

INFLUENCE OF ATTRACTANTS, HABITAT ATTRIBUTES, BAITING METHODS, AND
SPACE USE ON SITE VISITATION BY WILD PIGS (*SUS SCROFA*)

by

SYDNEY M. BREWER

(Under the Direction of James C. Beasley)

ABSTRACT

Wild pigs (*Sus scrofa*) are managed in their native and invasive range to mitigate their negative environmental and anthropogenic effects. Management programs often utilize remote cameras, traps, shooting, and toxic bait, all of which are improved by attracting individuals to a location which can sometimes be difficult. There is a need for further research on wild pig attractant methods. In Chapter 2, I evaluated the efficiency of different attractant types and what habitat attributes influenced wild pig site visitation. In Chapter 3, I investigated what intrinsic (sex, space use) and extrinsic (bait placement, scent lure, presence of other pigs) factors influenced individual wild pig bait site visitation. This research suggests managers and researchers should focus on using food-based baits, selecting sites based on habitat attributes and wild pig space use, and consider social interactions. These results contribute to wild pig attractant and baiting literature and further advance the management of this globally distributed pest species.

INDEX WORDS: Invasive species, wild pig management, attractants, bait, wild pig space use, fine-scale habitat attributes

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by

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Wild pigs (*Sus scrofa*) are found on every continent except Antarctica and considered one of the most widely distributed mammals (Massei and Genov 2004). Native to Europe, Asia, and parts of North Africa, wild boar have been intentionally introduced outside of their native range as a game species (Massei and Genov 2004, Engeman et al. 2013). Similarly, since their domestication, pigs have been both intentionally and accidentally introduced throughout much of the world as a food resource, where they have escaped and established feral populations (Mayer and Brisbin 1991, Mayer and Beasley 2018). Throughout much of their invasive range, introduced wild boar and escaped feral pigs have hybridized, and thus are referred to as wild pigs when outside of their native range (Keiter et al. 2016). Once introduced wild pigs are able to successfully expand throughout their non-native ranges due to a lack of natural predators, high reproductive potential, and ecological generalist behaviors (Mayer and Brisbin 2009, Bevins et al. 2014, Mayer and Beasley 2018). Over the last few decades, the geographic distribution and abundance of wild pigs in their invasive range and wild boar in their native range have substantially increased, driven by changing human land use and climate (Brook and Van Beest 2014, Massei et al. 2015, Snow et al. 2017, Lewis et al. 2019) as well as illegal translocations in their introduced range (Hampton et al. 2004, Tabak et al. 2017, Hernández et al. 2018).

While wild boar can be destructive in their native range, wild pigs are considered a destructive invasive species in introduced locations. Where wild pigs have been introduced and

considered invasive, they outcompete native species, damage crops and habitat, pose a disease risk, and overall, negatively impact ecosystems (Barrios-Garcia and Ballari 2012, Keiter and Beasley 2017, Simberloff and Rejmanek 2019, Corn and Yabsley 2020, Strickland et al. 2020, Risch et al. 2021, McDonough et al. 2022). Wild pigs are opportunistic omnivores consuming mostly plant material but also invertebrates, amphibians, reptiles, fish, birds and mammals (Everitt and Alaniz 1980, Barrios-Garcia and Ballari 2012, Schlichting et al. 2020, Canright et al. 2023). Wild pigs overlap in diet with and are thought to compete with cervids, mesocarnivores, gallinaceous birds, rodents and native herbivores. This competition is thought to be most intense over hard mast which is a high value food source (Sweitzer and Vuren 2002, Schlichting et al. 2020). Wild pigs display nonfatal aggression and displace roe deer (*Capreolus capreolus*) and white-tailed deer (*Odocoileus virginianus*) (Taylor and Hellgren 1997, Ferretti et al. 2011). They also have been documented to compete with other mammals over carrion (DeVault and Rhodes 2002, Turner et al. 2017). Wild pigs have direct impacts on threatened and endangered species including loggerhead sea turtles (*Caretta caretta*) by predateding nests, prairie chickens (*Tympanuchus cupido*) by predateding nests and degrading habitat, and Houston toads (*Bufo houstonensis*) by damaging breeding habitat (Brown et al. 2012, Engeman et al. 2013, McDonough et al. 2022), amongst others.

Wild pigs are considered ecosystem engineers because they disproportionately affect species diversity, composition, and other ecological factors where they exist (Boughton and Boughton 2014, Keiter and Beasley 2017). In particular, wild pig rooting and wallowing behavior can cause physical changes to water quality, soil chemistry, and plants, negatively impacting native species and habitats (Keiter and Beasley 2017, Schlichting et al. 2020, Strickland et al. 2020). Wild pigs negatively impact water quality through increased erosion,

sedimentation, nutrient loading and spread of pathogens (Garcia et al. 2012, Strickland et al. 2020). Rooting by wild pigs disturbs the soil surface which can facilitate the propagation of invasive plant species as well as decrease richness and diversity of native plant species (Singer et al. 1984, Cushman et al. 2004, Siemann et al. 2009, Barrios-Garcia and Ballari 2012). Wild pigs also can facilitate movement of exotic plants by dispersing seeds through endozoochory (digestive system) or epizoochory (externally via hair) (Lynes and Campbell 2000, Barrios-Garcia and Ballari 2012, Dovrat et al. 2012). Wild pigs also have the potential to serve as seed predators as most seeds are damaged when they are consumed (Gómez 2003, Siemann et al. 2009, Sanguinetti and Kitzberger 2010). Wild pigs cause damage to forests where they inhibit germination of numerous species through consumption of mast and rooting (Ickes et al. 2003, Siemann et al. 2009). This not only impacts forest habitat, but also the timber industry. Wild pigs root up seedlings and browse on roots of recently planted trees which can cause regeneration failure (Campbell and Long 2009a, Bevins et al. 2014). Within Tennessee and Alabama alone, wild pigs are estimated to cause \$1.5 million in timber losses per year (Glow et al. 2020).

Wild pigs are particularly detrimental to the agricultural industry. Agricultural producers experience direct damage from wild pigs consuming and trampling crops as well as rooting in hay fields and pastures (Strickland et al. 2020). McKee et al. (2020) estimated that in 12 states in the U.S., producers of six different crop type lost as estimated US \$272 million in 2018 due to direct crop damage. There has been documentation of producers transitioning to less profitable crops to avoid wild pig damage (Mengak 2016, Carlisle et al. 2021). Similar to wild pigs, wild boar cause substantial damage to crops in their native range with an estimated 37-88% of their diet consisting of agricultural products (Herrero et al. 2006, Giménez-Anaya et al. 2008, Garcia et al. 2012). Livestock producers are also impacted as wild pigs can be direct predators of

livestock. In Australia, wild pigs predate lambs and it is estimated in semi-arid landscapes wild pigs may take 30% of lambs in a flock (Pavlov et al. 1981, Bengsen et al. 2014). It has been documented that as wild pig density increases, the number of ewes that lose lambs increases through predation (Choquenot et al. 1997). In addition to direct losses to crops and livestock, wild pigs cause other damage on farms with an estimated US\$750,000/year in farm loss in Tennessee due to damage to fences, stored grains, and farm equipment (Poudyal et al. 2017). Other economic impacts caused by wild pigs and wild boar include rooting and depredation of gardens, damage to irrigation systems, and vehicle collisions (Mapston 2004, Adams et al. 2005, Mayer & Brisbin 2009, Beasley et al. 2014).

Wild pigs also are reservoirs for numerous viruses, bacteria and parasites that can be spread to livestock and/or wildlife in areas of localized water or food resources as well as to humans during preparation of harvested pigs (Ruiz-Fons et al. 2008, Meng et al. 2009, Barrios-Garcia and Ballari 2012, Carrasco-Garcia et al. 2016, Keiter and Beasley 2017). African Swine Fever and Classical Swine Fever are of particular concern to domestic swine producers as they are highly contagious transboundary viral diseases that affect wild pigs, wild boar, other African suids and domestic pigs by impacting reproduction and potential fatality (Sanchez-Vizcaino 2006, Meng et al. 2009). Pseudorabies is also a concern for producers as it is found in wild pigs around the world and can cause high piglet mortality (Bevins et al. 2014). Diseases including brucellosis, trichinella spiralis, and hepatitis E are all zoonotic diseases that can be transmitted to humans usually through processing carcasses or consuming contaminated meat (Li et al. 2005, Gottstein et al. 2009, Ketheesan et al. 2010, Bengsen et al. 2014, Bevins et al. 2014), while Japanese encephalitis is transmitted to humans through mosquitos (Bradshaw et al. 2007, Park et al. 2022). Wild pigs also are a disease threat to native species as they can transmit diseases such

as tuberculosis, foot and mouth disease, and avian influenza to native species including numerous mammals and birds (Hermoso De Mendoza et al. 2006, Miller et al. 2017). Foot and mouth disease can affect wildlife, livestock and humans and is the most contagious animal disease known, and would cost an estimated USD\$ 11.9 million – 5.8 billion if there was an outbreak involving wild pigs (Mohamed et al. 2011, Miller et al. 2017). These diseases can be detrimental to human health, the economy, and biodiversity.

Threats of competition, predation, destruction to habitat, diseases and damages caused by wild pigs and wild boar are widespread across the world. To reduce or eliminate their negative impacts, *Sus scrofa* are managed extensively throughout their invasive and native ranges. Where they are invasive, typically, the goal is population reduction or eradication which is often completed by lethal control through trapping and ground or aerial shooting. Removal and management of wild pigs can be costly and time-consuming. Prior studies have suggested removal of wild pigs cost on average ~\$50 US per wild pig (Bodenchuk 2014, Fischer et al. 2020), although cost and effort increase markedly as populations are reduced (Lombardo and Faulkner 2000, Mccann and Garcelon 2008).

To manage wild pig populations, managers predominantly utilize trapping and aerial and ground shooting for lethal control, although in some portions of their invasive range toxic baiting is also used to control populations (Twigg et al. 2007, Lapidge et al. 2012, Ditchkoff and Bodenchuk 2020, Snow et al. 2024b). To utilize any of these methods or to improve their effectiveness, managers must attract wild pigs to sites and rely on attractants (i.e. bait [food item], scent lures [non-food items appealing to the olfactory sense], visuals, etc.) to do so. Managers use a wide variety of baits since wild pigs are opportunistic omnivores and their response to baits may vary seasonally, as it may be more difficult to attract wild pigs to a bait site

when other food is readily available (Campbell and Long 2008, Lavelle et al. 2017). Whole kernel corn is commonly used by trappers due to its attractiveness to wild pigs and its wide availability (Saunders et al. 1993, Mayer and Brisbin 2009, Lavelle et al. 2017, Ditchkoff and Bodenchuk 2020). However, other baits including acorns, peanuts, milo, peas, dog food, catfish bait, and fruit, among others are used to attract wild pigs (Saunders et al. 1993, Mayer & Brisbin 2009, West et al. 2009, Lavelle et al. 2017). Previous research has shown mixed results in wild pig preferences for various baits, with similar visitation rates between corn, milo, peanuts, soybeans (West et al. 2009, Lavelle et al. 2017). In captive studies wild pigs have shown preferences towards corn, earth worms, peanuts and acorns (Foster et al. 2023), although peanut paste has been found to have similar visitation rates to corn (Snow et al. 2016).

Trappers also have different methods of presenting bait to wild pigs. Bait can be presented on the ground, in spin feeders, buried in the ground, or in other types of feeders in varying amounts. The most common method is presenting bait on the ground, as less equipment is required, in a central pile where the trap will be located or through trails of bait to potentially increase bait detection (Lavelle et al. 2017). However, there is no previous literature directly comparing the effectiveness of the presentation of bait at attracting wild pigs. Bait can be expensive for managers as pigs consume large amounts and traps are often baited for multiple weeks for each capture event. Thus, there is a need for additional research to optimize bait type and presentation preferences to improve the efficiency and success of control efforts for wild pigs.

In addition to bait, scent lures are commonly used to attract wild pigs to a site due to their advanced olfactory systems (Paudel et al. 2015, Brunjes et al. 2016). This advanced olfactory system plays an important role in their social interactions, breeding, and foraging behaviors

(Mayer and Brisbin 1986, 2009). In particular, wild pigs are social animals and rely on scent to maintain social groups and to find and attract mates for reproduction (Gabor et al. 1999, Lavelle et al. 2017). During breeding, males seek estrous females using odor cues where these females are attractive to males for 4-5 days (McIlroy and Gifford 2005, Lavelle et al. 2017). Sow estrous scent has been shown to be effective at attracting wild pigs when population density is low, or when animals have become trap shy (McIlroy and Gifford 2005), but Choquenot et al. (1993) found that female estrous scent was not an effective lure for trapping individuals. Wild pigs also rely on their keen sense of smell to locate food (Ditchkoff and Mayer 2009) as much of their diet is acquired from underground food sources such as invertebrate larvae, small fossorial vertebrates, tubers, rhizomes, worms and bulbs (Schley and Roper 2003, Ditchkoff and Mayer 2009, Canright et al. 2023).

Despite scent being thought of as an important factor in attracting wild pigs, there have been mixed results in scent attraction performance across locations. Specific scent lures have varied in performance between studies; for example strawberry scent lure was found to attract wild pigs in Texas by Campbell and Long (2008), but an additional study found strawberry lure did not perform well in attracting wild pigs with pharmaceuticals (Campbell and Long 2009b). Other studies across the U.S. and Australia have found that apple and strawberry (Campbell and Long 2008), corn oil and fish oil (Kavanaugh and Linhart 2000), used cooking oil and orange marmalade (Evans 2023), and creosote, fish stock, meatmeal, molasses and vanilla (Elsworth et al. 2004) are effective at attracting wild pigs, demonstrating that a variety of scents can attract wild pigs. Not only are there mixed studies on how scent lures performed compared to each other, but also studies finding that scent lures perform no better than control sites with no scent. For example, a study in the Great Smokey Mountains (USA) found control sites with no scent

had higher visitation rates than treatment sites with a scent lure (Wathen et al. 1988). Similarly, Snow et al. (2022) found little evidence that any scent lures among the 28 that were evaluated performed better than control sites. Collectively, these differing results raise additional questions regarding optimal bait and lure combinations for attracting wild pigs.

The majority of studies evaluating scent lure visitation by wild pigs have not included bait within experimental trials. Given their enhanced olfactory abilities, an important limitation to these studies is that wild pigs were potentially attracted to the scent, but their response was not detected on remote cameras if they approached the station but stayed out of frame when they realized there was no reward (bait) (Snow et al. 2022). By combining bait and scent lures, wild pigs should be attracted to a site and interact with the bait by investigating or consuming it, enabling them to be captured on camera. Thus, there is a need for further research that integrates both bait and scent lures for optimizing wild pig visitation to bait sites.

Bait and scent lures are typically placed on the landscape in locations that have the highest likelihood of detection by wild pigs. Wild pigs can survive in a diversity of environments enabling them to exist worldwide, but their habitat selection varies by location and season (Kay et al. 2017, Gray et al. 2020). However, water has been documented as an important resource as wild pigs have few sweat glands and require water to thermoregulate (Conley et al. 1972, Mayer and Brisbin 2009). As a result, wild pigs are often located near water and vegetation types associated with water including swamps, marshes, bottomland hardwoods, and riparian areas (Gray et al. 2020, Clontz et al. 2021). Natural wallows are depressions in the mud usually filled with water that allows wild pigs to coat their skin with mud and water and are often located in marshes, edges of flooded areas, muddy depressions on trails, and irrigated fields (Bracke 2011). Wild pigs usually visit wallows at least two times a day during warm conditions (Campbell and

Long 2009b). Another driving factor of where wild pigs are located is food. Wild pigs are opportunistic omnivores (Canright et al. 2023, 2024) but consume large amounts of mast and have been found to select habitat in agricultural areas when crops are mature (Schley and Roper 2003). Wild pigs are regularly found using dense vegetation for shade and protection as bedding and nesting sites (Spitz and Janeau 1995, Fernández-Llario 2004). In South Carolina wild pigs have been regularly associated with bottomland hardwoods which provide dense cover as well as proximity to water and food resources (Beasley et al. 2014, John J. Mayer et al. 2020, Clontz et al. 2021). Although wild pigs are habitat generalists; some of these fine-scale habitat features may influence wild pig movement and their ability to locate bait. For example, the spatial distribution of rooting is influenced by tree density and the presence of hard mast producing species, which provide cover and food (Stoakley et al. 2025). Wild pig vehicle collisions have also been associated with habitat and are more likely to occur near a stream and where pine (*Pinus spp.*) density was lower (Beasley et al. 2014). Further, a previous study on scent lures found that the most significant factor for increasing pig visitation was site location, with sites closer to roads being used more during the winter in South Carolina and closer to water flowlines in the winter in Texas (Snow et al. 2022). These studies suggest that habitat attributes may have a strong influence on wild pig visitation to bait sites.

Wild pigs use large amounts of space, averaging 6.1 km² (sd = 7.8 km²; MCP [minimum convex polygon]) and 12.4 km² (sd = 21.0 km²; AKDE [autocorrelated kernel density estimator]) in the southern United States with average monthly home ranges of 3.4 km² (sd = 4.6 km²; MCP) (Kay et al. 2017). Thus, wild pigs may rarely encounter a bait site placed on the landscape, even within their home range. The home ranges of wild pigs vary by sex, age, location, season, pig density and human activity (Singer et al. 1981, Dardaillon 1987, Dexter 1998, Gaston et al. 2008,

Campbell and Long 2010, Hartley et al. 2015, Kay et al. 2017). Bait is placed within wild pig home ranges to attract them, but it is unknown why individuals visit some bait sites in their home range over others (McRae et al. 2020). Previous studies have demonstrated that wild pigs will reliably visit bait sites when within 1 – 1.25 km from a wild pig’s location and wild pigs will expand their home range when bait is on the edge of their home range (Snow and VerCauteren 2019). Similarly, wild pigs traveled 1.46 km from their current location to bait on average in South Carolina. Wild pig movement is typically described as wandering over short distances (average daily movement = 0.35 km), with individuals typically displaying high site fidelity (Oliveira-Santos et al. 2016, Kay et al. 2017, Gray et al. 2020). However, their activity patterns are influenced by sex, cover, food, human pressure, temperature (Stegeman 1938, Campbell and Long 2010, Podgórski et al. 2016, Kay et al. 2017). Wild pigs also have the ability to move long distances during natal dispersal and for breeding opportunities (Hampton et al. 2004, Lapidge et al. 2004). Such data inform trapping programs regarding the location and density of baits that should be placed on the landscape (McRae et al. 2020). However, these previous bait studies provided wild pigs access to multiple bait sites at once, which may have confounded inferences in determining visitation rates and thresholds to specific baited sites within an individual’s home range (Snow and VerCauteren 2019, McRae et al. 2020).

Wildlife make decisions where to move on the landscape, which can be related to interactions with each other. Wild pigs are highly social animals existing in groups consisting of 1-3 or more adult females and their offspring (sounders) or small groups of related subadult males (Titus et al. 2022). Adult males are usually solitary but will interact with sounders for breeding. Due to the high reproductive potential of wild pigs (Chinn et al. 2022), most wild pig management is focused on removing sounders to decrease the population (Ditchkoff and

Bodenchuk 2020, Lewis et al. 2022). There is no previous research determining the response of sounders to attractants compared to individual wild pigs. Not only is there the potential for groups or sexes to respond to attractants differently, but there also is the potential for competition between them at bait sites. Wild pigs are semi-territorial and have the potential to exclude other individuals or social groups from resources and locations (Gabor et al. 1999, Sparklin et al. 2009, Kilgo et al. 2021). Males have been documented to display territoriality over resources and mating opportunities (Graves 1984, Gray et al. 2020) and sounders exhibit avoidance of neighboring sounders likely over food sources (Gabor et al. 1999, Sparklin et al. 2009). Thus, there is a need to determine how different individuals, and social groups interact at bait sites to improve bait site efficiency.

Despite wild pig global distribution and their negative impacts to native and anthropogenic systems, there remains a paucity of data on reliably effective attractant methods. The overarching goal of this study is to better understand how to improve attractant efficiency of wild pigs for management purposes by investigating attractant types, presentation methods, habitat and location, individual space use, and social interactions. Specifically, my objectives are to (1) determine whether a scent lure, bait, or combination of the two is the most effective at attracting wild pigs by comparing the probability of wild pig visitation and the time to initial detection of a wild pig, (2) examine the influence of biologically relevant habitat attributes (i.e. proximity to water, proximity to roads, percentage of hard mast producing trees, understory density, etc.) on wild pig visitation rates to sites, (3) determine how placement of bait, scent lure presence, location within home range, distance between a wild pig and bait site, home range size, and interactions of individuals from different social groups influenced individual wild pig

detection rates. Results from this research should aid in more efficient attractant methods and adaptive management strategies for wild pigs.

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CHAPTER 2
INFLUENCE OF ATTRACTANT AND HABITAT ON BAIT SITE VISITATION BY
WILD PIGS (*SUS SCROFA*)

Brewer SB, Snow NP, Beasley JC. Submitted to Journal of Pest Management Science

Abstract

Wild pigs (*Sus scrofa*), known for their impacts on ecosystems in both their native and invasive ranges, are commonly managed using lethal trapping or shooting methods reliant upon bait or scent lures. Previous studies evaluating the efficacy of attractants at improving wild pig visitations have yielded mixed results, likely reflecting the generalist foraging strategies of wild pigs as well as their fine-scale variability in space use. We conducted experimental trials at 743 sites in South Carolina, USA to quantify differences in wild pig visitation among a suite of bait, scent lures, and bait + scent lure combinations to identify which maximized visitation. We monitored sites using a remote camera for 7 days and quantified visitation rates and time to visitation. In addition, to identify habitat attributes that maximized wild pig visitation, we characterized a suite of habitat attributes at each location. Wild pigs visited more sites and had shorter times to visitation at sites with bait present (bait: 42.85%, 61.35 hours; bait+scent: 47.99%, 60.98 hours) than sites with scent lures alone (24.40%, 82.03 hours), with similar results for groups of wild pigs and individuals, emphasizing the effectiveness of bait in increasing visitation. Our habitat modeling results suggest wild pigs are more likely to locate bait sites in areas closer to water sources and in thick understory. We recommend managers maximize visitation of wild pigs by using high-value baits, not relying on scent lures, and intentionally selecting sites based on habitat attributes where wild pigs have nearby access to water and cover.

Introduction

Over the last few decades, the geographic distribution and abundance of wild *Sus scrofa* (wild pigs in their invasive range and wild boar in their native range (Keiter et al. 2016)) have substantially increased, driven by changing human land use and climate (Brook and Van Beest 2014, Massei et al. 2015, Snow et al. 2017, Lewis et al. 2019) as well as illegal translocations in

their introduced range (Hernández et al. 2018, Clontz et al. 2022). Growing populations of wild *Sus scrofa* across their native and invasive ranges have led to increased destructive impacts to both native and anthropogenic habitats (Barrios-Garcia and Ballari 2012). In particular, where wild pigs have been introduced and considered invasive, they outcompete native species, damage crops and habitat, pose a disease risk, and overall, negatively impact the ecosystem (Barrios-Garcia and Ballari 2012, Keiter and Beasley 2017, Simberloff and Rejmanek 2019, Corn and Yabsley 2020, Strickland et al. 2020, Risch et al. 2021, McDonough et al. 2022).

To reduce or eliminate their negative impacts, *Sus scrofa* are managed extensively throughout their invasive and native ranges. Where they are invasive, typically, the goal is population reduction or eradication which is often completed by lethal control through trapping and ground or aerial shooting (Ditchkoff and Bodenchuk 2020). Additionally, orally-delivered toxic baits have been (Shapiro et al. 2016, Poché et al. 2019) and continue to be developed for reducing populations of wild pigs (Snow et al. 2021, 2024a). To utilize these lethal control methods, managers must attract wild pigs to sites and rely on attractants to do so including bait (food reward item) and scent lures (non-food scent). Wild pigs are opportunistic omnivores that consume crops, grasses, legumes, hard mast, fungi, invertebrates, amphibians, reptiles, mammals, and birds, amongst other items (Canright et al. 2023, Mysterud et al. 2024), and thus their diet and response to baits can vary spatially and temporally depending on local availability (Campbell and Long 2008, Lavelle et al. 2017, Canright et al. 2024). Whole kernel corn is commonly used by trappers as a bait due to its attractiveness to wild pigs and its wide availability (Saunders et al. 1993, Mayer and Brisbin 2009, Lavelle et al. 2017, Ditchkoff and Bodenchuk 2020). However, given their wide dietary breadth a variety of baits have been utilized to attract wild pigs, although previous research has shown mixed results in how different

baits perform in attracting wild pigs (West et al. 2009, Snow et al. 2016, Lavelle et al. 2017, Foster et al. 2023).

In addition to bait, scent lures are commonly used to attract wild pigs to a site due to their advanced olfactory system. The olfactory bulb makes up 7% of a pig's brain size (Brunjes et al. 2016), compared to 0.01% in humans (Kavoi and Jameela 2011). This advanced olfactory system plays an important role in their social interactions, breeding, and foraging behaviors (Gabor et al. 1999, Lavelle et al. 2017). In particular, wild pigs rely on their keen sense of smell to locate food (Ditchkoff and Mayer 2009) as much of their diet is acquired from underground food sources such as invertebrate larvae, small fossorial vertebrates, tubers, rhizomes, corms and bulbs (Schley and Roper 2003, Ditchkoff and Mayer 2009, Canright et al. 2023). In addition to food-based lures, sow estrous scent has been shown to be effective at attracting wild pigs when population density is low, or when animals have become trap shy (McIlroy and Gifford 2005), although Choquenot et al. (1993) found that female estrous scent was not an effective lure for trapping wild pigs.

Despite scent being thought of as an important factor in attracting wild pigs, there have been mixed results in the performance of scent lures among studies (Kavanaugh and Linhart 2000, Elsworth et al. 2004, Campbell and Long 2008, 2009b, Evans 2023). For example, a study in the Great Smokey Mountains (USA) found control sites with no scent had higher visitation rates than sites with a scent lure (Wathen et al. 1988). Similarly, Snow et al. (2022) found little evidence that any scent lure among the 28 that were evaluated in the categories of food, pheromone and curiosity performed better than control sites, and several scents had lower visitation than control sites. However, the majority of studies evaluating visitation to scent lures by wild pigs have not included bait within experimental trials. Given their enhanced olfactory

abilities, an important limitation to these studies is that wild pigs were potentially attracted to the scent, but their response was not detected on remote cameras if they approached the station but stayed out of frame when they realized there was no reward (bait) (Snow et al. 2022). Thus, there is a need for further research that integrates both bait and scent lures for optimizing wild pig visitation to bait sites. Further, wild pigs are highly social (Titus et al. 2022) and management programs often focus on removal of entire social groups (Lewis et al. 2022, Kilgo et al. 2023), yet the response of groups of wild pigs (sounders) to attractants compared to individual wild pigs not been considered in previous studies.

Habitat also likely influences wild pig visitation of bait/scent locations (Snow et al. 2022). Although wild pigs are habitat generalists, at a coarse scale wild pigs are typically associated with wetlands, streams, hardwoods, and other similar habitats (Gray et al. 2020), the availability of which can influence home range size and shape (Clontz et al. 2022). In particular, wild pigs have limited thermoregulatory capabilities and thus often select for areas proximal to water and associated vegetation types. (McIlroy 1989, Thurfjell et al. 2009, Cooper and Sieckenius 2016). Within habitats where wild pigs are likely to occur, there are fine-scale habitat features that may influence wild pig movements and ability to locate bait. For example, the spatial distribution of rooting, wild pig vehicle collisions, and wild pig locations has been documented to be influenced by tree density, canopy cover, the presence of hard mast producing species, pine density, distance to swamp and creek habitat, and slope (Mitchell et al. 2007, Beasley et al. 2014, Panebianco et al. 2019, Stoakley et al 2025). These studies suggest that both coarse and fine scale habitat attributes may have a strong influence on wild pig visitation to bait sites.

Our goal was to compare wild pig visitation to bait, scent lure, and bait + scent to determine optimal attractants for detecting individuals and groups of wild pigs, as well as the influence of habitat attributes on visitation rates and time to visitation. Our objectives were to 1) compare visitation rates of individuals and groups of wild pigs to sites across various baits and/or scent lures reported in previous literature as effective at attracting wild pigs, 2) compare time to initial visitation for sites that wild pigs visited to determine what treatment attracted individuals and groups of wild pigs in the shortest time, and 3) quantify the influence of habitat attributes on visitation rates of wild pigs at bait sites. Results from this research should help maximize the efficacy of wild pig control efforts by improving site visitation, decreasing the time to site visitation, and ultimately decreasing the cost of control programs.

Methods

Study Site

We conducted this study in South Carolina, U.S. on the Savannah River Site (SRS), a 800 km² site managed by the United States Department of Energy (DOE). Most of the SRS was undeveloped lands or forested habitat (96%) that was managed for timber production and wildlife conservation by the United States Forest Service. At the time of our study the SRS consisted of approximately 50% upland pine including loblolly pine (*Pinus taeda*), longleaf pine (*Pinus palustris*), and slash pine (*Pinus elliottii*), 25% bottomland hardwood including sweetgum (*Liquidambar styraciflua*), swamp gum (*Eucalyptus ovata*), red maple (*Acer rubrum*), water oak (*Quercus nigra*), bald cypress (*Taxodium distichum*) and tupelo gum (*Nyssa sylvatica*), 10% herbaceous/shrub areas, 8% upland hardwoods including white oak (*Quercus alba*), black oak (*Quercus velutina*), mockernut hickory (*Carya tomentosa*), and southern red oak (*Quercus falcata*), and the rest was mixed forests and developed land. Over 20% of the SRS consisted of

wetlands and freshwater systems including the Savannah River. Wild pigs have been present on the SRS since the early 1950s (John J. Mayer et al. 2020), and are abundant and widely distributed across the site (Keiter et al. 2017).

Attractants

To quantify the effects of attractant type and habitat attributes on wild pig visitation to sites, we conducted experimental trials from January – April 2023 with various bait and scent lure combinations across the SRS and monitored wild pig visitation using remote cameras. We selected top performing bait from previous literature, also considering accessibility and cost of food bait. Whole kernel corn is the most common bait used for trapping wild pigs because of its availability and attractiveness (Lavelle et al. 2017), although peanut paste has been found to have similar visitation rate to corn (Snow et al. 2016). Therefore, we used whole kernel corn and whole dried peanuts as the two types of bait in the experimental treatments. In addition to bait, we selected three of the top performing scent lures from a previous study [Strawberry Flavor Oil (Olive Nation, Charlestown, MA, USA), Tuff Tusk Wild Hog Attractant (Razorback Outfitters LLC, McDade, TX, USA), and Tink’s Specialty Power Pig Sow-in-Heat Estrous (Tink’s®, Arcus Hunting LLC, Covington, GA, USA)] (Snow et al. 2022) representing disparate categories of lures (e.g., food, curiosity, and pheromone) for this study (Table 2.1). We also selected a fourth scent lure, worm tea, based on the finding of greater consumption of earth worms compared to corn by (Foster et al. 2023). We included a control scent (i.e. sterile water) for comparative purposes. We made plaster scent tabs infused with each of our scent lures following the methods of (Webster and Beasley 2019). We placed each tab in a Ziplock bag with the scent lure for a minimum of 24 hours prior to deployment in the field. We made worm tea by mixing Earthen Organics Worm Castings (Earthen Organics, Easley, SC, USA) with water in an 18.93 liter

bucket in a ratio of 946 ml of worm castings to 11.36 liters of water. We allowed worm tea to brew for a minimum of 48 hours then we poured 1.42 liters over 9.46 liters of either corn or peanuts to soak for a minimum of 12 hours before being deployed.

Field Trials

We used ArcGIS Pro 3.1.1 to create random points in wetland and riparian habitats across the SRS for experimental trials including flood plain oak forests, flood plain sweetgum forests, mixed bottomland hardwoods, mixed composition flood plain hardwoods, bald cypress and water tupelo, bottomland hardwoods and cypress, marsh, and wetland scrub forests habitats. We focused on these landscapes because wild pigs utilize wetlands and riparian habitats extensively for shelter and proximity to water (Gray et al. 2020, John J. Mayer et al. 2020, Clontz et al. 2021). Points were a minimum of 225 meters apart to avoid site habituation and within 150 meters of a road to facilitate accessibility (Supplementary Figure 1). We conducted 12 rounds of testing, which consisted of 80-120 sites for each round. During each round, we selected points that were a minimum of 1000 m apart to reduce the likelihood that individuals visited more than one site during a given round. Each site was monitored using a remote camera for seven days, after which we moved and reset cameras at new locations until all trials were complete. Points received a random treatment among the 15 possible treatments (Table 2.1). Treatments consisted of a bait, scent lure, combination of bait and scent, or no bait or scent (i.e. controls). Each of the 15 treatments (Table 2.1) had 50 replicates assigned randomly to the points established, resulting in trials at a total of 750 sites.

We deployed a remote camera (Hyperfire and Hyperfire 2 Professional Infrared; Reconyx®, Holmen, WI, USA) to monitor wild pig visitations at each site. We mounted cameras on trees approximately one meter off the ground. We set cameras to take three pictures per

motion activated trigger with a one second delay between pictures and a three-minute quiet period. We placed a bait pile (corn, peanuts, or control) 2.7 - 3.7 meters in front of the camera. We placed a scent tab (sow in heat, strawberry, tuff tusk, or control) in plastic chicken wire caging and hung it with wire on the nearest tree branch at least 1.8 meters above the bait pile to prevent wildlife tampering.

We processed images using the Colorado Parks and Wildlife Photo Database (Ivan and Newkirk 2016). For images with wild pigs, we delineated images into unique visits, with images that were >15 minutes from a previous image of a wild pig at that station recorded as a unique visit. We utilized a 15-minute period because the average length of a feeding bout is 14.2 minutes (Snow et al. 2016). For each of these visitations, we recorded whether an individual pig was visiting or a group of wild pigs (>1). We also recorded the age (adult or juvenile) and sex of each pig when possible, with juveniles and unidentifiable adults classified as unknown sex.

Attractant Performance Analysis

After removing seven sites where camera batteries failed prematurely, we quantified each of the 743 sites as having wild pigs visited or not. We used the 297 sites that had wild pig visitation and compared those locations to the 446 sites that did not have wild pig visitation using a used-unused framework (Manly et al. 2002). We fit general linear models in R 4.2.3 using the glm function in the stats package (R Core Team 2024). We ran three models with the response variable as whether a wild pig visited a site (yes/no), an individual pig visited a site (yes/no), or a group of wild pigs visited a site (yes/no) which each used a binomial distribution. We first used the specific bait and lure combination (i.e. corn + strawberry, peanut + worm, control + sow in heat, etc.) as the fixed effect in each model. Finding no significant differences among the specific

combinations, we pooled these combinations into treatment types (bait, scent, bait+scent, control; Table 2.1) and used treatment type as the fixed effect for each model. From the 297 sites that wild pigs visited, we calculated the time to initial visitation in hours as the difference in time from when the bait station was deployed and the time the first wild pig was captured on the remote camera. We fit a general linear model in R 4.2.3 using the glm function in the stats package (R Core Team 2024). The response variable was the time to visitation of a wild pig (hours) and we used an exponential distribution for the model. We did not develop separate models for groups and individual wild pigs due to small sample sizes. We first used the specific bait and lure combination as the fixed effect in the model. Finding no significant differences among the specific combinations, we combined these combinations into treatment types (bait, scent, bait+scent, control; Table 2.1) and used treatment type as the fixed effect for the model.

Effects of Habitat Attributes on Wild Pig Visitation to Bait Sites

We selected a random subset of the 743 sites used for our attractant analysis to quantify the influence of habitat on wild pig visitation to bait sites. The selected sites consisted of 50 control and 25 each of our other treatments that included bait (bait and bait+scent; 300 sites). We excluded scent only sites due to low visitation rates (24.40%; see results). At each of these sites we quantified the following biologically relevant fine-scale habitat attributes identified in the literature as potentially important in influencing wild pig visitation: overstory composition, understory composition, and percent of hard mast producing species. Within a 15-meter diameter of the site, we measured diameter at breast height (DBH) and identified every tree with a DBH greater than 10.16 cm. We also estimated the percentage of hard mast producing trees in this area. We visually categorized the understory within this 15m diameter as primarily consisting of palmettos, cane grass, seedlings (woody stems), or bare/litter.

In addition to fine-scale habitat attributes collected in the field, we also quantified additional site-specific habitat attributes using GIS layers in ArcGIS Pro 3.1.1 (Environmental Systems Research Institute, Redlands, CA). We characterized the location of streams and roads on SRS from existing geospatial layers. We classified primary roads as paved roads that are regularly traveled and secondary roads as unpaved roads that were gravel or logging roads with little vehicle travel. We determined specific forest types from the 2021 National Landcover Database (NCLD) raster layer (30 x 30 m resolution) (Dewitz 2023) and used the reclassification tool in ArcGIS Pro 3.1.1 to condense landcover into the following categories: open landscape, evergreens, and upland hardwoods. We excluded bottomland hardwoods as a landcover type because the majority of our points were located in this landcover type. We used the Euclidean Distance tool in ArcGIS Pro 3.1.1 to calculate distance to each of these habitat covariates from our bait trial locations. We used the NLCD 2021 USFS tree canopy raster (30 x 30 m resolution) to estimate the percent canopy cover at each location (USDA Forest Service 2023). We used lidar data provided by SRS Forest Service from 2018 to calculate normalized relative point density 0.15 – 2 meters off the ground to represent understory density (Campbell et al. 2018).

Habitat Analysis

We modeled wild pig visitation to bait sites following a used-unused design in which sites that had wild pig visitation were considered “used” and sites that did not have wild pig visitation were “unused”. We modeled the influence of distance to water, distance to landscape types, distance to roads primary roads, distance to secondary roads, canopy cover, hard mast producing trees, understory density, understory type, overstory type on the presence of wild pigs at a site. We fit a generalized linear model (glm) including all spatial explanatory variables as fixed effects in R 4.2.3 using the glm function in the stats package (R Core Team 2024). Habitat

variables and treatment type (Table 2.1) were all included as fixed effects in our global model (Table 2.2). We used Pearson's correlation test to determine that there was no correlation between our continuous predictor variables (i.e. Pearson's $|r| < 0.5$) and all were included in the model (Hosmer et al. 2013). From our global model we used a backwards direction stepwise regression framework to identify the most important habitat attributes from which to conduct further model selection. Backwards stepwise regression uses an iterative process that removes variables from the model if doing so improves the model's Akaike Information Criterion (AIC), until a subset of the most influential variables are retained. We then used the "dredge" function in the "MuMIn" package in R 4.2.3 on our top model produced from the stepwise regression analysis (Table 2.2) to compare all possible combinations of the remaining fixed effects (Barton 2009). We ranked models using AIC to determine what spatial variables best explained wild pigs' presence at a site (Burnham et al. 2002). We used the "MuMIn" package in R 4.2.3 to model average our top models ($< 2 \Delta AIC$) and calculate model averaged parameter estimates and 95% confidence intervals (CIs). To quantify the importance of each predictor variable, we then used the "sw" function in the "MuMIn" package in R 4.2.3 to sum the Akaike weights of our top models to get importance values from 0-1.

Results

Attractant Performance

Of the 750 original trials, 743 had usable data resulting in $> 240,000$ trail camera images with $> 33,000$ photos of wild pigs. Wild pigs visited 297 sites (39.97% including controls, 38.41% excluding controls), groups of wild pigs visited 165 sites (22.21% including controls, 22.69% excluding controls), and individual wild pigs (1218 unique visits, 701 male visits, 165

female visits, 352 unknown visits) visited 278 sites (37.42% including controls, 37.16% excluding controls) (Figure 2.1, Supplementary Table A.1).

We found evidence that wild pigs had greater visitation rates at sites with bait (42.85%; CI: 33.03-53.25; $p=0.006$) and bait+scent (47.99%, CI: 43-53.02; $p<0.001$) than sites with scent alone (24.40%; CI: 18.86-30.91) (Figure 2.1, Supplementary Table A.2, Supplementary Figure A.6). Groups of wild pigs had greater visitation rates at sites with bait (26.53%; CI: 18.11-36.41; $p<0.001$) and bait+scent (30.90%; CI: 26.29-35.69; $p<0.001$) than sites with scent alone (5.26%; CI: 2.66-9.22) (Figure 2.1, Supplementary Table A.2, Supplementary Figure A.7). Groups of wild pigs also had greater visitation rates at sites with bait+scent (30.90%; CI: 26.29-35.69) than control sites (10.20%; CI: 3.39-22.23; $p=0.022$). Individual wild pigs had greater visitation rates at sites with bait (41.84%; CI: 31.95-52.23; $p<0.001$) and bait+scent (42.71%; CI: 37.79-47.74; $p<0.001$) than sites with scent alone (24.40%; CI: 18.74-30.80) (Figure 2.1, Supplementary Table A.2, Supplementary Figure A.8). None of the other relationships were significant ($p<0.05$; Figure 2.1).

We found quicker times to visitation for bait+scent sites (60.98 hours; CI: 54.45-67.52; $p=0.051$) than sites with scent alone (82.03 hours; CI: 67.07-96.99), but surprisingly control sites (44.92 hours) also had quicker time to visitation than sites with scent alone (44.92 hours; CI: 25.33-64.51; $p=0.019$; Figure 2.2; Supplementary Table A.2; Supplementary Figure A.9). Groups of wild pigs had quicker time to visitation at control sites (22.04 hours; CI: -10.10-54.17) than bait+scent (66.64 hours; CI: 58.67-74.61; $p=0.003$), bait alone (64.44 hours; CI: 45.45-83.43; $p=0.008$), and scent alone (83.25 hours; CI: 38.95-127.56; $p=0.002$; Figure 2.2, Supplementary Table A.2). There was no difference in time to initial visitation between treatment types for individual pigs (Figure 2.2, Supplementary Table A.2).

Effects of Habitat Attributes on Wild Pig Visitation to Bait Sites

Of the 284 sites where we measured fine-scale habitat attributes in the field, 139 sites had wild pig visitation. Our backwards stepwise regression analysis on our global model resulted in a top model retaining the variables distance to water, distance to an open landscape, distance to evergreen habitat, understory density, primary understory type, and treatment. Model selection from this global model resulted in eight top models. (Supplementary Table A.3). All supported models included distance to water, primary understory species, and treatment, indicating that these three variables had the greatest influence on the probability of wild pigs locating a bait site (relative importance = 1 for all three variables; Table 2.2). Understory density (relative importance = 0.63), distance to open landscape (relative importance = 0.55), and distance to evergreen habitat (relative importance = 0.52) were in four of the top models (Table 2.2).

Model averaged parameter estimates from the top performing models indicated that wild pig visitation to bait sites was positively influenced by proximity to water sources, when bait + scent was present, and when the site was not in an understory of seedlings (Figure 2.3). Visitation also was positively influenced by sites closer to open landscapes, further from evergreen habitat, in areas of increased understory density, in an understory of palmettos, at locations with bait, and not in understories of seedlings or cane grass, although coefficients for these variables overlapped with 0 (Figure 2.3). The odds of detecting a wild pig at a bait site decreased by 11.21% for every 100-meter increase in distance to a water source (Supplementary Table A.4, Figure 2.4). Within sites with the understory species dominated by seedlings, the odds of detecting a wild pig at a site decreased by 59.1% (Supplementary Table A.4). The odds of detecting a wild pig at a site were 149.4% higher when bait+scent was present than control sites with no bait or scent present (Supplementary Table A.4).

Discussion

Collectively, our results demonstrate that use of bait and placing traps or cameras in habitats near water and in dense understory vegetation can maximize visitation of wild pigs and minimize their time to detection. Despite their widespread appeal and use in wild pig trapping, we found using scent alone was insufficient for attracting both individuals and groups of wild pigs to a site. The addition of scent to bait sites did appear to enhance the detectability of wild pig social groups compared to our control sites, although our results combined with those of Snow et al. (2022) and Wathen et al. (1988) suggest wild pigs may display an aversion to sites with certain novel scent lures, so managers should use caution when considering their application in management activities.

Scent lures have proven effective at attracting numerous wildlife species and thus are commonly used for trapping and monitoring (e.g., scent stations) (Andelt and Woolley 1996, Linhart et al. 1997, Ferreras et al. 2018, Holinda et al. 2020). However, despite their advanced olfactory system our results add to a growing body of literature suggesting that scent alone is ineffective for attracting wild pigs to traps or camera monitoring stations (Wathen et al. 1988, Elsworth et al. 2004, Snow et al. 2022, Evans 2023). We also found that wild pigs visited over one third of control sites consisting of no bait or scent. The high visitation of wild pigs to our control sites likely reflects the placement of camera stations in our study near preferred habitats (riparian areas) of wild pigs. Interestingly, control sites had shorter times to visitation than sites with scent lures. Similarly Snow et al. (2022) documented only two scents out of 28 performing better than control sites. Collectively, these results suggest wild pigs may display an aversion to sites with certain novel scent lures. Bait/scent aversion has been documented for numerous species, including wild pigs due to trapping pressure, nonlethal doses of toxicants/poisons, or

novel items that may be perceived as “risky” (Pawlina and Proulx 1999, Allsop et al. 2017, Prakash 2018, Beasley et al. 2021, Taggart et al. 2023). We recommend further research on novel scent lure aversion of wild pigs with GPS collars to determine how they may avoid these novel items.

A food reward is important for attracting wildlife and our results demonstrate that use of bait is critical to increase the probability of visitation and reduce times to initial visitation for wild pigs. Previous studies have demonstrated the use of bait is more efficient for attracting numerous species of wildlife than scent stations or non-baited wildlife captures for monitoring and research (Ferreira-Rodríguez and Pombal 2019, Heinlein et al. 2020). For wild pigs, in our study the two evaluated baits (corn and peanuts) had similar visitation rates and time to initial visitation, suggesting a variety of food-based baits may be effective for detecting wild pigs depending on local availability and wild pig preferences. Indeed, managers utilize a wide variety of baits across the world with success at attracting wild pigs and wild boar, with previous studies finding that wild pigs have similar visitation rates to various baits (Saunders et al. 1993, West et al. 2009, Snow et al. 2016, Lavelle et al. 2017, Foster et al. 2023). One constraint to our study is that wild pigs are trapped on the SRS with bait and have the potential to exhibit bait aversion; therefore, in areas where wild pigs have not been exposed to bait from trapping there is the potential for higher visitation rates than were observed in our study. Although groups of wild pigs had shorter times to visitation at sites with bait and scent than control sites, in general we did not observe a difference between bait only sites and those where scent was added to the bait site. Further research with GPS collars could inform if wild pigs are attracted from further distances if a scent attractant is combined with bait.

Our results also demonstrate that habitat attributes play an important role in wild pig visitation rates, with distance to a water source and understory type having the greatest influence among the habitat attributes evaluated in our study. Wild pigs can survive in a diversity of environments enabling them to exist worldwide, but their habitat selection varies by location and season (Kay et al. 2017, Gray et al. 2020). Wild pigs are dependent on water for foraging, wallowing, and thermoregulation, so much so that the absence of available surface water has been suggested as the only habitat attribute that effectively excludes wild pigs from an area (Dickson et al. 2003, Mayer and Brisbin 2009). Indeed, home range placement and shape, vehicle collisions, and rooting damage have all been shown to be related to water sources (Bratton et al. 1982, Beasley et al. 2014, Bengsen et al. 2014, Cooper and Sieckenius 2016, Clontz et al. 2021, Stoakley et al. 2025). This is due to the fact that wild pigs have few sweat glands and require water to thermoregulate (Conley et al. 1972). As a result, wild pigs are often located near water and vegetation types associated with water including swamps, marshes, bottomland hardwoods, and riparian areas (Gray et al. 2020, Clontz et al. 2021). Given the importance of water to wild pigs, it is unsurprising they are more likely to locate bait sites in close proximity to water sources.

Wild pigs were also more likely to locate bait sites in areas with specific understories. Understory habitat and understory density can be a driving factor in habitat selection for many species as this is the portion of their habitat that often provides food, shelter, and breeding sites (Lone et al. 2014, Tomita and Hiura 2021, Thorne and Ford 2022). For wild pigs specifically, dense areas can provide important shade for this species that is a poor thermoregulator and cover for bedding and nesting sites (Stegeman 1938, Conley et al. 1972, Spitz and Janeau 1995, Fernández-Llario 2004). In our study area, we found wild pigs less likely to locate sites with

seedlings as the primary understory type, representing a less dense understory type compared to cane grass and palmettos. In particular, among dense understory types in our study area, wild pigs tended to locate more sites in areas with saw palmettos (*Serenoa repens*). Saw palmetto is a native clumping, shrubby palm that typically grows 1.5-3.0 meters tall and spreads 1.2-3.0 meters wide and is considered a dense understory type (Anderson and Oakes 2012). Wild pigs have been documented consuming the apical meristem material by pulling new leaves out with their mouth and consuming the base (Tanner and Mullahey 2009, Canright et al. 2024). Wild pigs have also been documented constructing nests or bedding sites by cutting and piling palmettos to protect their young (West et al. 2009) (Supplementary Figure A.10). On the SRS, wild pigs may have located bait sites with palmettos as the primary understory more frequently because palmettos may provide cover and are usually located in floodplains near water sources at our study site. However, we had a relatively low sample size of sites with an understory dominated by palmettos, and thus future research investigating micro-habitat preferences of wild pigs would be useful to better elucidate the importance of palmettos for wild pigs.

Wild pigs are highly social animals, with groups typically consisting of 1-3 or more adult females and their offspring (i.e. sounders) or small groups of related subadult males (Titus et al. 2022), whereas adult males are typically solitary and only temporarily assimilate within sounders for breeding. Given their polygynous mating strategy and high reproductive capacity (Chinn et al. 2022), most wild pig management goal is focused on removing sounders to reduce population sizes (Ditchkoff and Bodenchuk 2020). Further, wild pigs are semi-territorial (Graves 1984, Gabor et al. 1999, Sparklin et al. 2009, Gray et al. 2020, Kilgo et al. 2021) and thus targeting groups and conducting whole sounder removal has been proven an effective method to reduce wild pig populations (Lewis et al. 2022, Kilgo et al. 2023). Sounders visited less control and

scent only sites than sites with bait signifying that bait is important for targeting these groups. Individual wild pigs were primarily males, and those individuals visited more control sites than sounders. Males tend to have larger home ranges and move more than females (Kay et al. 2017, Clontz et al. 2022); therefore, they may be encountering more control sites by chance while moving throughout the landscape.

We recommend managers focus on using baits, or foodstuffs that are locally available food resources to maximize wild pig visitation to traps or camera locations. Managers should avoid using only scent lures for attracting wild pigs unless they are used to enhance a bait, but when using scent should be careful because novel scents can act as deterrents. We also recommend managers optimize locations for bait sites by focusing on the shelter and water requirements of wild pigs within a given landscape. Given that both use of bait and certain habitat attributes (i.e. proximity to water and understory) were similarly important in influencing whether wild pigs visited a site, both these factors should be considered when establishing management programs. Finally, our data suggest that if wild pigs do not visit bait sites within a reasonable time frame (e.g., 1-2 weeks), shifting the bait site to a new location or use of alternative baits will likely be more effective in detecting wild pigs than deployment of novel scent attractants. Collectively, these recommendations should lead to increased efficiency and efficacy of wild pig management programs.

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CHAPTER 2 TABLES AND FIGURES

Table 2.1: Fifteen treatments performed January – April 2023 to quantify differences in wild pig visitation rates and time to visitation at scent, bait, and bait + scent trials. We utilized lures corn and peanuts as bait as well as scents [Strawberry Flavor Oil (Olive Nation, Charlestown, MA, USA), Tuff Tusk Wild Hog Attractant (Razorback Outfitters LLC, McDade, TX, USA), and Tink’s Specialty Power Pig Sow-in-Heat Estrous (Tink's®, Arcus Hunting LLC, Covington, GA, USA)] that represented disparate categories of attractants (food, curiosity, and pheromone) and a control (i.e. sterile water).

Treatment	Bait	Lure	Treatment Type
1	Control	Control	Control
2	Corn	Control	Bait
3	Peanut	Control	Bait
4	Corn	Sow in Heat	Bait + Scent
5	Corn	Strawberry	Bait + Scent
6	Corn	Tuff Tusk	Bait + Scent
7	Corn	Worm	Bait + Scent
8	Peanut	Sow in Heat	Bait + Scent
9	Peanut	Strawberry	Bait + Scent
10	Peanut	Tuff Tusk	Bait + Scent
11	Peanut	Worm	Bait + Scent
12	Control	Sow in Heat	Scent

13	Control	Strawberry	Scent
14	Control	Tuff Tusk	Scent
15	Control	Worm	Scent

Table 2.2: Importance values and the number of models in which the variable occurred for all variables retained in the 8 supported generalized linear mixed models evaluating the influence of habitat attributes on wild pig visitation to bait sites in South Carolina, USA. Distance to water is the standardized variable of distance to a water source in meters. Primary Understory is the type of dominant understory which was categorized as seedlings, bare/litter, palmettos, or cane grass. Treatment is determined by what was placed at the camera site to attract wild pigs which was bait only, scent only, bait+scent, or control. Understory density is the understory density at the location. Distance to Open Landscape is the standardized variable of distance to an open landscape in meters. Distance to Evergreen Habitat is the standardized variable of distance to evergreen habitat in meters.

Model Variable	Distance to Water	Primary_ Understory	Treatment	Understory Density	Distance to Open Landscapes	Distance to Evergreen Habitat
Importance Values	1.0	1.0	1.0	0.63	0.55	0.52
# of containing	8	8	8	4	4	4

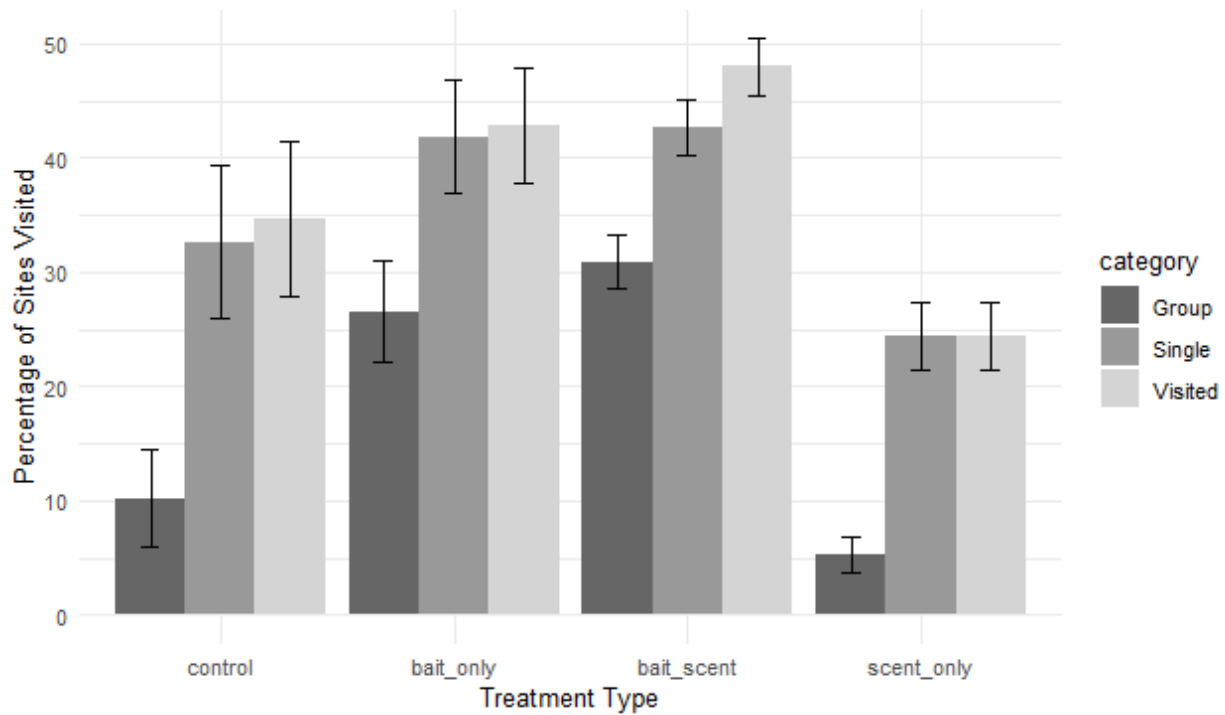


Figure 2.1: Percentage of sites with visitation for all wild pigs, groups of wild pigs (*Sus scrofa*), and individual pigs by treatment type. We used corn and peanuts for bait and strawberry, sow in heat, tuff tusk sour mash, and worm tea as scent lures. Control sites consisted of no bait or scent, bait only consisted of a bait, scent only consisted of a scent lure only, and bait+scent consisted of a bait and scent at the site. The visited bar represents any pig, single represents that an individual pig visited the site, and group represents that more than one pig visited the site at a time. This was conducted at the Savannah River Site, Aiken, SC, USA from January – April 2023.

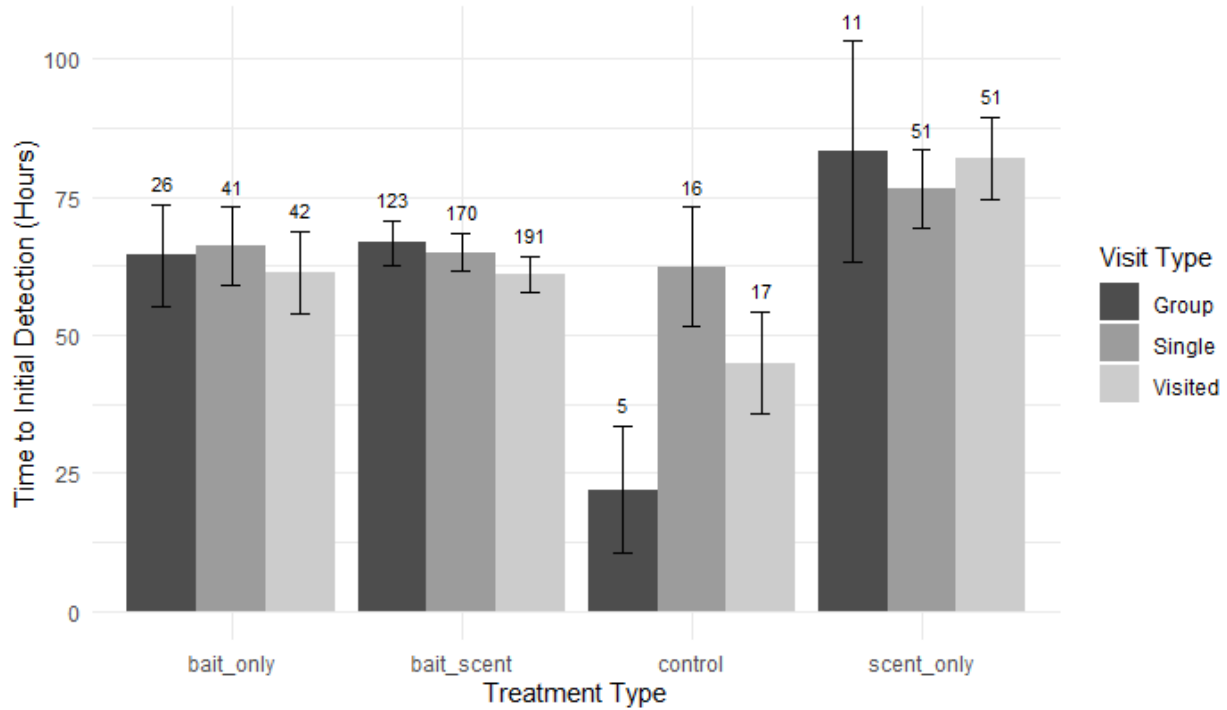


Figure 2.2: Average time to initial visitation in hours of a wild pig (*Sus scrofa*) at a site for all pigs, single pigs and groups of pigs for each of the treatment types for sites that had wild pig visitation with sample size below each bar representing the number of sites visited. We used corn and peanuts for bait and strawberry, sow in heat, tuff tusk sour mash, and worm tea as scent lures. Control sites consisted of no bait or scent, bait only consisted of a bait, scent only consisted of a scent lure only, and bait+scent consisted of a bait and scent at the site. The visited bar represents any pig, single represents that an individual pig visited the site, and group represents that more than one pig visited the site at a time. This was conducted at the Savannah River Site, Aiken, SC, USA from January – April 2023.

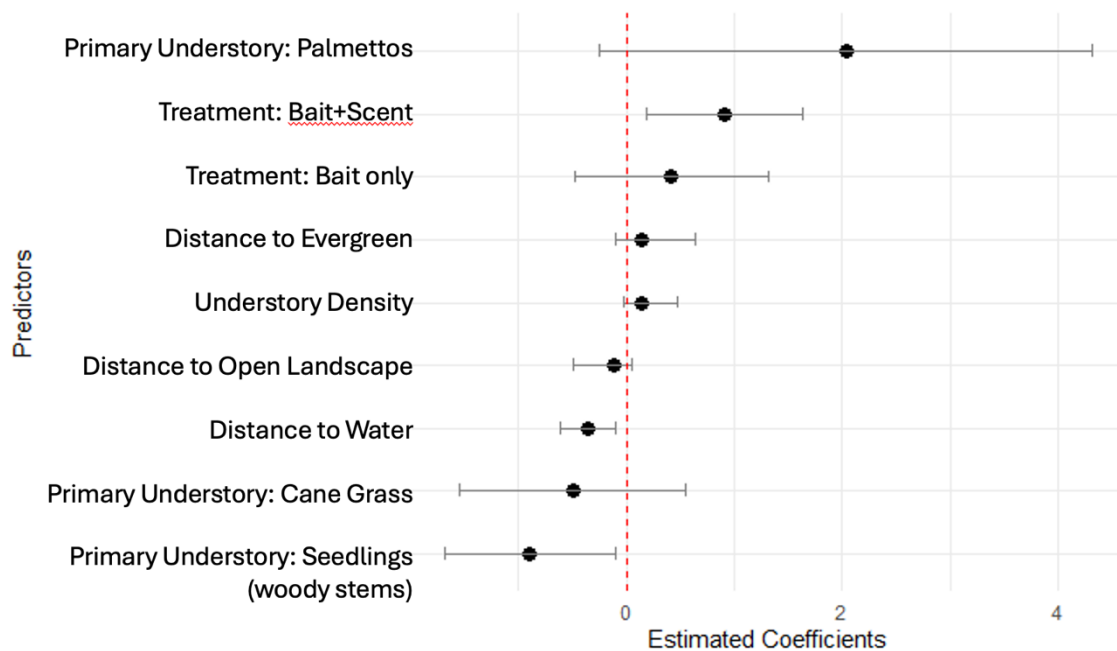


Figure 2.3: Estimated coefficients with 95% confidence intervals after model averaging top performing models for each of the habitat predictors for wild pig site visitation on the Savannah River Site, Aiken, SC, US in January – April 2023. The dashed line corresponds to 0 and if the confidence interval overlaps, the habitat predictor does not have a significant effect. Distance variables (distance to evergreen habitat, open landscapes, and water sources) that are < 0 indicate the sites had a higher probably of being detected closer to these features. All other habitat predictors (Primary Understory: Palmettos, Treatment: Bait+Scent, Treatment: Bait only, Understory Density, Primary Understory: Cane grass, and Primary Understory: Seedlings(woody stems)) that are > 0 indicate the sites had a higher probably of being detected with these predictors.

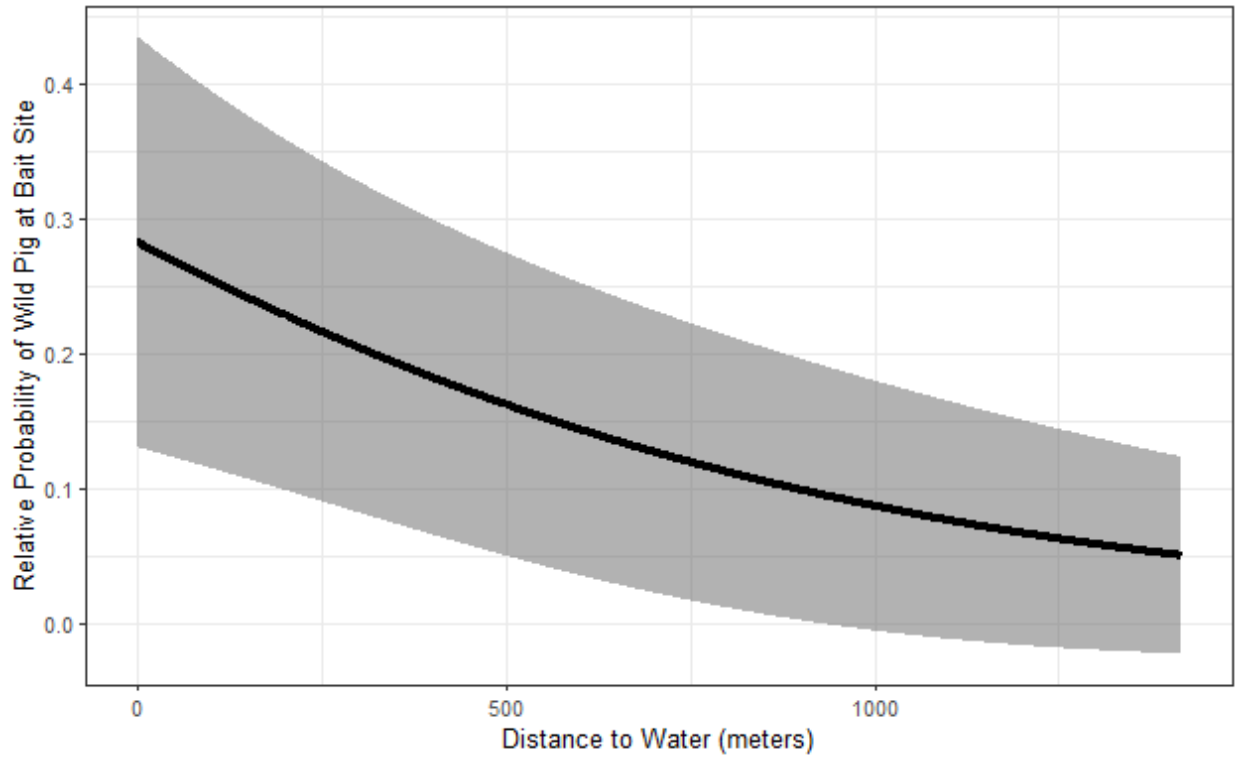


Figure 2.4: Predicted relative probability of wild pigs (*Sus scrofa*) being detected at a bait site in relation to distance to water sources in meters on the Savannah River Site near Aiken, SC, US from January – April 2023. The solid line represents the mean predicted probability and the shaded region represents the 95% confidence interval. This is based on our top performing model and holds all other predictors constant (distance to evergreen, distance to open landscape, understory density, and primary understory).

CHAPTER 3

PROXIMITY TO BAIT AND SOCIAL INTERACTIONS INFLUENCE INDIVIDUAL WILD PIG (*SUS SCROFA*) VISITATION AT BAIT SITES

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Abstract

Human-wildlife interactions and conflicts with pest species (native and invasive) are a growing problem worldwide, leading to a need for improved management tools and approaches for many species. Wild pigs (*Sus scrofa*) are a pest species that are extensively managed in both their native and invasive range, with the goal of population reduction or eradication to mitigate damages to native and anthropogenic ecosystems. Management programs for wild pigs often use remote cameras, traps, shooting, and toxic bait, often requiring attracting animals to a location with bait. We conducted 325 experimental bait site replicates on 52 collared individual wild pigs in South Carolina, USA to test the hypothesis that wild pig visitation to bait sites was influenced by a myriad of intrinsic (sex, space use) and extrinsic (bait placement methods, addition of scent lure, presence of other wild pigs) factors. Target wild pigs visited more sites and had shorter times to detection when the bait site was placed within areas of more concentrated use (52.1%; 100 hours), compared to the periphery of their home ranges (21.5%; 133.4 hours). Further, a target animal was more likely to find a bait site and had reduced times to detection when they were nearer to bait at deployment. However, females were less likely to visit a site and had longer times to detection when an adult male visited the site (26.2%; 75.5 hours) compared to when an adult male did not (54.5%; 194.4 hours), suggesting potential exclusion or avoidance behaviors at bait. The addition of scent or presentation method of bait did not influence visitation rates, suggesting that the location of the bait on the landscape has a greater influence on visitation by wild pigs than how it is presented, as long as a food attractant is provided. Collectively, these results add to the growing body of evidence that the location of bait on the landscape relative to the distribution of pigs is critical to optimizing detection, and that scent

alone is ineffective for attracting wild pigs. Further, managers should consider that the presence of adult males may reduce the likelihood of female or sounder visitation at sites.

Introduction

As humans continue to transform natural habitats for anthropogenic land use and move species around the world (Sakai et al. 2001, Foley et al. 2005), human-wildlife interactions and conflicts with nuisance and pest species are a growing problem worldwide. Many nuisance species are non-native, which have been either intentionally or unintentionally introduced by humans and often able to rapidly expand their range due to a lack of native predators and/or competitors, empty ecological niches, generalist diets, and high reproductive rates (Mooney and Hobbs 2000, Sakai et al. 2001). Once introduced, invasive species can negatively impact native ecosystems and wildlife in a myriad of ways, such as direct and indirect competition for resources (Bertolino et al. 2014, Abernethy et al. 2016), predation leading to shifts in community composition (Wiles et al. 2003, Chynoweth et al. 2013, Gizicki et al. 2018), and dissemination of disease (Hulme 2014, VaeBen and Hollert 2015). Invasive species also reduce biological diversity (Forseth and Innis 2004, Albins and Hixon 2008, Early et al. 2016), resulting in cascading effects on ecosystem structure and function as well as the economy (Miehls et al. 2009, Pejchar and Mooney 2009, Marbuah et al. 2014, Peller and Altermatt 2024). Invasive species are a primary threat to >40% of the native species listed as endangered or threatened in the United States alone (Pimental 2011) and are one of the greatest threats to biodiversity globally (Ducatez and Shine 2017, Dueñas et al. 2021).

Due to these negative impacts, invasive species are often managed to reduce or eradicate populations and mitigate damages (Centner and Shuman 2015, Beasley 2024). Despite these efforts, many invasive species continue to increase in number and distribution (Strayer 2009,

Engeman et al. 2018, Liebhold et al. 2021, Kouba et al. 2022). Native species also can be pest species, and as habitat loss, urbanization and climate change result in more frequent contact with humans, there has been a growing number of human-wildlife conflicts with native wildlife (Ayres and Lombardero 2000, Côté et al. 2004, Soulsbury and White 2015, Descovich et al. 2016). Therefore, there is a growing need for more efficient and effective management tools for controlling both native and non-native wildlife pests.

Wild pigs [*Sus scrofa*; invasive range; (Keiter et al. 2016)] and wild boar (native range) are among the most widely distributed and destructive vertebrate species in the world (Simberloff and Rejmanek 2019). As a result, *Sus scrofa* are extensively managed throughout their native and invasive ranges to mitigate their environmental, ecological, and economic impacts to native and anthropogenic systems (Barrios-Garcia and Ballari 2012, Keiter and Beasley 2017, Strickland et al. 2020, Risch et al. 2021). Despite widespread control efforts, the distribution and population size of both wild boar and wild pigs has increased markedly in recent decades, due to a combination of shifting land use, climate change, and intentional releases for sport hunting (Massei et al. 2015, Keiter and Beasley 2017, Snow et al. 2017, Vetter et al. 2020). To address the expanding distribution and impacts of wild boar and wild pigs, there is growing interest to improve control methods and management approaches (Beasley et al. 2018).

Managers rely on a variety of methods for detection and removal of wild pigs including remote cameras, trapping, shooting, and toxic baiting (Howald et al. 2007, Freeman et al. 2010, Berry et al. 2012, Doherty et al. 2017, Ditchkoff and Bodenchuk 2020). These methods all rely on or are improved by attractants that entice and maintain visitation to a location for a management action to take place. In particular, baiting is a powerful tool in wildlife management whereby a food source is used to attract species to a specific location for population surveys,

trapping purposes, or to consume a poison or oral vaccine (Weihong et al. 1999, Campbell and Long 2008, Berry et al. 2012, Du Preez et al. 2014, Lavelle et al. 2017, Rocke et al. 2017, Taggart et al. 2023). Indeed, baiting has been used to achieve almost all invasive rodent eradications and plays an important role in the management or conservation of feral cats (*Felis catus*; Howald et al. 2007, Campbell et al. 2011, Taggart et al. 2023), brown tree snakes (*Boiga irregularis*; (Clark et al. 2012, Engeman et al. 2018, Goetz et al. 2021), Tasmanian devils (*Sarcophilus harrisii*; (Dempsey et al. 2022), raccoons (*Procyon lotor*, (Kavanaugh and Linhart 2000, Blackwell et al. 2004, Smyser et al. 2013), wild pigs/wild boar (Snow et al. 2016, Lavelle et al. 2017, Foster et al. 2023) and numerous other species. However, not all bait sites are found by target species, which can reflect differences among species, bait type, animal movement behavior, sex, weather, location, and previous experiences with bait (Saunders et al. 1993, Blackwell et al. 2004, Algar et al. 2007, Beasley et al. 2015, Pitt et al. 2015, Lavelle et al. 2017, McRae et al. 2020). Presentation of bait also can influence the detection of sites (Linhart et al. 1997, Thomson and Kok 2002, King et al. 2007, Murphy et al. 2014), and many bait presentation strategies are used for wild pigs (e.g., bait placed in a pile or trail on the ground, buried, spin feeders, hog pipe—tethered and capped PVC pipe with holes, coupled with scent attractants), although the optimal method is unknown when considering cost, time, and amount of bait used (West et al. 2009, Lavelle et al. 2017). Bait can be expensive for managers; therefore, there is a need to identify optimal bait presentation strategies that improve efficiency.

Managers also have to consider the space use of a species to understand the density of bait sites needed and location bait sites should be placed on the landscape. Baits are often distributed homogenously across the landscape or in transects to maximize baiting efficiency; however, stratified baiting strategies that account for the movement behavior of target species

can increase the efficacy of baiting programs (Moseby et al. 2009, Beasley et al. 2015, Taggart et al. 2023). Wild pigs will often visit bait sites within 1 – 1.25 km from the center of their home range, and periodically up to 3 km away (Davis et al. 2017, Lavelle et al. 2018, Snow and VerCauteren 2019, Snow et al. 2019, McRae et al. 2020). However, in these previous bait studies wild pigs likely had access to more than one bait site at a given time based on home ranges of wild pigs in those areas, which may have confounded inferences in determining visitation rates within an individual's home range. Further, not all bait sites are found by wild pigs and it is unknown why wild pigs visit some bait sites in their home range but not others (Snow and VerCauteren 2019, McRae et al. 2020).

Both inter- and intra-specific competition also can influence rates of detection, movements, and behavior of individuals at bait sites (Smyser et al. 2010, Lashley et al. 2014, Harkins et al. 2019), which can be influenced by a myriad of biotic and abiotic factors. For example, social status and territoriality can influence camera visitation and trapping (Burt 1943, Windberg and Knowlton 1990, Séquin et al. 2003), as dominant animals or groups may exclude others from accessing sites. Wild pigs are highly social, with social groups (i.e., sounders) typically consisting of adult females and their offspring and solitary adult boars typically interacting to breed (Titus et al. 2022). However, both solitary males and female social groups are semi-territorial, with males displaying territoriality over resources and mating opportunities (Graves 1984, Gray et al. 2020) and sounders exhibiting spatio-temporal avoidance of neighboring social groups, likely over food resources (Gabor et al. 1999, Sparklin et al. 2009). Thus, there is the potential that wild pigs may display territoriality over bait sites and limit the visitation of a targeted individual or other social groups, although social dynamics are one of the least understood aspects of wild pig ecology (Beasley et al. 2018).

Our goal was to test the hypothesis that wild pig visitation to bait sites is influenced by a combination of both intrinsic (sex, space use) and extrinsic (bait placement methods, addition of scent lure, presence of other wild pigs) factors using wild pigs fitted with GPS collars and experimental placement of bait sites. We predicted that broadcasting bait in trails (e.g., lines of bait) compared to a single pile, and the addition of scent would result in greater visitation rates and shorter times to detection of wild pigs. We also predicted that bait sites placed closer to the core area of an animal's range would result in greater visitation rates and shorter times to detection than sites near the periphery of their range. Similarly, we predicted wild pigs nearer to the bait site at the time of deployment and those with smaller home range sizes would have greater visitation rates and shorter times to detection. Lastly, we predicted that the presence of wild pigs from outside an animal's social group would influence their use of a bait site. Specifically, we predicted that the presence of other pigs would decrease visitation rates and increase time to detection of targeted collared pigs. Further, given their semi-territorial nature (Gabor et al. 1999, Sparklin et al. 2009, Kilgo et al. 2021), we predicted that the effect of the presence of other wild pigs at bait sites would be stronger towards the periphery of an animal's home range. Results from this research should aid in the development and refinement of adaptive management strategies for controlling invasive wild pigs and other nuisance wildlife.

Methods

Study Site

We conducted this study between 2023 and 2024 on the Savannah River Site (SRS), a 800 km² property managed by the United States Department of Energy (DOE) located in western South Carolina, U.S. Around 96% of the SRS was undeveloped lands that was managed for timber production and wildlife management with the remaining land used for industrial activity

(Kilgo and Blake 2005). At the time of our study the SRS consisted of approximately 50% upland pine, 25% bottomland hardwood, 10% herbaceous/shrub areas, 8% upland, and the rest was mixed forests and developed land. Over 20% of the SRS consisted of wetlands and freshwater systems including the Savannah River. Wild pigs have been present on the SRS since the early 1950s (John J. Mayer et al. 2020). Since 1956, this population has been managed lethally to reduce damage, although wild pigs remain abundant (~ 2.5 adults/km²) and widely distributed across the site (Keiter et al. 2017, Mayer et al. 2020).

Wild Pig Captures

All capture and handling of animals was conducted under compliance with the University of Georgia Institutional Animal Care and Use Committee under permit (A2021 04-013-Y3-A11). We targeted trapping efforts in areas where wild pig activity was present with each site at least 2-km apart to reduce the likelihood of collared animals overlapping in space use. We captured wild pigs on the SRS from May 2023 – July 2023 and January 2024 – July 2024 using Pig Brigs (Pig Brig Trap System, Moodus, CT, USA) baited with whole peanuts which were monitored with remote cameras (Hyperfire and Hyperfire 2 Professional Infrared; Reconyx®) to identify adults to receive collars. We used a dart projector (X-Caliber, Pneu-Dart Inc., Pennsylvania, USA) to chemically immobilize captured individuals using a combination of Telazol (4.4 mg kg⁻¹; MWI Veterinary Supply, Idaho, USA) and Xylazine hydrochloride (2.2 mg kg⁻¹; Wildlife Pharmaceuticals Inc., Colorado, USA). While pigs were chemically immobilized, we measured body length, chest girth, and identified age through molar eruption (Matschke 1967). We collared one adult (≥ 3 years old) or subadult (1.5-3 years old) male or female from each trap with an iridium GPS collar (VECTRONIC GPS PLUS Globalstar-3; VECTRONIC Aerospace, Coralville, Iowa), aiming to collar one adult from a social group. Collars were programmed to

record GPS locations every 30 minutes and were equipped with mortality sensors that were activated after 24 hours of no movement.

Collared Wild Pig Bait Replicates

We excluded the first 24 hours of data after a collar was deployed to reduce bias in home range estimates from trapping effects and excluded any point with a dilution of precision value (DOP) over 5.0 to remove points with low precision. After one month of deployment, we calculated three metrics of space use (99%, 70% and 40% isopleths) based on utilization distributions (UD) derived using the kernel density estimator with the reference bandwidth (href) smoothing parameter in the *adehabitat* package in R (R Core Team 2023) (Calenge 2006) (Figure 3.3). We selected these three isopleths to represent different concentrations of each individual's space use within their home range: the 40% isopleth represented the core area, where that individual spends the majority of its time (likely important foraging and resting areas); the 70% isopleth represented areas of the home range that the animal uses more sporadically than the core area; and the 99% isopleth, which represented the periphery of the home range where the individual spends proportionally less time. For the purpose of this study, we considered each of these areas as distinct (i.e. the 99% UD excluded areas contained within the 70% and 40% isopleths; similarly, the 70% UD excluded the area encompassed by the 40% UD). These UD's were calculated prior to a bait site being deployed with 1 month of GPS fixes to generate a new set of UD's to capture the most up to date space use of that individual and to include potential movement influences by the previous baited replicate for the next home range calculation.

We conducted a series of bait site replicates for each collared pig with each replicate consisting of bait placed within one of the three isopleth categories (99%, 70%, 40%), bait placed in either a single pile or trails leading to a bait pile, and bait placed with or without a scent

attractant [Tink's Specialty Power Pig Sow-in-Heat Estrous (Tink's®, Arcus Hunting LLC, Covington, GA, USA)]. We selected sow in heat as our scent lure due to its performance at attracting pigs in previous literature and our interest in comparing its attractiveness by sex because males and females may respond differently to pheromone-based scents (Choquenot et al. 1993, McIlroy and Gifford 2005, Snow et al. 2022). This resulted 12 different treatments which were randomly selected for each replicate (Supplementary Table B.1). A collared pig targeted for each replicate only had access to one site at any given time (based on the known home ranges of the target pig and any wild pigs with adjacent territories) to ensure there were no competing effects between bait sites. We captured wild pigs with peanuts and we used corn for bait sites to reduce the possibility that pigs may avoid bait sites after being captured and fitted with collars. Sites for each replicate location were randomly generated in one of the randomly selected isopleths (99%, 70%, 40%) using ArcGIS Pro 3.1.1 (Esri 2023).

To determine visitation to bait sites by collared wild pigs, we mounted a remote camera (Hyperfire and Hyperfire 2 Professional White Flash; Reconyx®) and a remote cell camera (Spartan GoCam 4G/LTE; Spartan Camera) on a tree approximately one meter off the ground and ~3 meters from the bait site at each bait location. We set remote cameras to take three pictures per motion activated trigger with a one second delay between pictures and a three-minute quiet period. We used cell cameras to determine when our targeted collared pig found the site and when bait was fully consumed by a collared pig or non-target animal. We set cell cameras to take one picture per motion activated trigger with a ten-minute quiet period. We used a 22.68 kg bag of corn as the bait and presented it in a trail or pile. For a pile treatment, we placed the whole bag in a pile 2.7 - 3.7 meters in front of the remote cameras. For a trail treatment, we placed 11.34 kg in a pile 2.7 – 3.7 meters in front of the remote cameras and

equally distributed the remaining 11.34 kg in trails 25 meters long that ran in each of the four cardinal directions (north, south, east, and west). For scent treatments, we soaked a plaster tab (Webster and Beasley 2019) in sow in heat scent lure for at least 24 hours then placed it in plastic chicken wire caging and hung it with wire on the nearest tree to the bait pile at least 1.8 meters above the ground. For sites that were trails with scent, we drug a sponge that had been soaked in sow in heat along the trail of corn to disperse the scent on the trail and placed a scent tab hanging in a tree above the bait pile.

Each replicate was deployed for 14 days and was refreshed with bait if uncollared wild pigs or other species depleted the bait before the targeted collared pig visited the site. If a collared pig did not locate a site by day 14, we removed the replicate and deployed another replicate with another randomly assigned treatment and location for that target collared pig. For replicates detected by collared animals, once the bait was fully consumed, we started a 7-day period where that collared animal had no access to bait. After the 7-day period, we deployed another replicate with a randomly assigned treatment for that collared pig. We deployed collars May 2023 – July 2024 and replicates were conducted on wild pigs June 2023 – November 2024.

Photo Processing

We processed images in the Colorado Parks and Wildlife Photo Database (Ivan and Newkirk 2016) and identified each species in every image. For each visitation of wild pigs, we recorded the age (juvenile or adult) and sex of the individual pigs. We also determined if an uncollared wild pig visited the site before the targeted collared pig and categorized the age and sex of those uncollared pigs. We categorized these visitation events as sounder for social groups of wild pigs and categorized individuals as either males or females. We further identified animals in a collared pig's social group and categorized other wild pigs as not in the social group.

Data Preparation

We excluded any replicates if camera batteries failed prematurely, collars malfunctioned at the time of replicate deployment or had missed fixes, and collars with failed GPS. We classified each of the sites as having the targeted collared wild pig visited or not. We used our GPS collar data to calculate the distance (m) between the site location and the location of the collared pig at the time the site was deployed to the closest 30-minute fix from the collar. We also assigned a trial number for each replicate for each animal to account for the potential that wild pigs displayed learned behavior as they received more replicates. We delineated replicates into seasons based on food availability at our study site. We categorized April - September as the green (growing) season when there is abundant rainfall and vegetation is a green growing state; during this time wild pigs have food sources such as growing agricultural crops, sprouting grasses and herbs, fungi, etc. (Canright et al. 2023). We categorized October - January as the hard mast season when hard mast such as acorns, beechnuts, chestnuts, etc. are present on the ground and serve as a main food source for wild pigs (Wood and Roark 1980, Canright et al. 2023). We categorized February - March as the winter season when food sources are more limited to below ground foodstuffs due to hard mast being consumed and green vegetation not being available yet (Wood and Roark 1980). Although previous literature has found that habitat plays an important role in whether wild pigs locate a bait site (Snow et al. 2022, Chapter 1), we excluded habitat from our analysis because all sites were within or on average 171.94 meters or less away from optimal wild pig habitat (bottomland hardwoods, riparian areas, wetlands, swamps, marshes) and water sources within our study area because these locations were in wild pig home ranges (Clontz et al. 2021).

Statistical Analysis—Visitation Rates

We modeled collared wild pig visitation to sites following a used-unused design (Manly et al. 2002). We modeled the influence of isopleth (40%, 70%, 99%), bait presentation (trail or pile), scent lure (present or absent), sex of collared pig, distance between the collared pig and the site, and monthly home range size (99% UD) for the individual pig on the probability of visitation at bait sites by collared pigs. We included pig ID, trial number, and season as random effects in the model to account for random variation potentially caused by these factors. We standardized our continuous predictors and used a Pearson's correlation test to check for correlation between predictor variables (i.e. Pearson's $|r| < 0.5$). We excluded home range size from the overall model due to its correlation with sex and distance between the collared pig and site location (Hosmer et al. 2013) and ran separate univariate analysis on this variable for each sex since this was one of our primary research questions (see below). We fit a generalized linear mixed-effects model (glmm) including all other explanatory variables as fixed effects in a global model in Program R (v4.2.3) using the “glmer” function in the “lme4” package (Bates et al. 2015, R Core Team 2024). Our response variable was whether the targeted collared pig visited the site (yes/no) which followed a binomial distribution. We tested all possible combinations of models using the “dredge” function in the “MuMin” package in R 4.2.3 (Barton 2009, R Core Team 2024). We ranked models based on AIC to determine what fixed effects best explained the visitation of a collared individual wild pig at a site using a threshold of $\Delta 2$ for identifying supported models (Burnham et al. 2002). We model averaged the supported models to determine significant predictors. For significant predictors ($p < 0.05$), we followed up with *post hoc* multiple comparison Tukey's honest significant difference test to further investigate those significant relationships.

To determine the effect of home range size on collared pig bait site visitation, we fit separate glmms for male and female collared wild pigs including home range size as a fixed effect and pig ID as a random effect with whether the target collared pig visited the site as the response variable. We also were interested in determining whether increased exposure to bait would alter wild pig visitation to bait sites. Therefore, we fit a generalized linear model (glm) with trial number as a fixed effect and the response as whether the targeted collared wild pig visited or not (binomial distribution) to determine if wild pigs were displaying learned behavior towards bait sites. Similarly, to further investigate the potential influence of other wild pigs visiting a bait site before the collared pig (see results), we fit another separate glmm with whether a collared pig visited the sites (yes/no) as the response variable. We included boar before collared pig (yes/no), sounder before collared pig (yes/no), lone female before collared pig (yes/no), and sex of the collared pig as fixed effects, with sex of the collared pig interacting with each of the other fixed effects, and Pig ID as a random effect. This model was run separately due to model convergence issues from sample size when these three variables were added to the global model.

Statistical Analysis—Time to Visitation

We calculated the time to initial visitation of the targeted collared pig in hours as the difference in time from when the site was deployed until the pig was detected on the remote camera. For sites that did not have collared pig visitation, we used the time from when the site was deployed until the site was removed. We used cox proportional hazard models in the “survival” package in R to test the effects of our predictor variables in the previous global model determining what influences detection rates and included the same random effects from that model to determine how the bait trial persists through time. For significant predictors ($p < 0.05$),

we conducted *post hoc* multiple comparison Tukey's honest significant difference test to further investigate those significant relationships. As with our visitation rate analysis, we modeled home range size independently for male and female collared wild pigs due to its correlation with distance and sex. We also wanted to further investigate how visitation of wild pigs before a collared pig affected the time to detection, so we fit another cox proportional hazard model with boar before collared pig (yes/no), sounder before collared pig (yes/no), lone female before collared pig (yes/no), and sex of the collared pig as fixed effects, with sex of the collared pig interacting with each of the other fixed effects, and Pig ID as a random effect.

Results

Collared Wild Pig Visitation Rate

We collared 52 wild pigs, which received 1-18 (mean=8.8, sd=5.4) experimental bait replicates. After removing replicates with missing information caused by collar slips or failure, cameras that prematurely died, or sites that were tampered with, we conducted analysis on 325 replicates. On average, the collared wild pigs visited 41.98% of the sites, ranging from 0-100% among animals (Supplementary Table 2 Supplementary Figure B.1). Our model selection resulted in 10 supported models ($< \Delta AIC 2$) (Table 3.1). All supported models included distance between the wild pig and the site location at deployment, isopleth, and whether other pigs visited before the target individual, indicating that these three variables had the greatest influence on the probability of a collared pig locating a site among our measured variables (relative importance = 1; Table 3.2). Placement of bait (pile or trail; relative importance = 0.66; Table 3.2), scent (sow in heat present or not; relative importance 0.76), sex of the collared pig (relative importance 0.27), the interaction of isopleth and other pigs before (relative importance = 0.4), and the interaction between isopleth and scent (relative importance 0.76) were also in some of the

supported models. The interaction between isopleth and bait placement was not in any supported models.

Our model averaging of our supported models revealed that collared wild pigs were more likely to locate a bait site when they were in closer proximity to the sites at deployment ($p < 0.0001$; Figure 3.1). The odds a targeted wild pig located a bait site decreased by 9.57% for every 100-meter increase between the wild pig and the site at deployment (Figure 3.2). Collared wild pigs were less likely to locate bait sites in their 99% isopleth (21.49%) compared to their 40% isopleth (57.79%; $p < 0.0001$) and their 70% isopleth (46.29%; $p = 0.004$; Supplementary Table B.3; Figure 3.4). Collared wild pigs were also less likely to visit bait sites if other wild pigs visited the bait site before them (34.87%) compared to sites where other pigs did not (52.71%; $p = 0.03$; Figure 3.3). The other variables from the supported models were not significant in influencing wild pig visitation ($p > 0.05$; Figure 3.1).

From our follow up model evaluating the effect of home range size on wild pig visitation, collared male and female wild pigs were less likely to visit bait sites as their home range size increased (male $p = 0.048$, female $p = 0.006$). Visual observation of wild pig home ranges revealed some UD's were overestimating wild pig home range size due to large movements during the month. To account for this, we excluded home ranges that appeared to be overestimating by eliminating home range sizes that were larger than 1 sd away from the mean ($> 34.1 \text{ km}^2$). This resulted in the exclusion of 20 replicates, and we re-ran the analysis on the remaining 304 sites. Excluding these outliers, collared wild pigs were still less likely to visit bait sites as their home range size increased (male $p = 0.025$, female $p = 0.008$), with the odds a targeted male wild pig located a bait site decreasing by 5.88% for every 1 km^2 increase in home range size and the odds

a targeted female wild pig located a bait site decreasing by 10.46% for every 1 km² increase in home range size (Figure 3.2).

Our model investigating if wild pigs displayed learned behavior to repeated bait sites revealed no effect of trial number on bait site visitation ($p=0.403$). Thus, individuals were not more likely to visit bait sites as they received more experimental bait replicates throughout our study. From our supplemental model to determine how sounders, boars, and individual females influenced visitation rates of collared males and females, we found that collared wild pigs were less likely to visit a bait site if a boar was present at the site before them ($p<0.001$; Table 3.3). Specifically collared female wild pigs were less likely to visit bait sites if a boar visited the site before them ($p<0.001$; Supplementary Table B.4; Figure 3.3).

Collared Wild Pig Time to Initial Detection

From our Cox Proportional Hazard Model, we determined that collared wild pigs had shorter times to initial detection of bait sites in their 40% (203.82 hours; $p<0.0001$) and 70% (230.38 hours; $p=0.006$) isopleth compared to bait sites in their 99% (292.75 hours) isopleth (Supplementary Table B.3; Figure 3.4). Collared wild pigs also had shorter times to detection when distance between the pig and site at deployment was less ($p<0.0001$; Table 3.4; Figure 3.5). For every 100-meter increase in distance, the time to initial detection increased by 2.62 hours (Figure 3.5). Wild pigs also had shorter times to detection when other pigs were not present before (192.35 hours) compared to when other pigs were present at a site (274.56 hours; $p<0.0001$; Table 3.4; Figure 3.6). The interaction between scent and isopleth was also significant and *post hoc* Tukey testes revealed that wild pigs had longer times to detection for sites in the 99% isopleth with scent (312.24 hours) compared to sites in the 40% with no scent (209.47 hours; $p=0.008$), 40% with scent (197.76 hours; $p>0.001$), and 70% with scent (217.98 hours;

$p=0.009$; Supplementary Table B.6; Supplementary Figure B.2). Wild pigs also had longer detection times in the 99% isopleth with no scent (273.61 hours) compared to the 40% with scent (197.76 hours; $p=0.045$). The interaction between other pigs before and isopleth was also significant and post hoc Tukey tests revealed that wild pigs had shorter times to detection for sites in the 40% isopleth when other pigs did not visit before (117.18 hours) compared to all other isopleth and pig visitation groups ($p<0.05$; Supplementary Table B.7; Supplementary Figure B.3). Wild pigs also had shorter times to detection for sites in the 70% isopleth when other pigs did not visit before (207.05 hours; $p=0.006$) and in the 70% isopleth when other pigs did visit before (243.57 hours; $p=0.03$) compared to the 99% isopleth when other pigs visited before (317.08 hours). The remaining predictor variables (placement, scent, sex) were not significant in the model ($p>0.05$; Table 3.4).

From our separate home range size model, male and female collared pigs with smaller home ranges had shorter times to detection of bait sites (male $p=0.043$; female $p=0.005$). After excluding home ranges that were overestimated as with the visitation analysis, targeted collared pigs also had shorter times to detection of bait sites with smaller home range sizes (male $p=0.018$; female $p=0.006$). For every 5 km² increase in home range size of a collared pig, the time to initial detection increased by 21.90 hours for males and 32.04 hours for females (Figure 3.5). From our supplementary model investigating the effects of other pigs on visitation rates, collared individuals had longer times to detection if a boar visited the site before them (287.35 hours) compared to sites that a boar did not visit beforehand (204.15 hours; $p<0.001$; Supplementary Table B.8; Figure 3.6). Specifically, collared female wild pigs had longer times to detection if a boar visited the bait site before them (305.86 hours) compared to the sites boars did not (191.94 hours; $p<0.001$).

Discussion

Overall, our results suggest the distribution of bait relative to space-use by wild pigs on the landscape are critical factors influencing visitation rates and time to detection. However, wild pig visitation to bait sites also was influenced by the presence of wild pigs from outside their social group that we recorded at bait sites, likely reflecting their complex social dynamics (Titus et al. 2022) and semi-territorial behavior (Gabor et al. 1999, Sparklin et al. 2009, Kilgo et al. 2021). Despite their advanced olfactory systems (Gabor et al. 1999, Lavelle et al. 2017), the addition of scent did not impact visitation rates or time to detection, even along the periphery of an individual's home range. This provides further evidence that the addition of scent to bait stations is not effective at increasing detections of wild pigs (Wathen et al. 1988, Snow et al. 2022, Chapter 2), but rather the presence of bait and its distribution on the landscape relative to targeted individuals are more influential in locating wild pigs. Similarly, the placement of bait (trail or pile) did not influence visitation by wild pigs, suggesting that the location of the bait on the landscape has a greater influence on visitation by wild pigs than how it is presented (Saunders et al. 1993, Lavelle et al. 2017, Snow et al. 2022, Chapter 2).

All metrics of space use evaluated in this study (distance between the pig and site at deployment, placement within home range, and home range size) greatly influenced the detection of collared individuals. Wild pigs were more likely to locate bait sites and had shorter times to detection when bait was placed in closer proximity to the wild pig or within areas of greater utilization. Wild pigs have large home ranges [average estimates: 6.1 km² MCP; 12.4 km² AKDE (Kay et al. 2017)] and display high site fidelity to those ranges (Oliveira-Santos et al. 2016, Gray et al. 2020). Given that areas of greater utilization often contain refuges, bedding areas, and reliable food sources (Burt 1943, Ewer 1968, Samuel et al. 1985), it is unsurprising that

individuals are able to locate bait sites more quickly and consistently within these areas. Indeed, other research has found that species are more likely to locate sites when baits overlap with animal movement patterns, animal sign, and when bait is in closer proximity to the animal (Campbell et al. 2006, Tompkins and Ramsey 2007, Hegglin and Deplazes 2008, Beasley et al. 2015, Fancourt et al. 2021, Foo et al. 2025). Wild pigs in our study were able to locate bait at similar rates between the 40th and 70th isopleth, suggesting baits placed peripheral to bedding and key foraging areas may be similarly effective as those placed within their core areas. However, our results suggest wild pigs infrequently located bait sites along the periphery of their home range (71-99% isopleth), likely reflecting the more sporadic use of these areas. Further, among the bait sites detected by wild pigs in this study, individuals were much closer to the bait site at the time of deployment (\bar{x} = 746 meters on average; range = 20.93 - 4747.21 meters) compared to bait sites that they did not detect (\bar{x} = 1453.19 meters on average; range = 34.12 – 12651.65 meters). This supports the results of Snow & VerCauteren (2019), who found that wild pigs reliably visit sites within 1-1.25 km of their location, since wild pigs in our study only found 17.1% of sites > 1.5 km away from their location at the time of site deployment. These results further support the growing literature that bait site visitation rates are strongly influenced by animal space use.

Adult male wild pigs have larger home ranges on average than females (Dexter 1999, Kay et al. 2017, Clontz et al. 2022) and thus we expected the sex of the collared individual to influence visitation rates at bait sites; however, there was no difference in visitation between males and females in our study. Our results displayed that although males had larger home ranges, both males and females had greater visitation rates and shorter times to detection with smaller home ranges. These results may reflect the fact the adult males have higher daily

movement rates (Hartley et al. 2015, Kay et al. 2017), so they may be moving more on the landscape and increasing their likelihood of detecting a bait site. Males and females of other species detect trap sites, cameras, etc. at different rates due to differences in movement, vigilance, and boldness (Caravaggi et al. 2020, Johnstone et al. 2024). It is possible that we did not detect such differences between males and females since sites were placed within each individual's home range. However, previous bait studies for wild pigs have found that visitation rates do differ between sexes (Snow and VerCauteren 2019, McRae et al. 2020).

In this study we utilized sow in heat as our scent lure due to its potential to serve as a pheromone attraction for males and social attractant for females (Choquenot et al. 1993, McIlroy and Gifford 2005). The olfactory system plays an important role for wildlife to locate food sources but also chemical signals for reproductive behavior and social communication (Breer et al. 2006). We expected the addition of this estrous scent to increase visitation of wild pigs, especially for males, given that females are reproductively active throughout the year in the southeastern U.S. (Chinn et al. 2022). Although the addition of scent did not influence the visitation of wild pigs, we did find that bait sites placed near the periphery of an individual's home range that had scent actually had the longest times to detection. It is unclear whether this finding reflects avoidance of pheromone-based scent near their home range boundary or is an artifact of sample size ($n=53$). Nonetheless, sow in heat scent was ineffective at increasing detection of wild pigs across treatments in our study, adding to the growing body of evidence that scent, even when coupled with bait, is not an important attractant for luring wild pigs from further distances (Snow et al. 2022, Chapter 2).

We found evidence that our targeted wild pigs were less likely to visit a bait site and if they did, had longer times to detection if other non-collared pigs external of their social group

located the bait before them. In particular, males displaced female targeted pigs from visiting bait sites, with collared females being less likely to visit a bait site if an adult male found the bait before them. Wild pigs are semi-territorial (Gabor et al. 1999, Sparklin et al. 2009, Kilgo et al. 2021), and thus our results suggest wild pig social dynamics may play a crucial role in visitation to bait sites. Wild pig males are large mammals with an average adult body mass of 95-100kg (Mayer and Brisbin 2009, Mayer et al. 2020), enlarged canines (tusks), and often have a shoulder “shield” which is a thickened subcutaneous layer of tissue that serves as protection during fights and when displaying territoriality over mating opportunities (Graves 1984, Mayer and Brisbin 2009, Mayer 2021). Adult males usually only interact with sounders for breeding, displaying sexual segregation which is common in many species and may occur for a variety of reasons including sexual differences in activity budgets, avoidance of oddity effects, social preferences (males prefer to interact with and be with other males and females with other females), and avoidance of intrasexual aggression in mixed groups (Ruckstuhl 2007). Males of numerous species [e.g., primates, elephant seals (*Mirounga leonina*), wild dogs (*Lycaon pictus*)] display aggression towards or kill offspring (infanticide), especially during breeding season or over resources, which can lead to female avoidance (Hrdy 1979). Indeed, female wild pigs display sexual segregation during critical reproductive periods as they have been documented to defend an area or isolate their activity during farrowing (Graves 1984, Fernández-Llario 2004, Chinn et al. 2023) to potentially avoid areas that males are utilizing. Although we did not document behavior at our bait sites, male wild pigs may be displaying aggression over bait, resulting in collared female wild pigs avoiding the bait site to potentially protect their offspring. Given that most wild pig management programs are focused on removing whole sounders (Lewis et al.

2022, Kilgo et al. 2023), our results suggest removal of adult males may facilitate detection of sounders at bait sites, especially in areas where males may be monopolizing access to bait.

Conclusion:

Collectively, our results demonstrate that space use, social structure, and the distribution of optimal habitats are critical factors influencing the success of baiting programs for wild pigs. Although it is often unknown exactly where targeted animals are on the landscape for management purposes, or the extent of their movements without a GPS collar, focusing efforts within optimal habitat (i.e. proximity to water and understory; Chapter 2) and where there is high density of sign will lead to greater wild pig visitation rates and shorter times to detection. Other studies have demonstrated that one of the most important factors of a baiting program (i.e. toxic baiting) influencing success is simply whether the animal encounters that site (Fancourt et al. 2021). If pigs are not visiting a site, it is likely driven by the location of the bait site, and a manager should consider moving that site if it is not located by wild pigs in a reasonable time. Surprisingly, even though animals received multiple bait replicates over time, we did not detect any learned behavior displayed by animals monitored in this study. In fact, collared wild pigs only detected 41.98% of the bait sites in this study, potentially driven by the fact that at any given time, a wild pig was only presented with one bait site. To improve the likelihood of visitation, managers should consider placing multiple bait sites within an individual's presumed home range where wild pigs are spending the most time to maximize detections. Further, by understanding the social organization of a species and how animals can potentially exclude or attract others can lead in increased target wild pig visitation. Specifically, our results suggest that male wild pigs potentially exclude female wild pigs from bait sites. Managers should consider removing male wild pigs using a bait site to increase the likelihood of females, specifically

targeted sounders that drive population growth, visiting sites. By considering these factors, the efficiency of managing increasing pest species can be improved reducing the problems they cause.

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CHAPTER 3 TABLES AND FIGURES

Table 3.1: Top generalized linear mixed-effects models ($< \Delta AIC 2$) from our model comparison using an all-combinations approach to determine what influences wild pig (*Sus scrofa*) visitation to bait sites on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024.

Pig ID, season, and trial number were included as random effects in each model in the all-combinations approach. Distance represents the standardized distance in meters between the collared pig and the site at the time of deployment. Isopleth represents the 99%, 70% and 40% isopleths based on the utilization distributions (UD) for home range estimates.

Other_Pigs_Before represents whether another wild pig from a different social group visited a site before the target collared animal. Placement represents whether the bait was placed in a pile or in trails at the site. Scent represents whether there was the addition of a scent lure, sow in heat (Tink's®, Arcus Hunting LLC, Covington, GA, USA), at the site. Sex represents the sex of the target collared animal. Iso:Other_Pigs_Before represents the interaction of isopleth and whether wild pigs visited before and Iso:Scent represents the interaction of isopleth and whether scent was present at a site.

Model	Delta	AIC	Weight
Distance + Isopleth + Other_Pigs_Before + Placement + Scent + Iso:Scent	0		0.096
Distance + Isopleth + Other_Pigs_Before + Placement + Scent + Iso:Other_Pigs_Before + Iso:Scent	0.04		0.094

Distance + Isopleth + Other_Pigs_Before + Scent + Iso:Scent	0.58	0.072
Distance + Isopleth + Other_Pigs_Before + Placement + Scent + Sex + Iso:Scent	0.84	0.063
Distance + Isopleth + Other_Pigs_Before + Placement	1.14	0.054
Distance + Isopleth + Other_Pigs_Before + Placement + Scent + Sex + Iso:Other_Pigs_Before + Iso:Scent	1.18	0.053
Distance + Isopleth + Other_Pigs_Before + Placement + Iso:Other_Pigs_Before	1.2	0.053
Distance + Isopleth + Other_Pigs_Before + Scent + Iso:Other_Pigs_Before + Iso:Scent	1.27	0.051
Distance + Isopleth + Other_Pigs_Before + Scent + Sex + Iso:Scent	1.28	0.05
Distance + Isopleth + Other_Pigs_Before	1.71	0.041

Table 3.2: Importance values and the number of models in which the variable occurred for all variables retained in the 10 supported generalized linear mixed-effects models evaluating variables impacting target collared wild pig (*Sus scrofa*) bait site visitation on the Savannah River Sites near Aiken, SC, US from June 2023 – November 2024. Distance_std is the standardized distance in meters between the wild pig and the site at deployment. Isopleth is the UD of the home range estimate the site was placed in (40%, 70%, 99%). Other_Pigs_Before is whether another wild pig visited the site before the targeted collared pig. Scent was whether the scent, Tink’s Specialty Power Pig Sow-in-Heat Estrous (Tink's®, Arcus Hunting LLC, Covington, GA, USA)], was present at the site. Placement is determined by whether bait was placed in a pile in front of the camera or in trails 25 meters in length in each of the 4 cardinal directions. Isopleth:Scent is the interaction of isopleth (40%, 70%,99%) and scent (yes/no) and Isopleth:Other_Pigs_Before is the interaction of isopleth (40%, 70%,99%) and other pigs before the collared pig (yes/no).

Predictor	Importance Value	# Containing Models
Distance_std	1	10
Isopleth	1	10
Other_Pigs_Before	1	10
Scent	0.76	7
Isopleth:Scent	0.76	7
Placement	0.66	6
Isopleth:Other_Pigs_Before	0.4	4
Sex	0.27	3

Table 3.3: Results of generalized linear model to investigate the influence of wild pigs (*Sus scrofa*) visiting before and the sex of the collared pig on visitation rates and time to initial detection. Replicates were conducted on the Savannah River Site near Aiken, SC from June 2023 – November 2024. For each site we recorded whether the targeted collared pig visited and the time to that visitation. We determined if other pigs visited before and whether those pigs were a male (boar), sounder or lone female. In our modeling each of these were interacted with sex to determine if certain groups or sexes influenced target pig visitation.

Predictor	Visitation	Visitation	Visitation	Time	Time	Time p
	Estimate	SE	p	Estimate	SE	
Boar_Before_Yes	-1.184	0.339	0.00048	-1.096	0.268	4.25E-05
Sounder_Before_Yes	-0.043	0.334	0.897	-0.433	0.591	0.463
Female_Before_Yes	-0.003	0.68	0.997	-0.171	0.243	0.482
Sex_Male	-0.368	0.353	0.298	-0.38	0.259	0.144
Boar_Before_Yes:Sex_Male	0.913	0.515	0.076	0.801	0.399	0.055
Sounder_Before_Yes:Sex_Male	-0.135	0.523	0.796	0.087	0.844	0.918
Female_Before_Yes:Sex_Male	-0.308	1.01	0.761	0.021	0.394	0.958

Table 3.4: Summary table from Cox Proportional Hazard Model used to determine what predictors influence the time to detection of targeted collared wild pigs (*Sus scrofa*) at bait sites. Pig ID, season, and trial number were included as random effects in the Cox Proportional Hazard Model. Distance_std represents the standardized distance in meters between the collared pig and the site at the time of deployment. Isopleth represents the 99%, 70% and 40% isopleths based on the utilization distributions (UD) for home range estimates. Other_Pigs_Before represents whether another wild pig from a different social group visited a site before the target collared animal. Placement represents whether the bait was placed in a pile or in trails at the site. Scent represents whether there was the addition of a scent lure, sow in heat (Tink's®, Arcus Hunting LLC, Covington, GA, USA), at the site. Sex represents the sex of the target collared animal. Iso:Other_Pigs_Before represents the interaction of isopleth and whether wild pigs visited before and Iso:Scent represents the interaction of isopleth and whether scent was present at a site. Replicates were conducted on the Savannah River Site near Aiken, SC from June 2023 – November 2024.

Predictor	Estimate	SE	p
distance_std	-0.831	0.198	2.82 e-05
Sex_Male	-0.088	0.19	0.643
Scent_Yes	0.284	0.261	0.275
Isopleth70	-0.931	0.404	0.021
Isopleth99	-0.759	0.435	0.081
Placement_Trail	0.534	0.275	0.051
Other_Pigs_Before_Yes	-1.444	0.278	1.95 e-07
Scent_Yes:Iso70	0.128	0.388	0.741

Scent_Yes:Iso99	-1.106	0.522	0.034
Iso70:Placement_Trail	-0.132	0.398	0.739
Iso99:Placement_Trail	-0.265	0.496	0.593
Iso70:Other_Pigs_Before_Yes	1.183	0.407	0.004
Iso99:Other_Pigs_Before_Yes	0.506	0.507	0.318

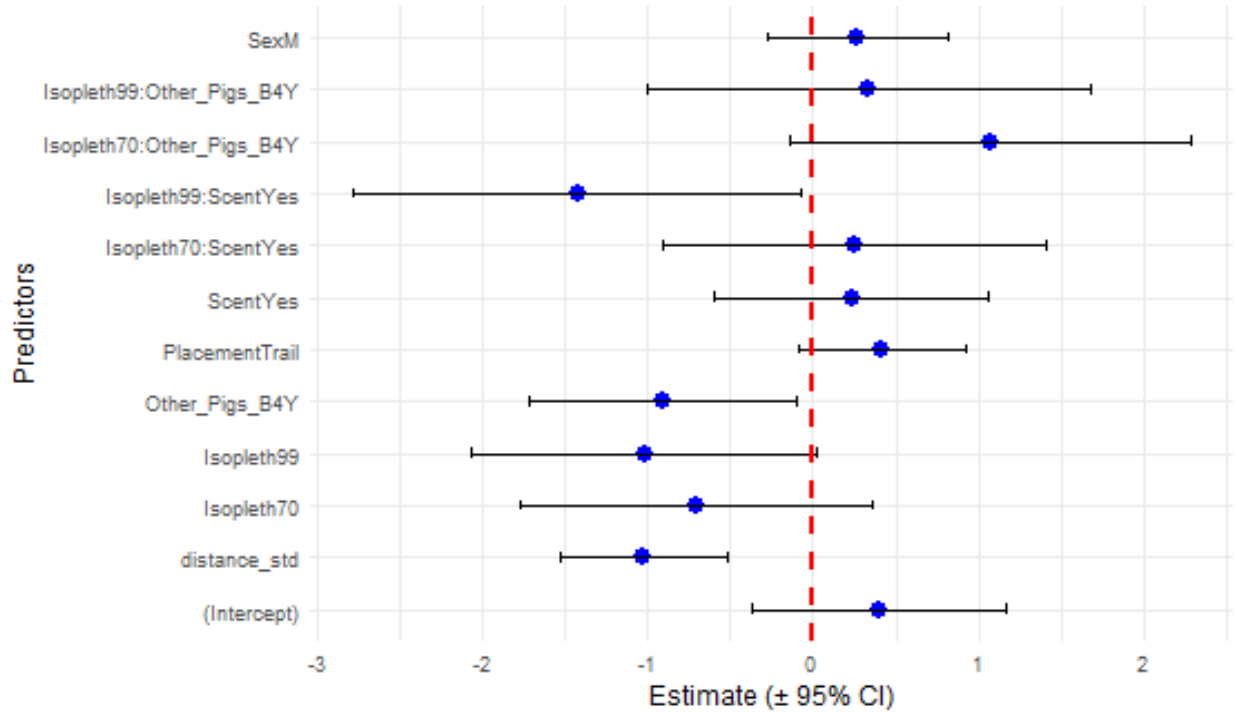


Figure 3.1: Estimated coefficients with 95% confidence intervals after model averaging top performing generalized linear mixed-effects models for each of the predictors for determining individual collared wild pig site (*Sus scrofa*) visitation on the Savannah River Site, Aiken, SC, US in June 2023 – November 2024. The dashed line corresponds to 0 and if the confidence interval overlaps, the predictor does not have a significant effect. The distance variable (*dist_std*) that is < 0 indicate the sites had a greater probably of being detected at smaller distances. All other predictors that are > 0 indicate the sites had a greater probably of being detected with these predictors Distance_std represents the standardized distance in meters between the collared pig and the site at the time of deployment. Isopleth represents the 99%, 70% and 40% isopleths based on the utilization distributions (UD) for home range estimates. Other_Pigs_Before represents whether another wild pig from a different social group visited a site before the target collared individual. Placement represents whether the bait was placed in a pile or in trails at the site. Scent represents whether there was the addition of a scent lure, sow in heat (Tink's®, Arcus

Hunting LLC, Covington, GA, USA), at the site. Sex represents the scent of the target collared individual. Iso:Other_Pigs_Before represents the interaction of isopleth and whether wild pigs visited before and Iso:Scent represents the interaction of isopleth and whether scent was present at a site.

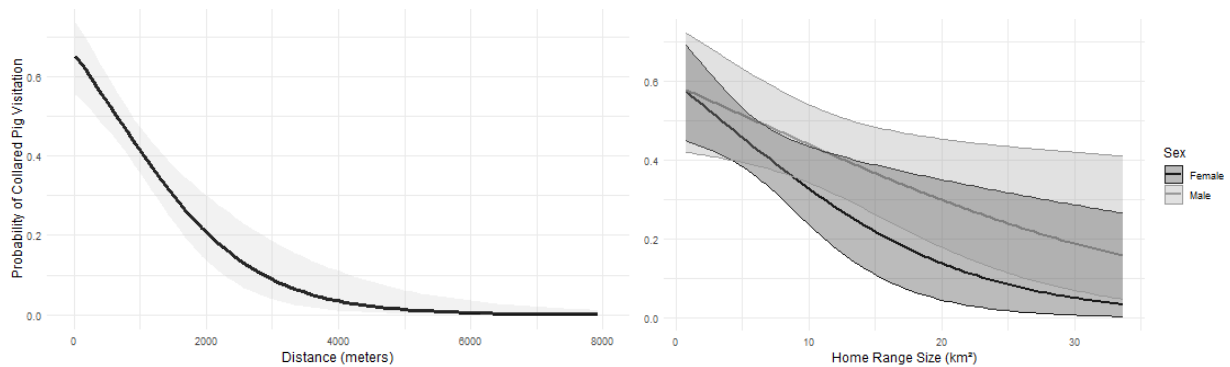


Figure 3.2: Predictive relative probability of a targeted collared wild pig (*Sus scrofa*) being detected as a function of distance (meters) and home range size (km²) on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Distance represents the distance in meters between the collared pig and bait site at deployments and home range size in km² is the estimated 99% UD from AKDE methods for each one month prior to replicate deployment. The solid line represents the mean predicted probability and the shaded region represents the 95% confidence interval. This is based on our top performing generalized linear mixed model and holds all other predictors constant (isopleth, sex, scent, other pigs before, and placement).

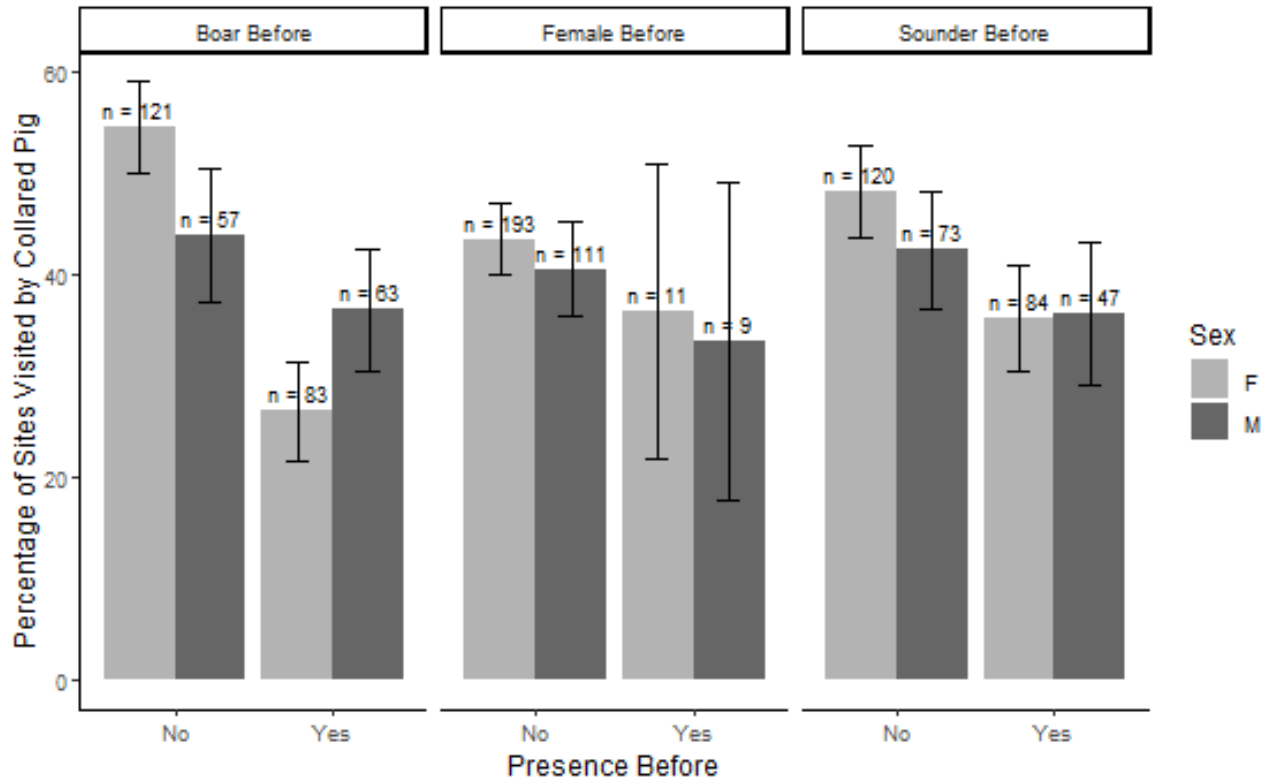


Figure 3.3: Percentage of bait sites visited by a collared wild pig (*Sus scrofa*) by the sex of the collared pig (male or female) and whether a nontarget male (boar) visited the site before, female visited the site before or sounder visited the site before at experimental bait sites. We determined whether wild pigs from another social group visited the bait site before and then categorized them by number and sex. Sample size is represented above each bar and the lines represent the 95% confidence interval. This was conducted at the Savannah River Site, Aiken, SC, USA from June 2023 – November 2024.

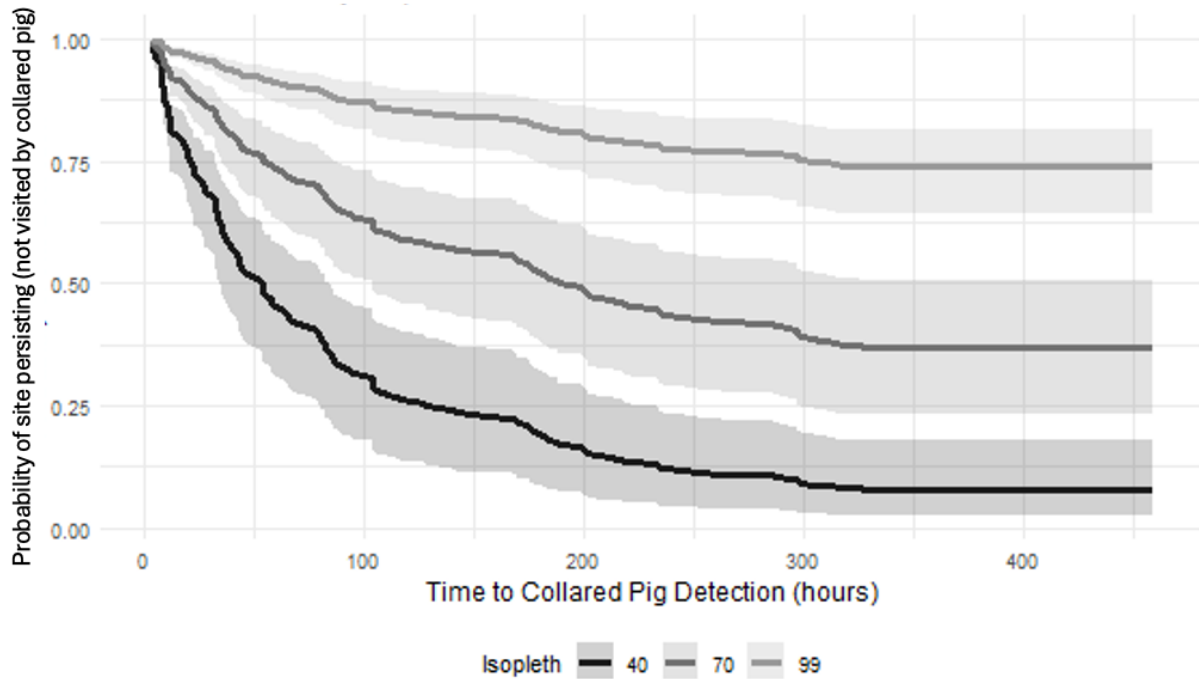


Figure 3.4: Survival curve for each isopleth of the home range representing the probability of a bait site persisting (not visited by collared targeted wild pig [*Sus scrofa*]) and the time to initial detection for bait replicates conducted June 2023 – November 2024 on the Savannah River Site near Aiken, SC, US. The solid lines represent the mean predicted probability and the shaded regions represent the 95% confidence interval for each isopleth. Isopleth represents the 99%, 70% and 40% isopleths based on the utilization distributions (UD) for kernel density home range estimates calculated with data from the month prior to the experimental replicate.

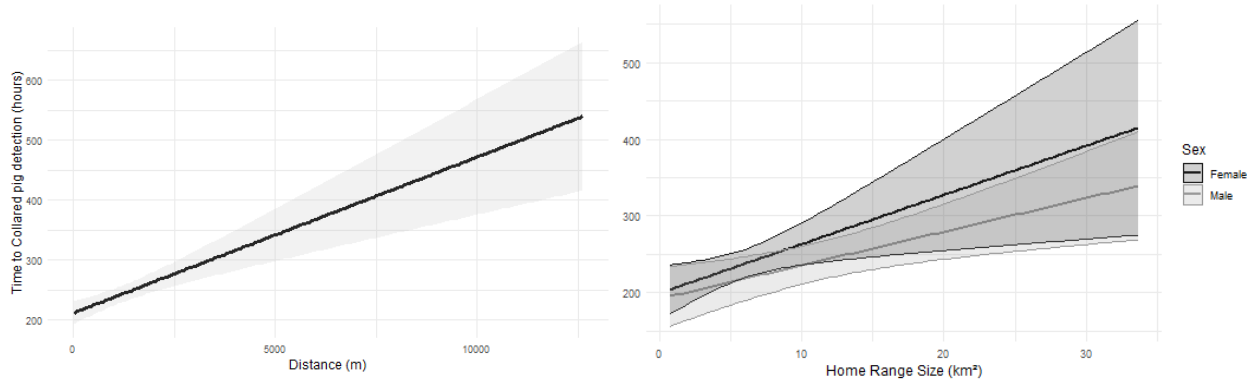


Figure 3.5: Linear model prediction figure for time to detection of a targeted collared wild pig (*Sus scrofa*) by distance (meters) and home range size (km²) on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. The solid line represents the mean predicted probability and the shaded region represents the 95% confidence interval. Time to initial detection was calculated by the time difference in hours between the camera being deployed and the target pig captured on camera. For sites that had no target collared pig visitation, the duration of the camera deployment was the assigned time

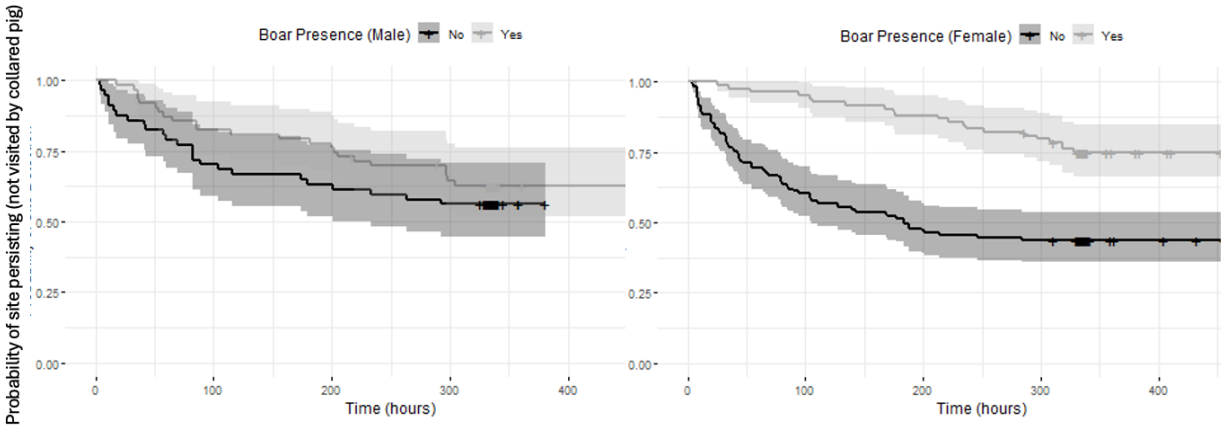


Figure 3.6: Survival curve for whether a male (boar) wild pig (*Sus scrofa*) visited a bait site before the target collared pig for each sex of collared pig (male and female) representing the probability of a bait site persisting through time (not visited by a target collared animal) and the time to initial detection for bait sites conducted June 2023- November 2024 on the Savannah River Site near Aiken, SC, US. The solid line represents the mean predicted probability and the shaded region represents the 95% confidence interval.

CONCLUSIONS

Wild pigs (*Sus scrofa*) are extensively managed throughout their native and invasive range; however, they continue to expand in distribution and abundance. Therefore, there is an ongoing need to improve management by increasing removal efficiency. Specifically, there is a need to better understand methods for attracting wild pigs in order to improve the efficiency of removal tools including traps, toxic baiting, and aerial and ground shooting. Previous research has investigated attractant types, wild pig movement in response to bait, and habitat attributes associated with wild pigs, but there are knowledge gaps in comparing differing attractant types, bait presentation, fine-scale habitat attributes associated with bait site visitation, wild pig response to bait, and social interactions at bait sites.

My thesis research addresses these critical knowledge gaps, producing new information that can be used to improve upon existing approaches for managing invasive wild pigs. In Chapter 1, I synthesized the current state of knowledge about attracting wild pigs for management purposes. In chapter 2, I conducted extensive baiting surveys to evaluate the visitation rates and time to detection of wild pigs at different types of attractants and what habitat features influence visitation. For chapter 3, I determined the underlying factors most influential in individual wild pig bait site visitation by evaluating a variety of intrinsic (sex, space use) and extrinsic (bait placement methods, addition of scent lure, presence of other wild pigs) factors for detecting target collared wild pigs. I conducted all of the research described in this thesis in the southeastern U.S., on the Savannah River Site (SRS) near Aiken, SC. The results from this

research fill gaps in the literature about attractants and will help with improving wild pig attractant methods, and therefore wild pig management and research.

In chapter 2, I selected two top performing baits and four top performing scent lures from previous literature and deployed those bait and scent lure combinations (bait, scent, bait+scent), as well as control sites, across the landscape in wild pig habitat to determine what attractants had the highest visitation rate and shortest time to initial detection for wild pigs. The results from this revealed that scent lures alone are inefficient at attracting wild pigs and adds to the growing body of literature supporting that wild pigs respond more strongly to the presence of bait than scent lures in terms of visitation. Further, this study produced greater visitation rates at control sites, consisting of no attractant, compared to scent lure only sites, signifying that wild pigs may display aversion to novel scents. My results further indicated that bait is an important attractant for wild pigs, and that a variety of foodstuffs can be utilized depending on local availability and wild pig preferences. Wild pigs had higher than expected visitation rates at control sites, likely reflecting that our sites were placed in preferred habitats of wild pigs but lead to the investigation of what fine scale habitat features influence wild pig visitation at sites.

As part of my research in Chapter 2, I also collected information on percent of hard mast producing trees, understory type, understory density, and proximity to water, secondary roads, primary roads, evergreen habitat, and upland hardwoods at experimental trial locations. From my modeling, I determined that habitat attributes, or the location of the attractant site, is just as important as providing a bait and both should be considered when establishing a management program. Specifically, wild pig bait site visitation was driven by site proximity to water and understory type and density. This information can aid managers in selecting locations to scout for pig sign or starting locations for placing attractant sites on the landscape. Overall, the results

from this chapter demonstrate that to attract wild pigs, bait must be provided, and the location of habitat attributes must be considered to improve attractant efficiency.

In chapter 3, I collared 52 individual wild pigs with GPS units and conducted 325 experimental bait replicates on these individuals. One of my primary objectives was to determine whether the presentation of bait (pile or trail) and the addition of scent influenced visitation rates or time to detection. I also aimed to evaluate the impact of an individual's space use behavior as well as the presence of wild pigs from outside of their social group on visitation to bait sites. The results from this experiment revealed that wild pig movement and location of the bait relative to where wild pigs are on the landscape strongly influence visitation rates and times to detection of individual target wild pigs, as well as the presence of other pigs from outside their social group. Bait sites had greater visitation rates and shorter times to detection when placed in closer proximity to their core areas, which represents the key foraging and bedding areas where they spend most of their time. Wild pigs were less likely to find and had longer times to detection at bait sites on the periphery of their home range, even with the addition of a scent lure, which is likely due to these individuals only occasionally utilizing these areas. Further, wild pigs were more likely to detect sites in closer proximity to their location at the time of bait deployment. Sites detected by wild pigs were on average 746 meters from their location at the time of deployment, whereas sites that were not detected were on average 1453 meters away, further supporting previous research stating that wild pigs reliably visit bait sites within 1-1.25 km (Snow and VerCauteren 2019). The presence of wild pigs from another social group also had a significant impact on target wild pig visitation; specifically target females were less likely to visit and had longer times to detection if an adult male was present at the site. Wild pigs are semi-territorial and my results suggest males may be excluding females from bait sites to some extent,

but further research is needed. Lastly, I concluded that the addition of scent, placement of bait, or sex of the individual had no effect on wild pig visitation, suggesting that the location of the bait has more of an influence on visitation than these factors. Overall chapter 3 results demonstrate the importance of considering a species' space use and taking into consideration landscape and habitat attributes, as well as a need to further investigate the social interactions of wild pigs at bait sites in order to improve visitation rates at bait sites.

The results from this thesis fill critical knowledge gaps regarding the management of wild pigs for research and population control and provides opportunities for further research to build on. Understanding how different potential attractants and habitat attributes influence wild pig visitation as well as the fact that space use metrics and social interactions drive bait site visitation can increase site visitation for managers trying to deploy traps, sites for gunning, cameras for population estimates, toxicants, and oral vaccines. Specifically, both chapters highlight the importance of providing provide a bait to attract wild pigs, and that scent lures are not effective. Managers should focus on finding locally available and affordable baits, since scent lures were not effective at attracting wild pigs, even at the periphery of their home range, and wild pigs may display some aversion to novel scents. Further, both chapters signify the importance of the location of a bait site regarding habitat and wild pig space use. If wild pigs are not visiting a bait site in a reasonable amount of time, my results suggest moving the site to a new location instead of adding a scent lure or changing the placement of the bait. Without GPS collars, managers do not know the exact locations of wild pigs but can use important habitat attributes and locate pig sign to place bait within their higher usage areas to increase visitation rates. Managers typically target sounders due to their high reproductive potential, but my results suggest that adult males may displace females from bait sites. Managers may want to remove

male wild pigs and continue to maintain a bait site to allow females to visit; however further research is needed on wild pig social interaction at bait sites. Overall, this thesis represents an important contribution to wild pig attractant and baiting literature and further contributes to the management of this globally distributed pest.

LITERATURE CITED

Snow, N. P., and K. C. VerCauteren. 2019. Movement responses inform effectiveness and consequences of baiting wild pigs for population control. *Crop Protection* 124:104835.

APPENDICES

CHAPTER 2 SUPPLEMENTARY TABLES AND FIGURES

Supplementary Table A.1: The percentage of sites visited including all treatments and all treatments except control sites for any wild pig (*Sus scrofa*), groups of wild pigs, and an individual wild pig on the Savannah River Site near Aiken, SC, US from January-April 2023.

Visitation Type	% Sites Visited	% Sites Visited (excluding controls)
Any Wild Pig	39.70%	38.41%
Groups of Wild Pigs	22.21%	22.69%
Individual Wild Pig	37.42%	37.16%

Supplementary Table A.2: The percentage of sites visited and the average time to detection of a wild pig (*Sus scrofa*) in hours by treatment type for any wild pig, group of wild pigs, or an individual wild pig. We used corn and peanuts for bait and strawberry, sow in heat, tuff tusk sour mash, and worm tea as scent lures. Control sites consisted of no bait or scent, bait only consisted of a bait, scent only consisted of a scent lure only, and bait+scent consisted of a bait and scent at the site. The any pig category represents any pig, single represents that an individual pig visited the site, and group represents that more than one pig visited the site at a time. This was conducted at the Savannah River Site, Aiken, SC, USA from January – April 2023.

Visitation Type	Treatment	% Sites Visited	95% CI for % Sites Visited	Average	95% CI for Time
				Time to Detection (hours)	to Detection
Any Wild Pig	Bait	42.85%	33.03 - 53.25%	61.35	46.49 - 76.22
Any Wild Pig	Scent	24.40%	18.86 - 30.91%	82.03	67.07 - 96.99
Any Wild Pig	Bait+Scent	47.99%	43.00 - 53.02%	60.98	54.45 - 67.52
Any Wild Pig	Control	34.69%	22.06 - 49.71%	44.92	25.34 - 64.51
Group of Wild Pigs	Bait	26.53%	18.11 - 36.41%	64.44	45.45 - 83.43
Group of Wild Pigs	Scent	5.26%	2.66 - 9.22%	83.25	38.95 - 127.56
Group of Wild Pigs	Bait+Scent	30.90%	26.29 - 35.69%	66.64	58.67 - 74.61
Group of Wild Pigs	Control	10.20%	3.39 - 22.23%	22.04	-10.10 - 54.17
Individual Wild Pig	Bait	41.84%	31.95 - 52.23%	66.13	52.08 - 80.18
Individual Wild Pig	Scent	24.40%	18.74 - 30.80%	76.44	62.34 - 90.54
Individual Wild Pig	Bait+Scent	42.71%	37.79 - 47.74%	64.96	58.07 - 71.85

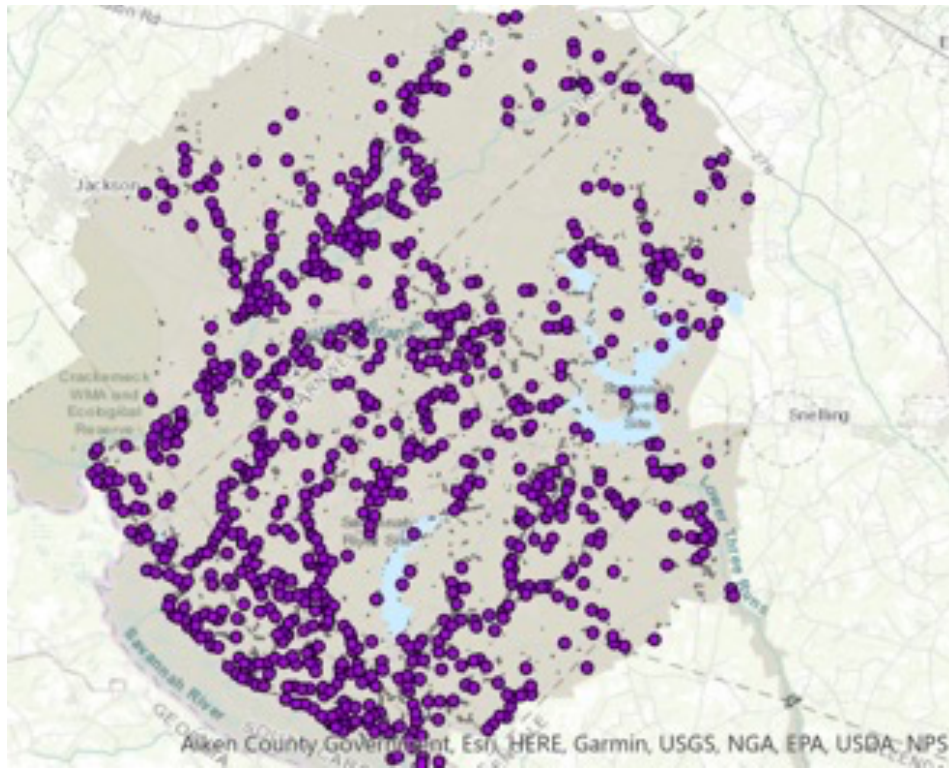
Individual Wild Pig	Control	32.65%	19.95 - 47.54%	62.37	39.32 - 85.43
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Supplementary Table A.3: Top models ($< \Delta AIC$ 2) from our model comparison using an all-combinations approach after the stepwise regression for determining the habitat factors that influence wild pig (*Sus scrofa*) bait site visitation on the Savannah River Site near Aiken, SC, US from January-April 2023.

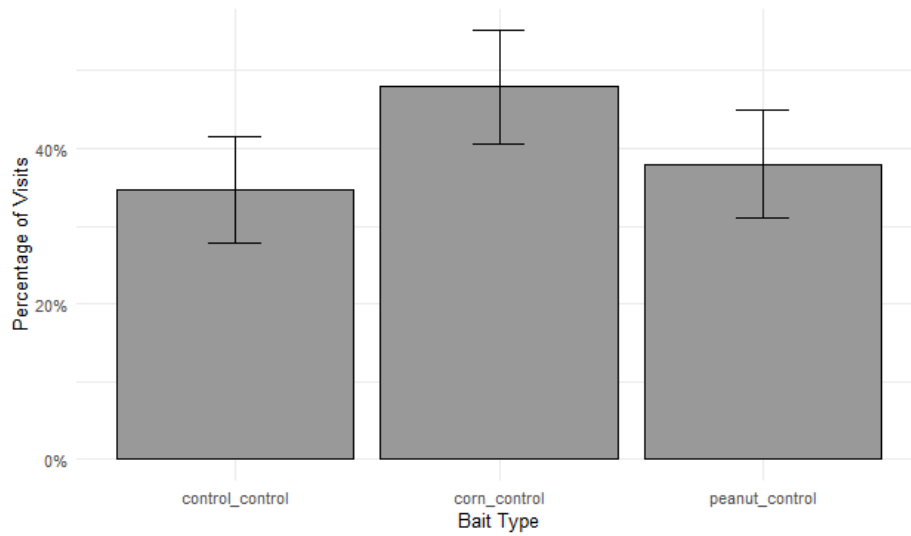
Model	AICc	Delta	
		AIC	Weight
Water Dist + Open Land Dist + Evergreen Dist + Under Density + Pri Understory + Treatment	370.8	0	0.146
Water Dist + Open Land Dist + Under Density + Pri Understory + Treatment	371.0	0.13	0.137
Water Dist + Under Density + Pri Understory + Treatment	371.4	0.58	0.109
Water Dist + Evergreen Dist + Under Density + Pri Understory + Treatment	371.7	0.88	0.094
Water Dist + Evergreen Dist + Open Land Dist + Pri Understory + Treatment	371.9	1.07	0.086
Water Dist + Evergreen Dist + Pri Understory + Treatment	372.1	1.30	0.076
Water Dist + Pri Understory + Treatment	372.4	1.54	0.68
Water Dist + Open Land Dist + Pri Understory + Treatment	372.6	1.78	0.060

Supplementary Table A.4: Coefficient table in odds ratios for top performing models ($< \Delta AIC 2$) after model averaging for habitat predictors influencing wild pig (*Sus scrofa*) bait site visitation on the Savannah River Site near Aiken, SC, US, 2023.

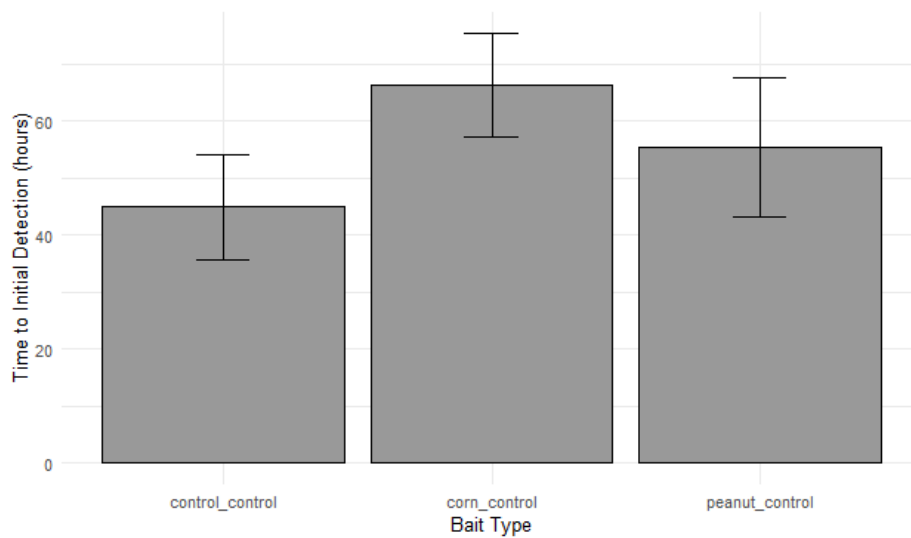
Predictor	Estimate	Std.Error	CI.Lower	CI.Upper
(Intercept)	0.911	1.610	0.357	2.326
EucDist_open_land_std	0.885	1.164	0.607	1.056
EucDist_evergreen_std	1.153	1.212	0.910	1.904
lidar_std	1.148	1.156	0.974	1.593
NEAR_Wetland_std	0.698	1.141	0.539	0.904
Pri_UnderstoryCane Grass	0.608	1.703	0.213	1.734
Pri_UnderstoryPalmettos	7.639	3.199	0.775	75.345
Pri_UnderstorySeedlings (woody stems)	0.409	1.495	0.186	0.903
Treatment Bait_only	1.516	1.578	0.617	3.724
Treatment Bait_scent	2.494	1.446	1.207	5.156



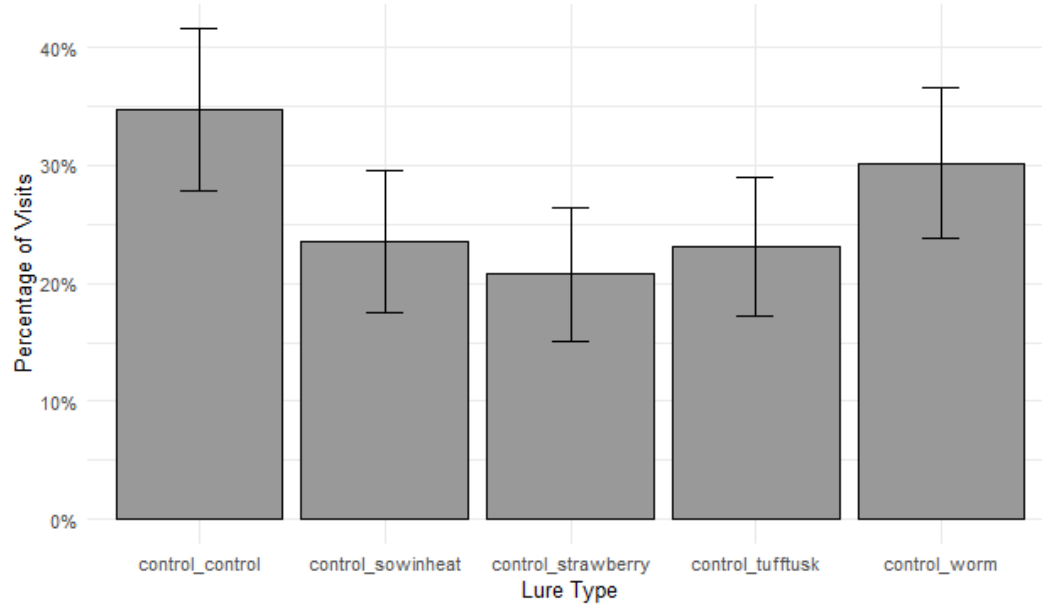
Supplementary Figure A.1: Points generated in ArcGIS Pro 3.1.1 in riparian habitats across the Savannah River Site near Aiken, SC, US for experimental trials including flood plain oak forests, flood plain sweetgum forests, mixed bottomland hardwoods, mixed composition flood plain hardwoods, bald cypress and water tupelo, bottomland hardwoods and cypress, marsh, and wetland scrub forests habitats. Points are a minimum of 225 meters apart to avoid site habituation and within 150 meters of a road to facilitate accessibility.



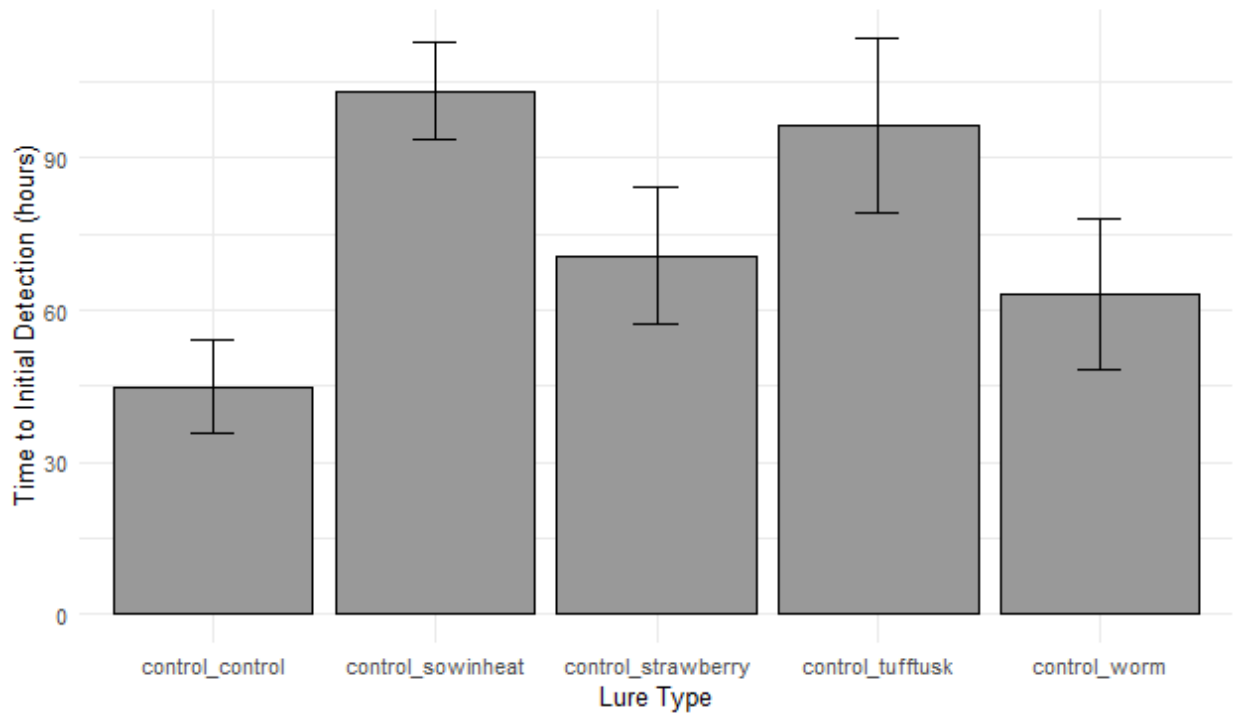
Supplementary Figure A.2: Percentage of sites with wild pig (*Sus scrofa*) visitation by bait type [corn, peanuts, control (no bait)] on the Savannah River Site near Aiken, SC, US in January-April 2023.



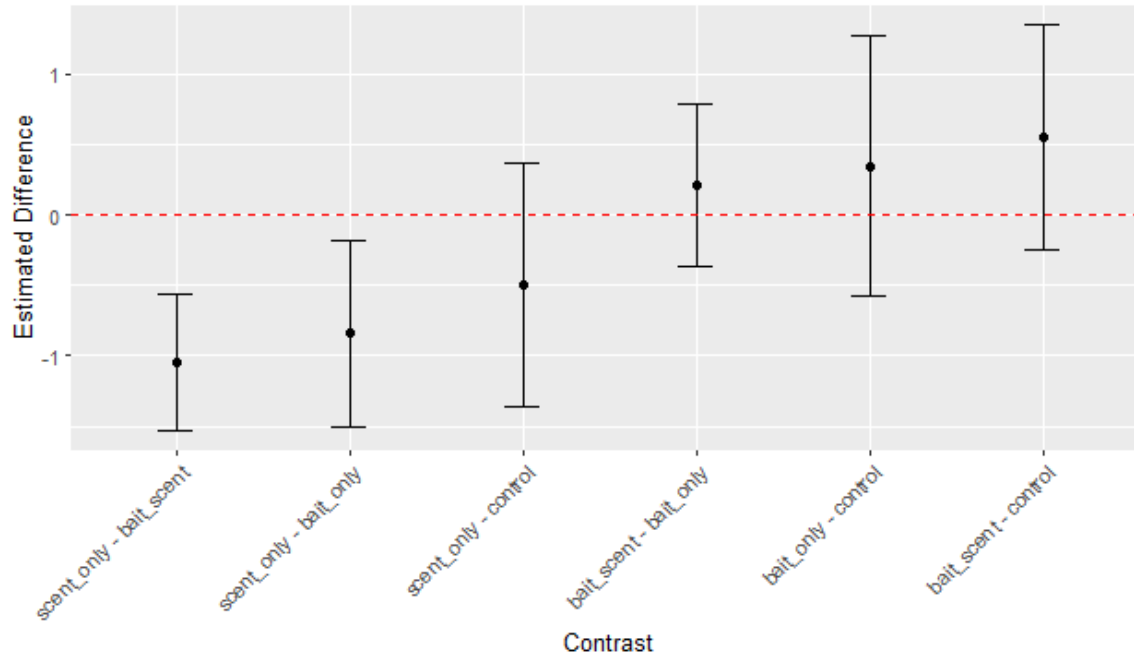
Supplementary Figure A.3: Initial time to visitation of a wild pig (*Sus scrofa*) in hours by bait type on the Savannah River Site near Aiken, SC, US in January-April 2023. Time to initial visitation is the time difference in hours between when the camera was deployed and when a pig when captured in a photo.



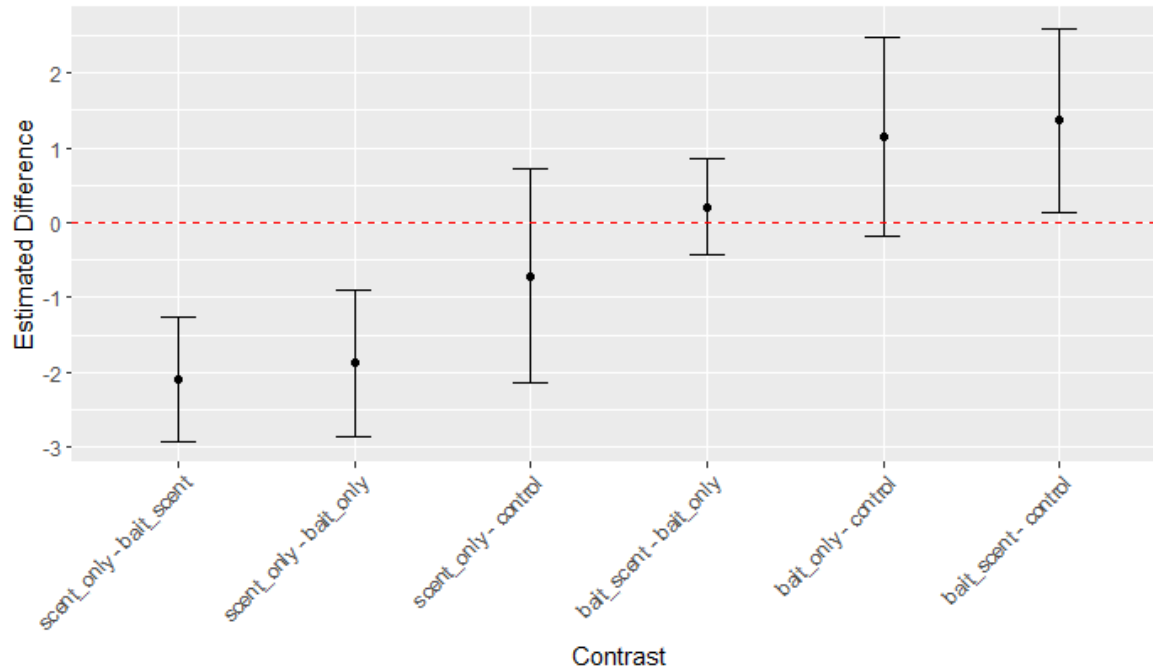
Supplementary Figure A.4: Percentage of sites with wild pig (*Sus scrofa*) visitation by lure type on the Savannah River Site near Aiken, SC, US in January-April 2023. Comparing sites with sow in heat only, strawberry only, tuff tusk only, worm only, and no bait or scent (control).



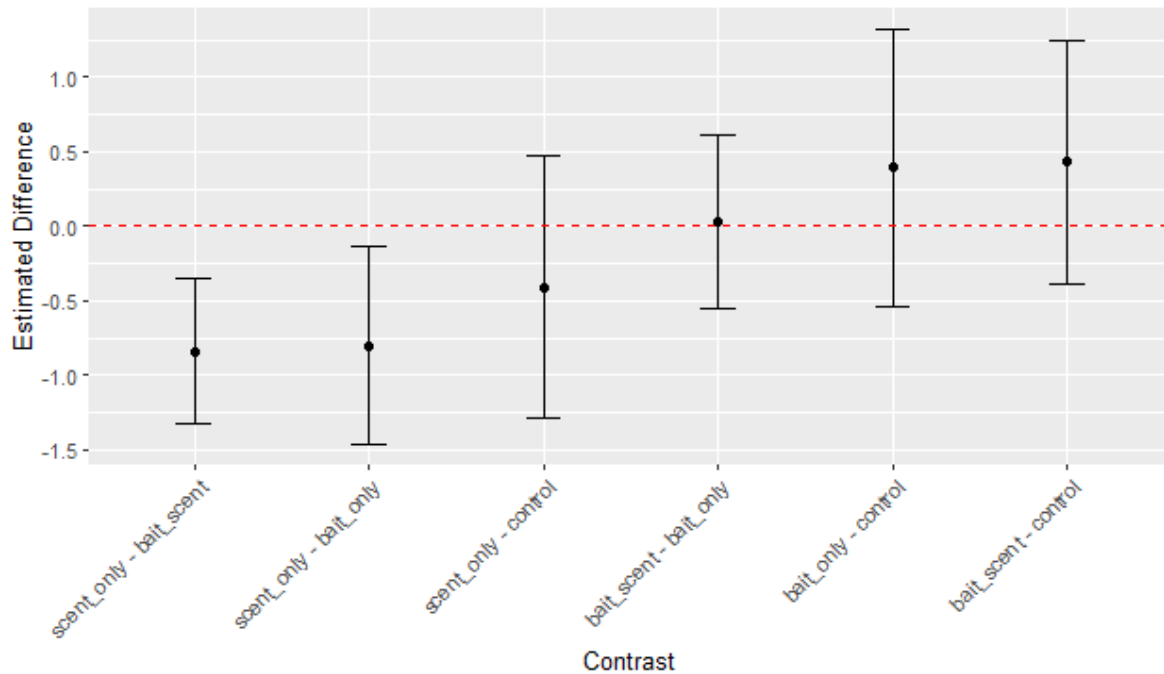
Supplementary Figure A.5: Initial time to visitation of a wild pig (*Sus scrofa*) in hours by lure type on the Savannah River Site near Aiken, SC, US in January-April 2023. Comparing sites with sow in heat only, strawberry only, tuff tusk only, worm only, and no bait or scent (control). Time to initial visitation is the time difference in hours between when the camera was deployed and when a pig when captured in a photo.



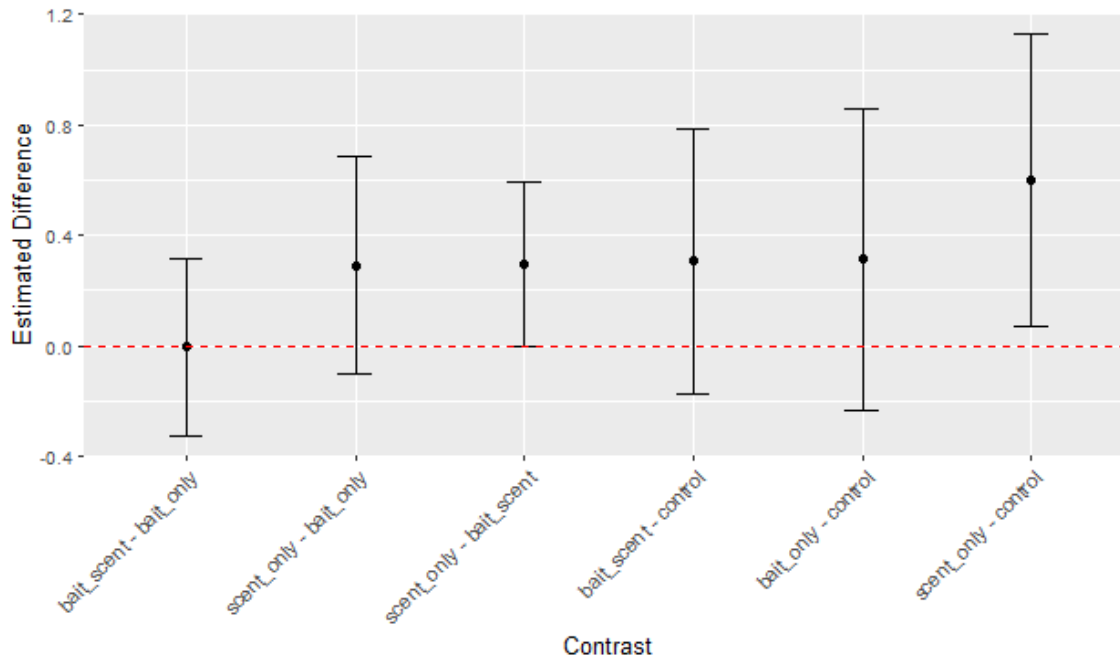
Supplementary Figure A.6: Tukey Test results from GLM modeling for wild pig (*Sus scrofa*) site visitation by treatment type on the Savannah River Site near Aiken, SC, US in January-April 2023. The dashed line corresponds to a value of 0 where if the confidence interval overlaps, the comparison is not significantly different. Bait only represents sites with bait present, scent only with scent present, bait+scent with bait and scent present, and control has no bait or scent present.



Supplementary Figure A.7: Tukey Test results from GLM modeling for groups of wild pigs (*Sus scrofa*) site visitation by treatment type on the Savannah River Site near Aiken, SC, US in January-April 2023. We categorized any visitation event with > 1 pig as a group visitation. The dashed line corresponds to a value of 0 where if the confidence interval overlaps, the comparison is not significantly different. Bait only represents sites with bait present, scent only with scent present, bait+scent with bait and scent present, and control has no bait or scent present.



Supplementary Figure A.8: Tukey Test results from GLM modeling for individual wild pig (*Sus scrofa*) site visitation by treatment type on the Savannah River Site near Aiken, SC, US in January-April 2023. We categorized any visitation event with only 1 pig as a individual visitation. The dashed line corresponds to a value of 0 where if the confidence interval overlaps, the comparison is not significantly different. Bait only represents sites with bait present, scent only with scent present, bait+scent with bait and scent present, and control has no bait or scent present.



Supplementary Figure A.9: Tukey Test results from GLM modeling for wild pig (*Sus scrofa*) time to initial visitation for all pigs by treatment type on the Savannah River Site near Aiken, SC, US in January-April 2023. Time to initial visitation was determined by the difference in hours between the time the camera was deployed and the time a wild pig was in a photo. The dashed line corresponds to a value of 0 where if the confidence interval overlaps, the comparison is not significantly different. Bait only represents sites with bait present, scent only with scent present, bait+scent with bait and scent present, and control has no bait or scent present.



Supplementary Figure A.10: Wild pig (*Sus scrofa*) nesting site made from saw palmettos on the Savannah River Site near Aiken, SC, USA. Photo by James C. Beasley, used with permission.

CHAPTER 3 SUPPLEMENTARY TABLES AND FIGURES

Supplementary Table B.1: Twelve treatments randomly assigned as replicates to collared wild pigs (*Sus scrofa*) performed June 2023 – November 2024 on the Savannah River Site near Aiken, SC, US to quantify differences in visitation rates and time to visitation of target animals. Isopleth represents a space use metric of the home range and is the utilization distributions of the kernel density estimator were broken down to the 99%, 70%, and 40% isopleths. Presentation represents whether corn was presented in a pile in front of the camera or distributed in trails 25 meters in each direction and a pile in front of the camera. Scent represents whether a scent lure (Tink’s Specialty Power Pig Sow-in-Heat Estrous [Tink’s®, Arcus Hunting LLC, Covington, GA, USA]) was present or not

Treatment	Isopleth	Presentation	Scent
1	40%	Pile	Yes
2	40%	Pile	No
3	40%	Trail	Yes
4	40%	Trail	No
5	70%	Pile	Yes
6	70%	Pile	No
7	70%	Trail	Yes
8	70%	Trail	No
9	99%	Pile	Yes

10	99%	Pile	No
11	99%	Trail	Yes
12	99%	Trail	No

Supplementary Table B.2: Percentage of bait sites visited by each individual pig ID on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Pig ID represents individual collared wild pigs. Also recorded is the number of replicates each wild pig received, standard error, and the 95% confidence intervals.

Pig ID	Replicates		SE	CI	
	Count	% Visited		lower	upper
P674	1	0	0	0	0
P631	1	100	0	100	100
P971	3	33.33	27.22	0	86.68
P628	3	33.33	27.22	0	86.68
P535	3	0	0	0	0
P533	3	66.67	27.22	13.32	100
P527	3	66.67	27.22	13.32	100
P972	4	25	21.65	0	67.44
P967	4	75	21.65	32.56	100
P666	4	75	21.65	32.56	100
P636	4	25	21.65	0	67.44
P627	4	0	0	0	0
P525	4	0	0	0	0
P964	5	0	0	0	0
P952	6	33.33	19.25	0	71.05
P635	6	33.33	19.25	0	71.05
P536	6	33.33	19.25	0	71.05

P379	6	66.67	19.25	28.95	100
P959	8	50	17.68	15.35	84.65
P545	8	37.5	17.12	3.95	71.05
P540	8	25	15.31	0	55.01
P672	10	40	15.49	9.64	70.36
P667	12	50	14.43	21.71	78.29
P541	13	15.38	10.01	0	34.99
P532	13	53.85	13.83	26.75	80.95
P973	14	21.43	10.97	0	42.92
P970	14	50	13.36	23.81	76.19
P958	14	50	13.36	23.81	76.19
P673	14	42.86	13.23	16.93	68.78
P664	14	28.57	12.07	4.91	52.24
P526	14	64.29	12.81	39.19	89.39
P531	15	46.67	12.88	21.42	71.91
P549	16	56.25	12.4	31.94	80.56
P383	16	37.5	12.1	13.78	61.22
P539	17	41.17	11.94	17.78	64.57
P529	17	47.06	12.11	23.33	70.79
P378	18	55.56	11.71	32.59	78.51

Supplementary Table B.3: Pairwise comparison for isopleth to explore difference between each isopleth from our average model from our top generalized linear mixed-effects models ($< \Delta AIC$ 2) from our model comparison using an all-combinations approach to determine what influences wild pig (*Sus scrofa*) visitation to bait sites on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Isopleth represents the 99%, 70% and 40% isopleths based on the utilization distributions (UD) for home range estimates.

Pairwise	Estimate	SE	p
Iso40-Iso70	0.381	0.292	0.393
Iso40-Iso99	1.498	0.347	<0.0001
Iso70-Iso99	1.117	0.346	0.0035

Supplementary Table B.4: Pairwise comparison for the interaction between an adult male (boar) wild pig (*Sus scrofa*) visiting a bait site before a targeted collared wild pig by sex of the collared pig from our averaged model from our top generalized linear mixed-effects models ($< \Delta AIC 2$) from our model comparison using an all-combinations approach to determine what influences wild pig (*Sus scrofa*) visitation to bait site on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024.

Pairwise	Estimate	SE	p
No_Boar_Before:Female - Boar_Before:Female	1.202	0.309	0.0006
No_Boar_Before:Female - No_Boar_Before:Male	0.429	0.323	0.546
No_Boar_Before:Female - Boar_Before:Male	0.736	0.319	0.097
Boar_Before:Female - No_Boar_Before:Male	-0.773	0.365	0.147
Boar_Before:Female - Boar_Before:Male	-0.466	0.361	0.568
No_Boar_Before:Male - Boar_Before:Male	0.307	0.374	0.845

Supplementary Table B.5: Pairwise comparison to explore difference between each isopleth from a Cox Proportional Hazard Model used to determine what predictors influence the time to detection of targeted collared wild pigs (*Sus scrofa*) at bait sites on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Isopleth represents a space use metric of the home range and is the utilization distributions of the kernel density estimator were broken down to the 99%, 70%, and 40% isopleths.

Pairwise	Estimate	SE	p
Iso40-Iso70	0.342	0.197	0.191
Iso40-Iso99	1.191	0.271	<0.0001
Iso70-Iso99	0.849	0.275	0.006

Supplementary Table B.6: Pairwise comparisons follow up to further investigate scent:isopleth interaction from a Cox Proportional Hazard Model used to determine what predictors influence the time to detection of targeted collared wild pigs (*Sus scrofa*) at bait sites on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Isopleth represents a space use metric of the home range and is the utilization distributions of the kernel density estimator were broken down to the 99%, 70%, and 40% isopleths. Scent represents whether there was an addition of a scent lure (Tink’s Specialty Power Pig Sow-in-Heat Estrous [Tink's®, Arcus Hunting LLC, Covington, GA, USA]).

Pairwise Scent:Iso	Estimate	SE	p
Iso40_No_Scent : Iso40_Yes_Scent	-0.284	0.261	0.885
Iso40_No_Scent : Iso70_No_Scent	0.406	0.28	0.698
Iso40_No_Scent : Iso70_Yes_Scent	-0.007	0.273	1
Iso40_No_Scent : Iso99_No_Scent	0.638	0.32	0.345
Iso40_No_Scent : Iso99_Yes_Scent	1.459	0.427	0.008
Iso40_Yes_Scent : Iso70_No_Scent	0.69	0.277	0.127
Iso40_Yes_Scent : Iso70_Yes_Scent	0.278	0.272	0.912
Iso40_Yes_Scent : Iso99_No_Scent	0.922	0.319	0.045
Iso40_Yes_Scent : Iso99_Yes_Scent	1.744	0.425	0.0006
Iso70_No_Scent : Iso70_Yes_Scent	-0.412	0.286	0.699
Iso70_No_Scent : Iso99_No_Scent	0.232	0.332	0.982
Iso70_No_Scent : Iso99_Yes_Scent	1.054	0.435	0.149
Iso70_Yes_Scent : Iso99_No_Scent	0.645	0.325	0.351
Iso70_Yes_Scent : Iso99_Yes_Scent	1.466	0.431	0.009

Iso99_No_Scent : Iso99_Yes_Scent	0.822	0.454	0.459
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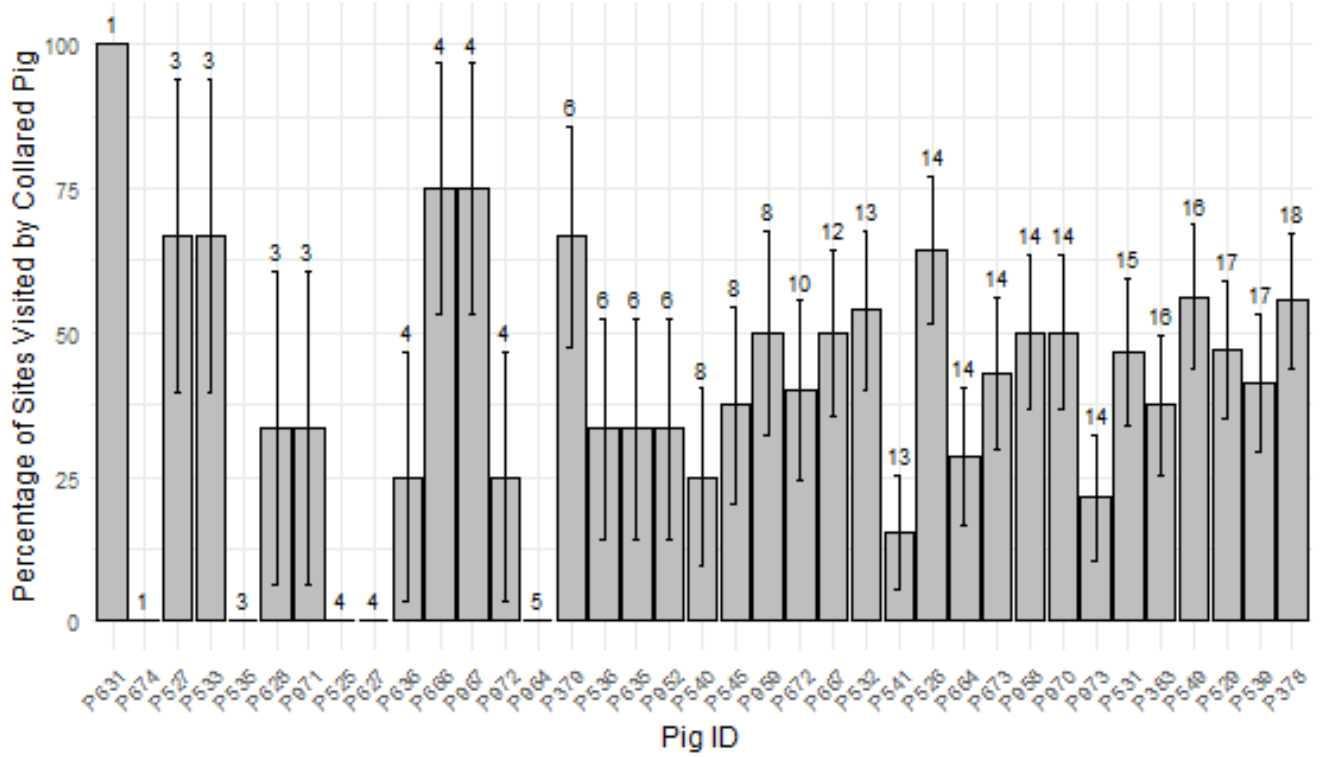
Supplementary Table B.7: Pairwise comparisons follow up to further investigate other pigs before:isopleth interaction from a Cox Proportional Hazard Model used to determine what predictors influence the time to detection of targeted collared wild pigs (*Sus scrofa*) at bait sites on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Isopleth represents a space use metric of the home range and is the utilization distributions of the kernel density estimator were broken down to the 99%, 70%, and 40% isopleths. Other pigs before represents whether a wild pig from another social group visited the site before the target collared animal.

Pairwise Other_Pigs_Before:Iso	Estimate	SE	p
Iso40_No_Pigs_Before : Iso40_Yes_Pigs_Before	1.44	0.278	<0.0001
Iso40_No_Pigs_Before : Iso70_No_Pigs_Before	0.933	0.292	0.0178
Iso40_No_Pigs_Before : Iso70_Yes_Pigs_Before	1.19	0.257	<0.0001
Iso40_No_Pigs_Before : Iso99_No_Pigs_Before	1.44	0.341	0.0003
Iso40_No_Pigs_Before : Iso99_Yes_Pigs_Before	2.38	0.393	<0.0001
Iso40_Yes_Pigs_Before : Iso70_No_Pigs_Before	-0.511	0.306	0.55
Iso40_Yes_Pigs_Before : Iso70_Yes_Pigs_Before	-0.25	0.273	0.943
Iso40_Yes_Pigs_Before : Iso99_No_Pigs_Before	0.000059	0.351	1
Iso40_Yes_Pigs_Before : Iso99_Yes_Pigs_Before	0.938	0.4	0.175
Iso70_No_Pigs_Before : Iso70_Yes_Pigs_Before	0.261	0.883	0.951
Iso70_No_Pigs_Before : Iso99_No_Pigs_Before	0.511	1.396	0.729
Iso70_No_Pigs_Before : Iso99_Yes_Pigs_Before	1.45	3.51	0.006
Iso70_Yes_Pigs_Before : Iso99_No_Pigs_Before	0.25	0.732	0.978
Iso70_Yes_Pigs_Before : Iso99_Yes_Pigs_Before	1.19	3.04	0.029

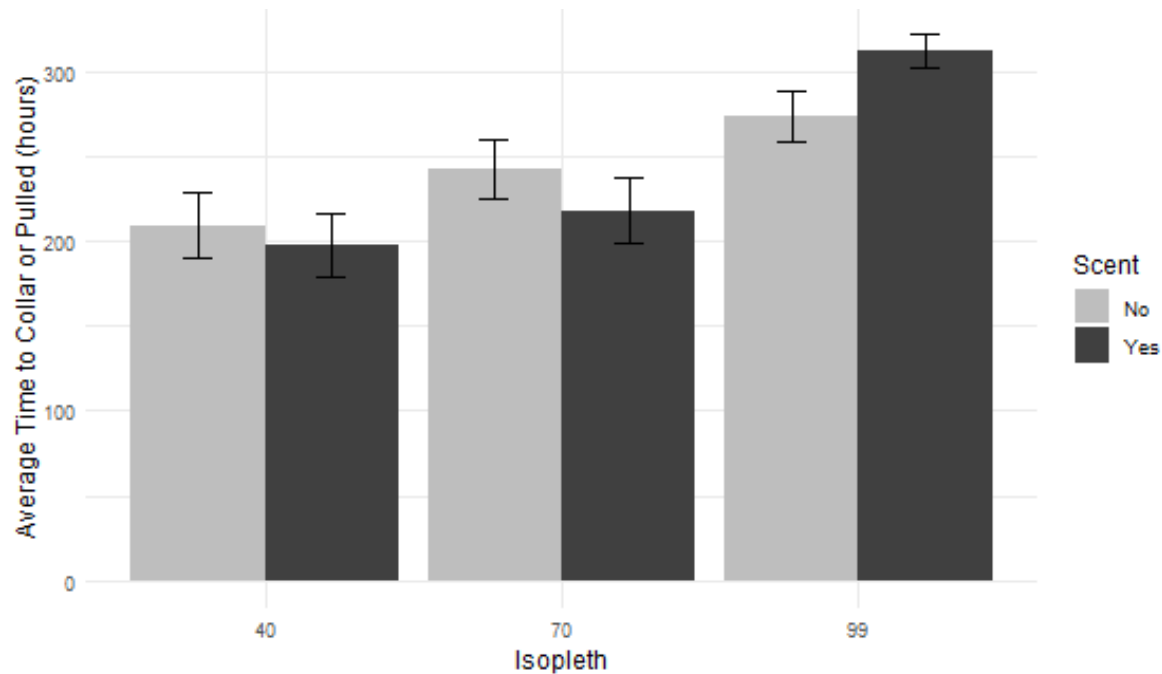
Iso99_No_Pigs_Before : Iso99_Yes_Pigs_Before	0.938	2.194	0.24
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Supplementary Table B.8: Multiple comparisons to further investigate the visitation of an adult male wild pig (boar) before the target collared individual interaction with the sex of the collared pig from a Cox Proportional Hazard Model used to determine what predictors influence the time to detection of targeted collared wild pigs (*Sus scrofa*) at bait sites on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Boar before represents if an adult male from a different social group visited a bait site before a collared animal and sex represents the sex of the collared pig.

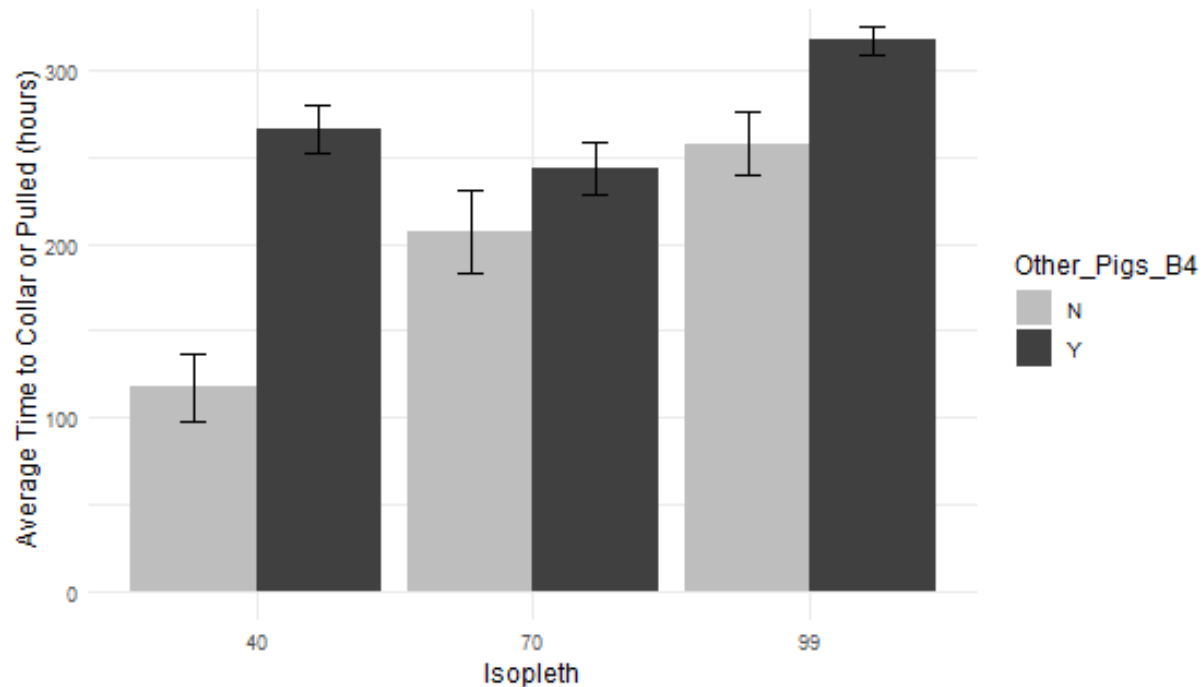
Pairwise Boar_Before:Sex	Estimate	SE	p
Boar_Before_No_Female:Boar_Before_Yes_Female	1.096	0.268	0.0002
Boar_Before_No_Female:Boar_Before_No_Male	0.326	0.449	0.886
Boar_Before_No_Female:Boar_Before_Yes_Male	0.622	0.463	0.535
Boar_Before_Yes_Female:Boar_Before_No_Male	-0.77	0.477	0.371
Boar_Before_Yes_Female:Boar_Before_Yes_Male	-0.474	0.49	0.768
Boar_Before_No_Male: Boar_Before_Yes_Male	0.296	0.298	0.753



Supplementary Figure B.1: Percentage of bait sites visited by each individual pig ID on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. Pig ID represents individual collared wild pigs. Lines represent the 95% confidence interval and number of replicates per pig ID is provided above each bar.



Supplementary Figure B.2: The average time to the initial detection of a collared targeted wild pig (*Sus scrofa*) for whether there was scent present or not at each isopleth at replicates conducted on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. The three isopleths to represent different concentrations of each animal’s space use within their home range: the 40% isopleth represented the core area, where that animal spends the majority of its time (likely important foraging and resting areas); the 70% isopleth represented areas of the home range that the animal uses but more sporadically than the core area; and the 99% isopleth, which represents the periphery of the home range where the animal does not spend a lot of time but occasionally moves into. We used Tink’s Specialty Power Pig Sow-in-Heat Estrous (Tink's®, Arcus Hunting LLC, Covington, GA, USA) as our scent lure.



Supplementary Figure B.3: The average time to the initial detection of a collared targeted wild pig (*Sus scrofa*) for whether other wild pigs visited the site before the targeted pig at each isopleth at replicates conducted on the Savannah River Site near Aiken, SC, US from June 2023 – November 2024. The three isopleths to represent different concentrations of each animal’s space use within their home range: the 40% isopleth represented the core area, where that animal spends the majority of its time (likely important foraging and resting areas); the 70% isopleth represented areas of the home range that the animal uses but more sporadically than the core area; and the 99% isopleth, which represents the periphery of the home range where the animal does not spend a lot of time but occasionally moves into. We determined whether a wild pig, not in the same social group, visited a bait site before the collared targeted individual.