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Tools and Technology

Improved Strategies for Handling Entire Sounders of Wild Pigs

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ABSTRACT As wild pigs (*Sus scrofa*) expand throughout North America researchers are increasingly being tasked with trapping and marking entire sounders (family groups) to attach monitoring devices or other identifying markers to gather knowledge to inform management. Capture and marking procedures can be challenging, dangerous for both researchers and animals, and time consuming, particularly when handling sounders. We developed an integrated pig-handling system to efficiently sort, weigh, chemically immobilize, and mark multiple wild pigs simultaneously in a controlled manner. To assess the functionality of the system, we evaluated 18 capture events in Texas, USA, from January 2018 to March 2019, where we marked 221 pigs of varied age classes and group sizes (2–19 animals). Using the pig-handling system, we chemically immobilized 51 large (41–101 kg) pigs and manually restrained 170 smaller (<45 kg) pigs with injury rates below 4%. Average handling times for large pigs was 71.9 (SD = 25.7) min and <1 min for smaller ones. We released sounders intact and routinely recorded them together on motion-activated cameras. Incorporating a handling system into wild pig research and management is encouraged to facilitate safe handling procedures for both pigs and handlers. © 2021 The Wildlife Society. This article is a U.S. Government work and is in the public domain in the USA.

KEY WORDS capture, handling trailer, immobilization, research, *Sus scrofa*, wild pig, wildlife damage management.

Invasive wild pig (*Sus scrofa*) numbers are expanding across the United States (U.S.) resulting in increased management challenges associated with agricultural and natural resource damage (Bevins et al. 2014, Snow et al. 2017). An increased emphasis on understanding and managing wild pigs was demonstrated by the development of the U.S. Department of Agriculture (USDA) National Feral Swine Damage Management Program. This Program is supported by USD $20 million in Congressionally appropriated funding (USDA 2015), and an additional USD $15 million annually through the Agriculture Improvement Act (2018). The National Feral Swine Damage Management Program emphasizes the importance of the problem and in developing tools that enable researchers to answer questions regarding the management of wild pigs. Wild pig ecology is at the foundation of such research and a thorough understanding of behaviors and movements of wild pigs in response to specific stimuli is needed to inform how management actions in one area affect adjacent areas. Research on movement of pigs requires capture and handling so that tracking collars and ear tags can be deployed.

Specific study objectives and animal care oversight committees determine appropriate capture and handling protocols. Injury, trauma, and mortality rates are common measures of safety during captures, and a goal of zero for each deleterious outcome should be sought. Releasing minimally stressed and uninjured research animals ensures that the best quality, unbiased, and repeatable results are reported (Quinn et al. 2012, 2014). Safety and minimization of impacts on pigs and handlers is of utmost importance, yet commonly used capture and handling procedures are labor intensive and

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can be injurious to both animals and handlers (Sweitzer et al. 1997*a*, Barasona et al. 2013). The type of trap used to capture pigs often influences the number of wild pigs captured per event (Fenati et al. 2008, Williams et al. 2011, Barasona et al. 2013), with corral traps being the most common tool used for capturing entire sounders (family groups; Sweitzer et al. 1997*a*, Williams et al. 2011, Gaskamp 2012). Use of specialized gates, remote monitoring, and user-activated trigger controls facilitate the capture of specific pigs (Gaskamp 2012).

Chemical immobilization and physical restraint are two handling strategies used for outfitting pigs with monitoring devices (Sweitzer et al. 1997*b*, Sparklin et al. 2009, Wyckoff et al. 2009, Lavelle et al. 2018, Ellis et al. 2019). Simple physical restraint may be more cost effective, but requires increased physical effort, can be dangerous to handlers, and can result in physical injury to wild pigs (e.g., trauma, hyperthermia, capture myopathy). Depending on size, physically handling a group of wild pigs caught in a trap can be untenable. Chemical immobilization with sedatives or anesthetic agents can be time consuming and expensive, but is safer for handlers and pigs, and likely results in less post-capture morbidity. As such, there is a balance between safety and efficiency that must be sought when handling groups of pigs.

Pigs typically live in groups (i.e., sounders) averaging five to six animals of varying age and sex, with males frequently found alone or in small groups (Ilse and Hellgren 1995, Gabor et al. 1999, Adkins 2005, Mayer and Brisbin 2009). The minimum size of sounders in Texas (TX) and Oklahoma (OK) ranged from 5–27 animals (Gabor et al. 1999, Gaskamp 2012). As the number of pigs captured increases, so does the number of handlers needed, duration of handling time, and potential for injury to animals or handlers (Sweitzer et al. 1997*b*, Fenati et al. 2008). Handling times of >50 min per pig are common when chemically immobilizing pigs for research purposes (Sweitzer et al. 1997*b*, Barasona et al. 2013). During previous capture events, mean handling times ranged from 77–83 min for captures with box and corral traps followed by chemical immobilization (M. J. Lavelle, unpublished data). When multiple pigs are to be chemically immobilized in a trap, successful delivery of immobilization agents in a manner that allows synchronous sedation of all the targeted animals is difficult. Allowing those target animals to simultaneously succumb to recently administered immobilization agents or recover without disturbance is also problematic. To achieve the goal of humane and efficient handling and release of intact sounders, we reviewed and revised previous tools and techniques and developed an integrated handling system. Our proposed system includes a mobile pig-handling trailer and modified corral trap and holding pen design (Fig. 1). We present descriptive data to demonstrate the benefits and functionality of an integrated handling system based on injury rates and handling times we experienced.

STUDY AREA

We conducted pig captures on privately-owned properties in two areas of northern TX, USA. The first area included

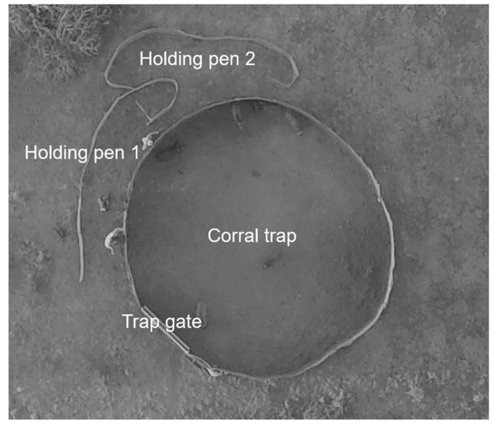

Figure 1. Trap arrangement designed to accept pig-handling trailer and hold wild pigs (*Sus scrofa*) for group release during capture efforts in San Antonio, TX, USA, in January 2017.

private rangeland used primarily for grazing cattle within the Rolling Plains ecoregion (Smith and Campbell 1996), and was dominated by mesquite (*Prosopis* spp.), buffalo grass (*Buchloe dactyloides*), and prickly pear cactus (*Opuntia* spp.). The second area consisted of privately-owned farms within the Blackland Prairie region of northeastern TX, having cultivated crops and rangeland interspersed with riparian corridors (Smith and Campbell 1996).

METHODS

Animal Captures

Data compiled for our manuscript come from 2 research studies undertaken during January 2018 through March 2019. Both studies required capture, processing, and release of entire sounders. We used corral traps constructed of 6.1-m × 1.5-m welded-wire fence panels with 10.2-cm × 5.1-cm mesh openings (Horse Panels, Oklahoma Steel, Madill, OK, USA) attached to 1.8-m steel t-posts, fitted with 2.4-m wide Jager Pro™ remotely monitored and user-activated gate systems (Jager Pro™, LLC., Fortson, GA, USA; Fig. 1). To reduce injury, we installed shrouds of shade cloth (24.4 m long by 1.3 m tall, 80% coverage shade cloth: Memphis Net and Twine Co. Inc., Memphis, TN, USA; Lavelle et al. 2019) around the circumference of the corral traps prior to processing pigs. Capture and handling procedures were approved by the United States Department of Agriculture/Animal Plant and Health Inspection Service/ Wildlife Services (USDA/APHIS/WS), National Wildlife Research Center (NWRC; QA-2632, QA-3046) and Texas A&M University-Kingsville (2018-12-04/1435) Institutional Animal Care and Use committees.

Trailer Development

Prior to capture efforts in 2018, we developed a mobile handling trailer to facilitate handling, processing, and release of entire sounders of pigs. We modified a Titan 4-horse trailer (Titan Trailer MFG. INC., Waterville, KS, USA) to facilitate sorting, immobilizing, marking, and holding an entire sounder. The primary modifications were

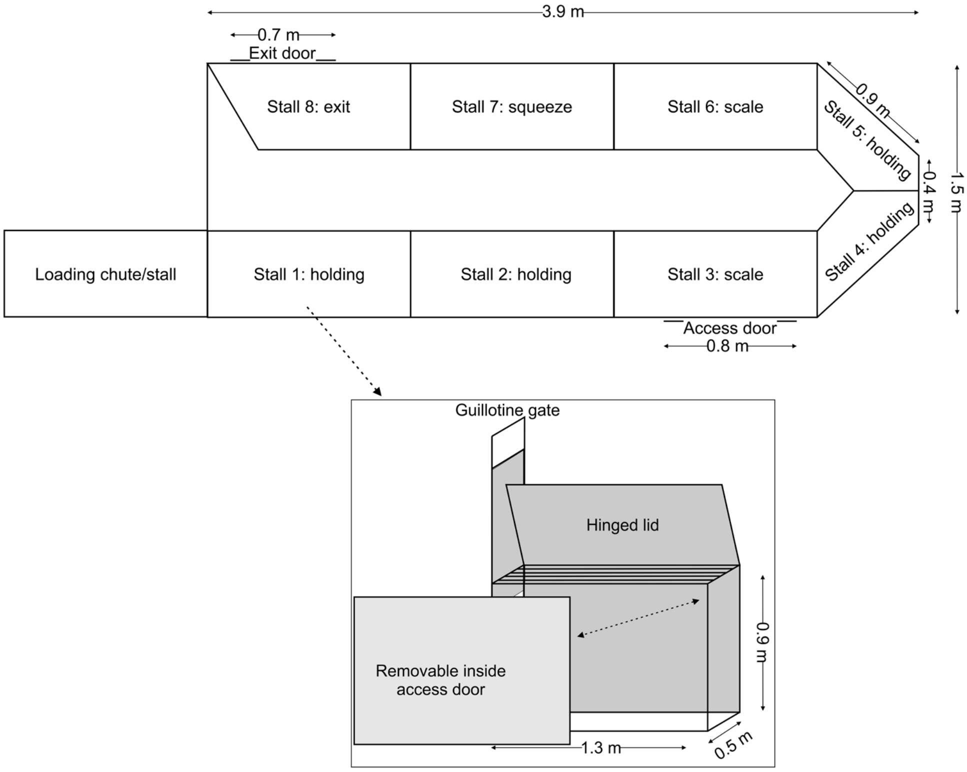

Figure 2. Layout of pig-handling trailer developed to facilitate outfitting wild pigs (*Sus scrofa*) with monitoring devices during capture efforts in San Antonio, TX, USA, in January 2017.

the installation of 8 linked, individual stalls with removable walls in a U-shaped configuration along the interior trailer walls for sorting pigs and incorporation of livestock scales (W110 Weigh Scale System, Gallagher™, Oswego, IL, USA) into the floor of 2 stalls (Fig. 2; stalls 3 and 6). We also designed and incorporated a squeeze mechanism into one stall (Fig. 3; stall 7). The squeeze incorporated a locking, adjustable restraint panel that pivoted below the floor and could be adjusted to accommodate any pig. We included removable vertical bars, sliding lower doors, and a door in the outer wall of the trailer to provide access to the entire pig when restrained in the squeeze. Each stall had independently operable LED lights to improve visibility and facilitate movement of pigs from one stall to the next (Grandin 1982). We installed a removable panel opening to the interior of the trailer on each stall to enable removing pigs from the stalls as needed. To improve holding conditions and promote airflow, the top of each stall was comprised of fixed metal bars covered by a hinged solid plastic lid, and we installed a reversible ventilation fan in the roof of the trailer. We also constructed removable loading chutes and doors at the back and side of the trailer to facilitate loading and unloading pigs.

Trap Modifications

We modified the standard corral trap design (i.e., round trap with one gate) to facilitate loading and unloading pigs from the trailer and to hold pigs until the entire sounder was processed and ready to be released (Fig 1). To accommodate pigs after handling in the trailer, we constructed two crescent-shaped holding pens external to the corral trap (also lined with shade cloth) connected to the exit door on the trailer (Fig. 1). Additionally, we constructed a trap divider of rigid utility panels lined with shade cloth that we lowered into the corral following capture to facilitate loading pigs into the trailer. We also used the divider to subdivide the interior of the corral trap into separate holding and handling areas for animals under varying stages of chemical immobilization.

Animal Handling

All pigs were moved from the trap into the trailer where they were sorted for handling. Handling included weighing, determining sex, collecting tissue for genetic analyses, and recording general physical body condition and characteristics. We immobilized pigs >40 kg with either a mixture of tiletamine-zolazepam (Telazol®, Zoetis, Parsippany-Troy Hills, NJ, USA) and xylazine (AnaSed®, Lloyd Inc, Shenandoah, Iowa, USA; Sweitzer et al. 1997*b*), a combination of medetomidine, midazolam, and butorphanol, or pre-mixed butorphanol, azaperone, and medetomidine (MMB and BAM™; Wildlife Pharmaceuticals Inc., Windsor, Colorado, USA; Ellis et al. 2019) via intramuscular injection using a pole syringe (jabstick; Complete Automatic Tranquilizing & Medication System, Dan-Inject ApS, Denmark). Immediately following injection, we either released the pigs into holding pens or allowed them to succumb to the immobilant within a stall. Once pigs were chemically immobilized, we relocated them to the empty corral, handled them as described above, and outfitted them with GPS collars (Vertex Plus-2, Vectronic Aerospace

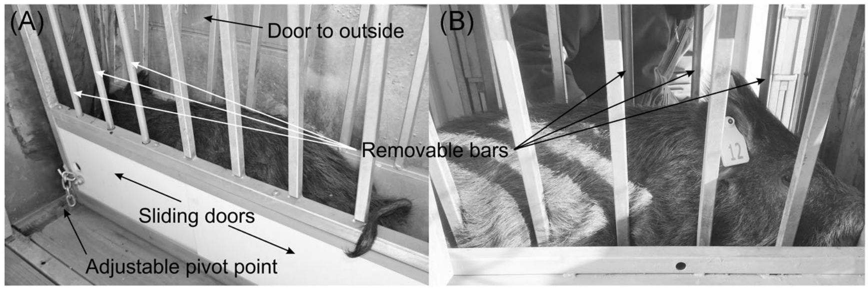

Figure 3. Close-up of manual squeeze mechanism installed in pig-handling trailer to facilitate outfitting wild pigs (*Sus scrofa*) with monitoring devices during capture efforts in San Antonio, TX, USA, in January 2017. A) View of adjustable squeeze panel from inside of trailer. B) View from outside of trailer looking in at squeeze mechanism through access door.

GmbH, Berlin, Germany) and ear tags. We physically restrained smaller pigs (≤40 kg) in the squeeze to attach Very High Frequency (VHF) ear tags (V2E 154A, Sirtrack, Havelock North, New Zealand) and/or uniquely identifiable ear tags (Allflex USA Inc., Dallas, TX, USA), then released them into one of the shrouded holding pens located external to the corral (Fig. 1). Once all smaller pigs were processed and the larger chemically immobilized pigs sufficiently recovered (alert, ambulatory), following intramuscular injection of recommended reversal agents by hand injection (Ellis et al. 2019) we moved the smaller pigs into the trap with the larger pigs and released the intact sounder simultaneously.

Data Collection and Presentation

During capture events we recorded whether pigs were physically restrained or chemically immobilized, whether pigs sustained injuries, and handling duration. Noted injuries included lacerations on the rostrum, nasal bone fractures, and avulsed lips caused by impacts with the corral trap panels prior to shrouding. Our handling time for chemically immobilized pigs was based on distinct points in time and included the period from initial injection of immobilization agents to the administration of the reversal agent.

RESULTS

With an average of 8 handlers (range = 6–9), we processed 18 groups ($\bar{x}$ = 12.3 pigs; range = 2–19) of pigs consisting of a total of 221 pigs in our handling system. The injury rate recorded using the corral trap and trailer combination for pigs was <4% (8/221), consisting primarily of minor nasal lacerations. Human injuries consisted of a single elbow strain for one handler. We chemically immobilized 51 large (41–101 kg) pigs and manually restrained 170 smaller (<45 kg) pigs. Average handling time for large pigs was 71.9 min (SD = 25.7; range = 30–126). Although we did not consistently collect data on the duration of handling smaller pigs without chemical immobilization (to sex animals, collect tissues for DNA analysis, and apply ear tags), we occasionally recorded events requiring <60 sec/pig. We handled 8 pigs ≥90 kg and 21 pigs ≥1.4 m in length, which did not exceed the capability of the trailer or pose a perceivable increase in risk to handlers. We successfully loaded all pigs into the trailer in all trapping events except for one situation in which 2 aggressive boars would not enter the chute. We confined the 2 aggressive boars within a small area of the corral trap using the shade-cloth-lined divider and chemically immobilized them using agents delivered with a pole syringe.

DISCUSSION

We developed equipment and modified strategies to minimize adverse impacts on captured wild pigs, resulting in an accumulated injury rate below 4%. This injury rate was lower than our previously compiled injury rate associated with corral traps (12%; Lavelle et al. 2019), and considerably lower than injury rates reported by others that sometimes approached 100% (Sweitzer et al. 1997*a*, Fenati et al. 2008). Injuries to pigs in corral traps are likely related to the number of individuals in the trap, the size of the trap area relative to fight-or-flight responses, and the type of wire panels used to construct the traps. Each factor may contribute to animal fatigue, stress, and trauma, and can generate lengthy periods for darting (Lavelle et al. 2019), which in turn affects the quality of chemical immobilization and increases the likelihood of deleterious post-immobilization responses (e.g., capture myopathy, hyperthermia; Sweitzer et al. 1997*a*, Fenati et al. 2008, Lavelle et al. 2019).

To facilitate loading pigs into the trailer we constructed a shrouded trap divider, though found it was unnecessary during 14 of the 18 handling events. We discovered that by simply standing outside the trap opposite of the trailer, our presence typically motivated pigs to enter the trailer, demonstrating that animals will remove themselves from a perceived threat (Moberg 2000). Once within the trailer, small pigs tended to lay down until stimulated to move from one stall to another, while larger pigs tended to stand quietly in the stalls. Simply opening a divider between stalls and turning the light on in a desired stall and off in the occupied stall was often effective in moving pigs between stalls.

The level of stimulation in the target animals, length of the induction time following immobilization drug administration, number of handlers per pig, handling, and reversal requirements for immobilization drugs all contribute to handling times. The duration of immobilization drug action was often the primary factor determining efficiency of handling. Large pigs required chemical immobilization to be outfitted with GPS collars regardless of handling strategy, whereas the trailer allowed us to physically restrain all remaining pigs in a safe, efficient manner in the squeeze mechanism without the use of chemical immobilization. Handling efficiency of small pigs was greatly improved relative to time and safety for both animals and humans. Additionally, we could rapidly process the small ones (<60 sec each) while waiting for the chemically-immobilized large pigs to recover.

Sounder dynamics are poorly understood and are challenging to study without identification and monitoring of all individuals (Maselli et al. 2014, Focardi et al. 2015, Beasley et al. 2018). Furthermore, disruption of sounder composition through removals or failure to maximize the number of individuals monitored has potential to result in misleading conclusions (Maselli et al. 2014, Focardi et al. 2015). Although recaptures occur (Sparklin et al. 2009), researchers have documented the reluctance or avoidance of trap sites by individual animals following their presence when a trap is triggered and their cohorts are captured (Gaskamp 2012), emphasizing the importance of capturing entire sounders when possible.

Inaccurate weight estimates contribute to miscalculation of chemical immobilization agents, which can result in erratic responses to chemical immobilization (Sweitzer et al. 1997*b*, Fenati et al. 2008, Kreeger and Arnemo 2012). To circumvent issues associated with under- or over-dosing an animal or delivering multiple doses of immobilization agent(s), scales in the handling trailer enabled us to acquire accurate weights of pigs for calculating exact dosages. When remote drug delivery systems are used (i.e., darting), efficacy of chemical immobilization can be further complicated by misplaced darts or missed shots causing waste of the drugs, injurious impacts, and unknown doses of immobilization agent delivered. By weighing and restraining larger pigs in the squeeze, we provided controlled delivery of immobilization drugs by direct injection via pole syringe.

MANAGEMENT IMPLICATIONS

Our integrated handling system worked well for our specific application, though several limitations should be considered. The main limitations include topography and environmental conditions, such as thick vegetation, mud, or rugged terrain, which limit where and when the trailer can be used and must be taken into account during initial trap placement and construction. Maneuvering the trailer in alignment with the trap can also be challenging and time consuming. However, the process was simplified by pushing the trailer with a front-mounted hitch rather than pushing from the rear of the tow vehicle, as precise adjustments and visibility are greatly improved. Cost may also be prohibitive, but a rudimentary version of our trailer developed from a single axle flatbed trailer would be sufficient, much easier to maneuver, and less expensive (final cost of our trailer ≈ USD $20,000). Labor to fabricate the trailer was our primary expense, thus a custom handling system need not be cost prohibitive, especially if a competent welder is available on staff. Although the handling trailer was the central component of our integrated handling system, individual features such as holding corrals, trap shrouds, scales for acquiring known pig weights, and a squeeze mechanism would be valuable additions to any handling system. Each of these items were an improvement to our previous handling process by turning an often chaotic event into a controlled and predictable procedure. Additionally, by recording details during every capture and handling event, we identified inefficiencies and ways to overcome them. Thus, we recommend recording and reviewing details routinely to improve the safety and efficiency of handling processes specific to individual requirements.

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