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Original Article

Box Traps for Feral Swine Capture: A Comparison of Gate Styles in Texas

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ABSTRACT Many different types of traps have been developed to increase feral swine (*Sus scrofa*) capture efficiency. Though not previously compared, gate styles may influence capture success. Our objectives were to report feral swine capture data from 31 trapping campaigns conducted in 17 counties from 2005 to 2011 in Texas, USA, compare capture rates by demographic category between side-swing and rooter gates, and evaluate influences of moisture, using the Palmer Drought Severity Index (PDSI), on juvenile capture rates. We trapped feral swine during all months of the year. Our trap configurations were identical with the exception of gate style. Traps had either side-swing or rooter gates. We captured 1,310 feral swine during 2,424 trap-nights. We found no differences in capture rates between gate styles for adults, adult males, or adult females. However, we found juvenile capture rates and total capture rates to differ between gate styles. Box traps with rooter gates captured more juveniles, resulting in more total captures than in box traps with side-swing gates. Partitioned rooter gates are constructed to allow for continual entry after the gate has been tripped; whereas with single-panel side-swine gates, continual entry may be more challenging for juvenile animals that lack the size and strength to push through the spring tension. Rooter gates should be considered over side-swing gates in management programs aimed at overall damage reduction. However, in management or research programs that seek to capture adult feral swine, side-swing gates may be more appropriate because fewer non-target juvenile feral swine are captured. Published 2012. This article is a U.S. Government work and is in the public domain in the USA.

KEY WORDS box traps, control, damage, feral swine, rooter gate, side-swing gate, *Sus scrofa*.

In the United States, feral swine (*Sus scrofa*) are a widely distributed invasive species that account for extraordinary agricultural and environmental losses. Damage caused by feral swine include food and water contamination (Kaller and Kelso 2006, Jay et al. 2007, Doupé et al. 2010), human and livestock pathogen transmission risks (Hall et al. 2008, Wyckoff et al. 2009), property damage, reduction in crop yields, and competition with native species (Seward et al. 2004). A conservative estimate of US$ 800 million in annual damage has been reported for feral swine residing in the United States alone (Pimentel et al. 2005).

Natural resource managers in the United States have a variety of control methods available to decrease damage generated by feral swine, including fencing, trapping, snares, aerial and ground shooting, and hunting with dogs (Campbell and Long 2009). Each damage-control method has associated advantages and disadvantages, including costs, labor requirements, safety concerns, legal and social considerations, and appropriate spatial and temporal contexts (Campbell and Long 2009).

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Many different types of traps have been developed and modified to increase capture efficiency (Foreyt and Glazener 1979). However, there are 2 primary types of feral swine traps, portable box traps, and semi-permanent corral traps (Choquenot et al. 1993). Box traps typically have 6 sides (i.e., top, bottom, 2 sides, front, and back), are rectangular in shape, and are available at most hardware and farm-and-ranch stores in Texas, USA. Corral traps are typically rounded (to keep feral swine from escaping by piling-up in corners), larger in area than box traps, and have no top or bottom. Variation in these 2 trap types may include size, materials used, trigger mechanism, and gate style (West et al. 2009). Different types of traps may be more effective than others depending on personnel time, resources, sounder size, and feral swine behavior (Campbell and Long 2009). For example, a recent study from Fort Benning, Georgia, USA, found feral swine capture rates were 4 times greater for corral traps than for box traps (Williams et al. 2011*a*). However, in Texas, box traps are often used by landowners and recreationalists because of their availability and portability, and because practitioners are not necessarily attempting to capture feral swine to control damage, but instead are removing a few feral swine for consumption or other utilitarian uses.

Though not previously compared, gate styles may also influence capture success (Williams et al. 2011*a*).

Common trap gates include spring-charged saloon gates, spring-charged side-swing gates, gravity-charged guillotine gates, and gravity-charged rooter gates with or without partitions (e.g., for the latter see Belden and Frankenberger 1977). Each of these gates can be triggered or released through feral swine activity at the site of bait placement within the trap, monofilament fishing line or rope tied to the trigger, and a prop placed in such a position that it maintains the gate in an open position (Williams et al. 2011*a*).

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center maintained a field station in Kingsville, Texas from 2004 to 2011 aimed at developing new methods for managing feral swine damage and diseases. During this time, field station personnel and their partners captured feral swine using box traps, in partial fulfillment of 8 study protocols. The box traps had either side-swing or partitioned rooter gates. Our objectives were to report capture data from 31 trapping campaigns conducted from 2005 to 2011, compare capture rates by demographic category between side-swing and rooter gates, and evaluate influences of moisture on juvenile capture rates by using the Palmer Drought Severity Index (PDSI). The PDSI measures the duration and intensity of the long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during the current month is dependent on the current weather patterns plus the cumulative patterns of previous months (NCPC 2011). Based on our experience and without prior scientific evaluation, we did not expect differences between gate styles; however, we expected a positive relationship between PDSI and juvenile capture rates because feral swine are resource-dependent breeders (Taylor et al. 1998).

STUDY AREA

Our trapping campaigns occurred in 16 counties throughout southern Texas, including Aransas, Brooks, Cameron, Dimmit, Duval, Hidalgo, Jim Hogg, Jim Wells, Kenedy,

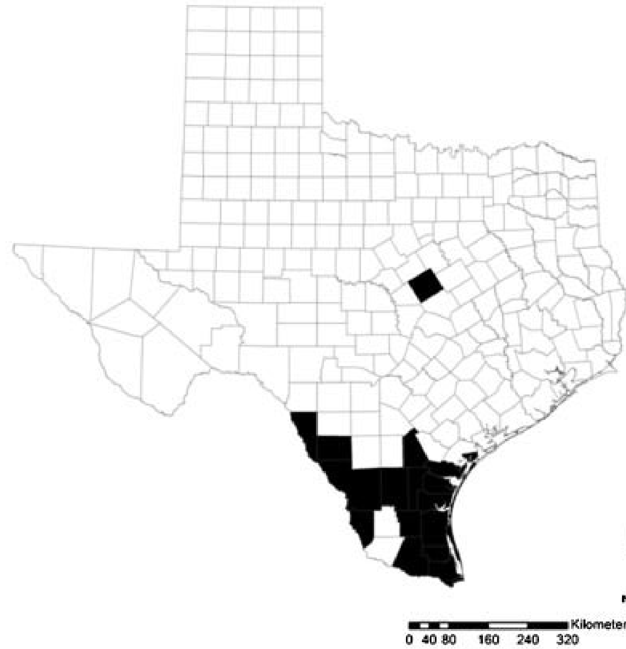

Figure 1. Distribution of the 17 Texas, USA, counties (shaded) in which 31 feral swine (*Sus scrofa*) trapping campaigns were conducted involving box traps with either side-swing or rooter gates from April 2005 to February 2011.

Kleberg, Live Oak, Nueces, San Patricio, Webb, Willacy, and Zapata counties. We also trapped Fort Hood in Coryell County, which was located in central Texas (Fig. 1). We conducted trapping on 23 private, state, and federal properties, which averaged 13,900 ha; throughout the study, we trapped a total area of 320,000 ha. Precipitation was variable throughout our study (Fig. 2) and monthly moisture for counties during trapping campaigns ranged from extremely moist to extreme drought from 2005 to 2011 (NCPC 2011).

METHODS

We trapped feral swine during all months of the year (Table 1). Our trap configurations (and price) were identical,

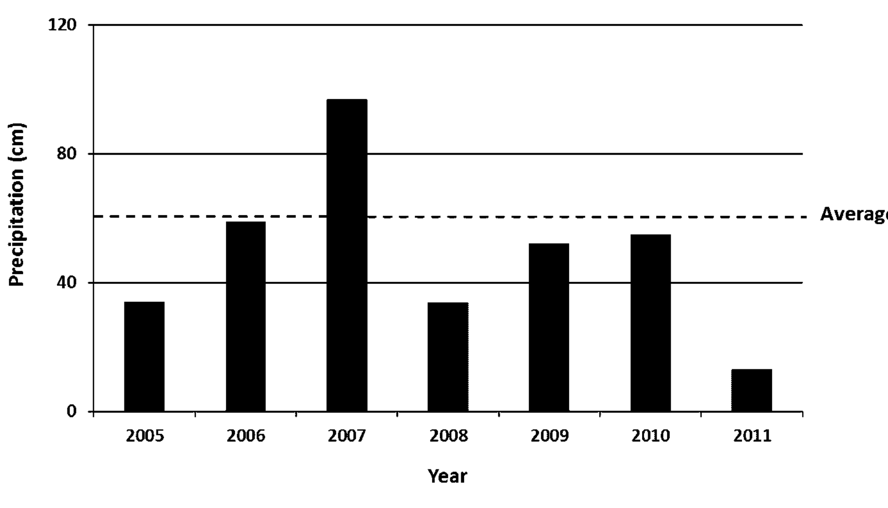

Figure 2. Annual and long-term average precipitation (cm) for Cotulla, Texas, USA, which was a central location of our feral swine (*Sus scrofa*) trapping campaigns, from April 2005 to February 2011.

Table 1. County, dates of trapping, bait used, gate style used, total captures, and maximum number of feral swine (*Sus scrofa*) captured per trap-night during 31 trapping campaigns conducted in Texas, USA, from April 2005 to February 2011.

County	Dates	Bait used	Gate style	Total captures	Max. no. of captures/trap-night
Duval	20–29 Apr 2005	Soured corn	Side-swing	22	7
Kleberg	12 Aug–29 Sep 2005	Soured corn	Side-swing	49	8
San Patricio	7–24 Jun 2006	Soured grain sorghum	Side-swing	87	12
San Patricio	21 Nov–20 Dec 2006	Soured corn	Side swing	47	5
Jim Wells	18 Dec 2006–3 Feb 2008	Dry and soured corn	Side-swing and rooter	24	8
Coryell	10–29 Jan 2007	Soured corn	Side-swing and rooter	17	6
Willacy	23 Jan–9 Feb 2007	Soured corn	Side-swing	17	4
Willacy	13–23 Feb 2007	Soured corn	Side-swing and rooter	15	5
Hidalgo	13 Feb–1 Mar 2007	Soured corn	Side-swing and rooter	16	3
Duval	15 Feb–15 Mar 2007	Dry corn	Side-swing	1	1
Brooks	6 Mar–4 Apr 2007	Soured corn	Side-swing and rooter	69	11
Live Oak	13 Mar–18 May 2007	Soured corn	Side-swing and rooter	79	8
Kleberg	2 Apr–8 May 2007	Dry corn	Side-swing	104	7
Cameron	29 Apr–31 May 2007	Soured corn	Side-swing	8	3
Cameron	6–22 Jun 2007	Soured corn	Side-swing	1	1
Cameron	6–22 Jun 2007	Soured corn	Side-swing and rooter	13	5
Aransas	19 Jun–24 Aug 2007	Soured corn	Side-swing and rooter	37	8
Kleberg	3–30 Jan 2008	Soured corn	Side-swing and rooter	63	10
San Patricio	6-21 May 2008	Soured corn	Side-swing and rooter	67	10
Kleberg	3 Feb–25 Sep 2009	Dry corn	Side-swing and rooter	8	8
Kleberg	6 Feb–9 Sep 2009	Dry corn	Side-swing	8	4
Nueces	18 Feb–9 Sep 2009	Dry corn	Side-swing	40	14
San Patricio	10–26 Feb 2010	Dry corn	Side-swing and rooter	67	6
Brooks	13–16 Jun 2010	Soured corn	Side-swing and rooter	50	8
Duval	21 Jun–26 Aug 2010	Soured corn	Side-swing and rooter	102	13
Zapata	20 Jul–19 Aug 2010	Soured corn	Side-swing and rooter	90	13
Maverick	19 Jul–17 Aug 2010	Soured corn	Side-swing and rooter	53	10
Webb	24 Jul–4 Aug 2010	Soured corn	Rooter	19	8
Dimmit	30 Aug–23 Sep 2010	Soured corn	Side-swing and rooter	29	9
Kenedy	13–16 Sep 2010	Soured corn	Side-swing and rooter	39	9
San Patricio	3–22 Feb 2011	Dry corn	Side-swing and rooter	69	9

with the exception of gate style. Traps were 2.4 m in length, 1.2 m in width, and 0.9 m in height (Younger Brothers, Seguin, TX). Traps with side-swing gates had an opening of 0.6 m and consisted of a single panel that pivoted vertically and remained closed by force of spring tension (Fig. 3). Traps with rooter gates had an opening of 1.2 m and consisted of 4 partitioned panels that pivoted horizontally and remained closed by force of gravity (Fig. 4).

We placed traps in shaded areas adjacent to recent feral swine activity (e.g., rooting), food resources (e.g., deer feeders), and sources of free water. We pre-baited traps with dry whole-kernel corn, soured whole-kernel corn, or soured grain sorghum (Table 1) until feral swine were entering traps and removing bait. We baited, set, and checked traps daily from 0600 hr to 1100 hr. Our traps were triggered as previously described above. Upon capture, feral

Figure 3. A box trap with side-swing gate used in feral swine (*Sus scrofa*) trapping campaigns conducted in Texas, USA, from April 2005 to February 2011.

Figure 4. A box trap with rooter gate used in feral swine (*Sus scrofa*) trapping campaigns conducted in Texas, USA, from April 2005 to February 2011.

swine were chemically immobilized for marking and collar placement, or killed by a gunshot to the head (AVMA 2007), depending upon the study protocol objectives. We recorded location, gate style, sex, age (adult or juvenile), and total number of animals caught. We determined age based on estimated weight, and considered swine <22.7 kg to be juveniles and swine ≥22.7 kg to be adults (Williams et al. 2011*a*). We released all non-target animals (e.g., collared peccaries [*Pecari tajacu*]) immediately upon arrival at traps. All capture and handling procedures were approved by the Institutional Animal Care and Use Committee at the National Wildlife Research Center (Permit nos. QA-1283, QA-1308, QA-1309, QA-1528, QA-1593, QA-1720, QA-1749, QA-1826).

For each demographic category, we standardized capture data among trapping campaigns by dividing the total number of captures by the number of trap-nights. We conducted analyses on the number of captures per 100 trap-nights for adult, adult male, adult female, juvenile, and total captures. We used a 2-tailed, 2-sample rank sum test to compare capture rates between gate styles using PROC NPAR1WAY WILCOXON of the SAS program (Schulman 1992). We determined statistical significance at $\alpha = 0.05$. Additionally, we plotted mean juvenile feral swine capture rates (captures/100 trap-nights) by PDSI for all juvenile captures to evaluate influences of moisture on juvenile capture rates.

RESULTS

We captured 1,310 feral swine during 2,424 trap-nights (Table 1). Sex and age ratios were 674 males:636 females and 576 adults:726 juveniles, respectively. Of the 536 adult feral swine in which sex was recorded (40 adult feral swine were not included due to missing data on sex) we found 282 to be male and 254 to be female. Of our 31 trapping campaigns, 8 trapping campaigns recorded the maximum number of captures per trap-night of ≥10 animals and 18 trapping campaigns recorded the maximum number of captures per trap-night of ≥8 animals.

Table 2. Mean (SE) feral swine (*Sus scrofa*) capture rate (captures/100 trap-nights) for box traps with side-swing and rooter gates during 31 trapping campaigns conducted in 17 Texas counties, USA, from April 2005 to February 2011.

	Ad		Ad M		Ad F		Juv		Total	
Gate style	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Side-swing	23	3	11	2	11	1	31	6	54	8
Rooter	31	5	15	3	16	3	80	23	111	27

We found no differences in capture rates between gate styles for adults ($Z_{48} = 1.149$, $P = 0.25$), adult males ($Z_{47} = 0.663$, $P = 0.507$), or adult females ($Z_{47} = 1.192$, $P = 0.233$; Table 2). However, we found juvenile capture rates ($Z_{48} = 2.002$, $P = 0.045$) and total capture rates ($Z_{48} = 2.04$; $P = 0.041$) to differ between gate styles. Box traps with rooter gates captured more juveniles (which resulted in more total captures) than did box traps with side-swing gates (Table 2). Furthermore, we found no relationship between mean juvenile feral swine capture rates and PDSI (Fig. 5).

DISCUSSION

Our discovery of greater juvenile and total trapping effectiveness for rooter gates was counter to our hypothesis. However, partitioned rooter gates are constructed to allow for continual entry after the gate has been tripped; whereas, with single-panel side-swine gates, continual entry may be more challenging for juvenile animals that lack the size and strength to push through the spring tension. We believe this likely explains our observed differences between gate styles for juvenile capture rates, though we did not document this with direct or photographic observations. Similarly, researchers in France that studied wild boar observed capture rates of adult females with gravity-charged guillotine gates, which did not allow for continual entry, to be less than remotely triggered gates (Fournier et al. 1995). An alternative explanation for greater juvenile trapping effectiveness

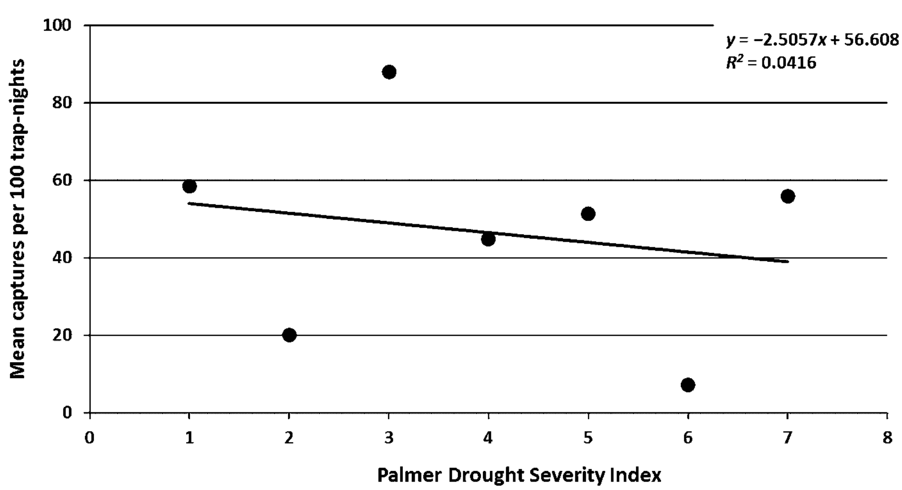

Figure 5. Mean juvenile feral swine (*Sus scrofa*) capture rates (captures/100 trap-nights) plotted by Palmer Drought Severity Index (PDSI) for box-trap captures during 31 trapping campaigns conducted in 17 Texas counties, USA, from April 2005 to February 2011. PDSI 1 = extremely moist, PDSI 2 = very moist, PDSI 3 = moderately moist, PDSI 4 = average moisture, PDSI 5 = moderate drought, PDSI 6 = severe drought, PDSI 7 = extreme drought (NCPC 2011).

with rooter gates is that these gates were approximately twice as wide as side-swing gates and may have allowed more juveniles to enter the trap.

Also counter to our hypothesis, we found no relationship between PDSI, which incorporates monthly temperatures and precipitation, and juvenile capture rates. Our hypothesis was based on the observation that the more favorable moisture conditions are, the more reproductively active feral swine would be (Taylor et al. 1998). It is plausible that feral swine breeding activities in Texas are more determined by the state's bimodal precipitation and seasonal temperature patterns (Taylor et al. 1998) and less influenced by monthly variation in moisture. Alternatively, many landowners in Texas provide feed, including corn and protein pellets, to supplement white-tailed deer (*Odocoileus virginianus*) populations. However, much of this feed is consumed by non-target wildlife, such as feral swine (Lambert and Demarais 2001). These added nutritional resources may facilitate feral swine reproduction during unfavorable moisture conditions, when they otherwise would be unlikely to reproduce.

Researchers at Fort Benning, Georgia, found adult male feral swine averse to entering box traps and subsequent capture (Williams et al. 2011*a*). However, we found that 53% of the adult feral swine captured were male. Although we do not know the proportion of the adult population that was male and female before and after our trapping campaigns (and, therefore, we were unable to determine whether our captures were biased by sex; Choquenot et al. 1993), we can conclude that adult male feral swine regularly entered box traps and were captured frequently. We attribute these differences in behavior to the fact that feral swine populations upon which we conducted our trapping campaigns were relatively naïve to trapping. In fact, for many of the feral swine we captured, our traps were the first that they would have encountered; whereas, feral swine at Fort Benning were highly persecuted (Sparklin et al. 2009). Further illustrating the naivety within our feral swine populations, we found 26% of our trapping campaigns to record capture events of $\geq$10 animals and 58% of our trapping campaigns to record capture events of $\geq$8 animals. Box traps may be more effective within feral swine populations that have not experienced intensive prior management.

Trapping success is highly variable and dependent on many factors, such as feral swine density, alternate food sources, and duration of pre-baiting (Williams et al. 2011*b*). Our capture data revealed a pooled mean (total captures for both gate styles) of 54 swine per 100 trap-nights, which ranged by trapping campaign from 10 to 190 swine per 100 trap-nights. Previous research in southern and eastern Texas found box-trap captures of 16 and 13 swine per 100 trap-nights, respectively (Wyckoff et al. 2006). Other studies using box and corral traps outside of Texas have found similar feral swine capture rates. For example, at Fort Benning, Georgia, researchers captured 23 swine per 100 trap-nights using corral traps and 14 swine per 100 trap-nights using box traps (Williams et al. 2011*a*); whereas, in Australia researchers captured 40 swine per 100 trap-nights (Saunders et al. 1993) and 250 swine per 100 trap-nights (Caley 1994) in corral traps. Variation in trap success between these studies was likely due to trapping methodology, such as pre-baiting, trap density, feral swine density, trap placement, and prior management. Consequently, we do not believe it prudent to make universal recommendations on styles of traps, because capture success is highly unpredictable. We do recommend developing and implementing a comprehensive feral swine damage-management plan that integrates all legal and socially acceptable techniques for controlling feral swine damage (Campbell and Long 2009).

MANAGEMENT IMPLICATIONS

Our observed differences in total capture rates between gate styles suggest that box traps with rooter gates are more effective than box traps with side-swing gates. Consequently, rooter gates should be considered over side-swing gates in management programs aimed at overall damage reduction. However, in management or research programs that seek to capture adult feral swine (such as targeted pathogen surveillance; Campbell et al. 2011) or for placement of GPS collars (Campbell et al. 2010), side-swing gates may be more appropriate because fewer non-target juvenile feral swine are captured.

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