fill them to capacity regardless of manufacturer recommendations. A high-density wild pig population may require more toxicants than a low-density wild pig population. Manufacturers should develop best management practices for differing wild pig densities. Manufacturers could limit the capacity of feeders or develop label requirements based on wild pig densities.

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