FINAL PERFORMANCE REPORT

Federal Aid Grant No. F17AP00207 (E-87-R-1)

Surveys to Determine Impacts of Grazing and Pecan Orchards on the American Burying Beetle

Oklahoma Department of Wildlife Conservation

April 1, 2017 – March 31, 2018

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Principal Investigator: W. Wyatt Hoback, Department of Entomology and Plant Pathology, Oklahoma State University

A. ABSTRACT:

The American Burying Beetle (*Nicrophorus americanus,* ABB) is a federally-endangered insect in the family Silphidae, a group known as "carrion beetles". The prevailing hypothesis for the ABB's decline is habitat loss and fragmentation (Sikes & Raithel, 2002; USFWS, 2008). To understand how the species is being impacted, it is important to understand the ABB's *habitat association,* or the habitat that is best suited consistently for supporting the species. The three primary objectives of this project were to 1) assess the presence and density of ABBs in areas within the range that are experiencing two different agricultural practices, 2) investigate the presence of ABBs on selected sites throughout the currently delineated occupied range, and 3) determine possible habitat associations of ABBs. Surveys were conducted in 11 Oklahoma counties, with 125 traps deployed and a total of 599 trap nights. A total of 53 ABBs were captured, with 50 being captured on sites grazed by cattle and none being captured on pecan orchards.

B. BACKGROUND:

Silphidae is a small family of beetles referred to as the "carrion beetles". Carrion beetles survive using the carcasses of small animals for feeding and reproduction. This family contains 30 genera and 208 species found worldwide, of which 8 genera and 30 species may be found in North America. The Silphidae family is subdivided into the subfamilies Silphinae and Nicrophorinae. While Silphinae primarily feed on larvae of other scavengers, including maggots found in carrion, most Nicrophorinae (burying beetles) use appropriately sized carrion and use it for reproduction (Hoback, et al. 2004). To do so, burying beetles have developed complex social interactions and have the ability to bury suitably-sized carrion underground to protect it from other scavengers. This carcass is then maintained by the parents for sustenance and to feed and rear their young until pupation (Suzuki, 2013).

Of the burying beetles, the most-studied in North America is *Nicrophorus americanus*, the critically endangered American Burying beetle (ABB) (USFWS, 2008). Historically, the ABB's range extended across 35 states and 3 adjacent Canadian provinces, accounting for the entire eastern half of the country (Leasure & Hoback, 2017). However, that range has since decreased by nearly 90% over the last century, and what remains is located on the far edges of that

historical range. With additional surveys after its 1989 listing, populations were found in Rhode Island, Arkansas, Kansas, Texas, Nebraska, Oklahoma, and South Dakota. Currently, there exist three geographically isolated populations centered in Nebraska, Oklahoma, and on Block Island, Rhode Island (Bedick, et al., 1999; USFWS, 2015). In the U.S. Fish and Wildlife's 5-Year Review of the ABB, published in 2008, they report ABB occurrences in 21 counties in Oklahoma, with a particularly notable concentration located in Muskogee county (USFWS, 2008).

Emerging in early spring/summer, young adult ABB will locate a suitable carcass, between 100-200g in size, and a pair will work together to bury it underground. As a member of *Nicrophorinae*, mated pairs of ABB must bury and maintain "brood balls", assembled from suitable carrion, for their own nourishment and for the survival of their larvae. This brood ball is crucial to the survival of the new generation, as the parents use it to nourish their larvae and protect them from parasites until they pupate beneath the soil (Suzuki, 2013; USFWS, 2015). If the breeding pair is unable to find or bury a suitable carcass, their cache of food is disturbed, or their pupae are prematurely uncovered, they cannot rear their brood and numbers will decline. Therefore, not only does increased human development limit and fragment their range in which to search for carrion, it also hurts the chances for the species to repopulate, particularly in areas with frequent soil disruption, such as agriculture. Particularly in the central US, naturally-occurring prairie has been tilled for cropland or converted for livestock grazing.

Understanding the species' habitat association allows us to better conserve the species and allow its life cycle to continue. This is a difficult task, as the species appears to show different habitats preference between isolated populations, with possible factors including availability of food, climate, and (possibly) the type of vegetation in the environment (Leasure & Hoback, 2017). However, there is little understanding of how the species reacts to land already converted from its natural landscape for human development and use. In Eastern Oklahoma, natural features such as Great Plains prairie and old growth forests are rapidly dwindling. However, some human agricultural practices can maintain a habitat structure conducive to ABB occupation, such as grazed rangelands and cultivated tree orchards. Such land management activities may closely mimic native grasslands and savannahs historically maintained by fire and nomadic herds of American Bison (*Bison bison*).

C. OBJECTIVES:

To determine presence or absence of American burying beetles (ABB) associated with pecan orchards and cattle ranches relative to ABB numbers in undisturbed areas in eastern and southeastern Oklahoma.

D. PROCEDURES:

<u>Surveys to Determine Presence of ABBs Throughout Current Delineated Range</u>

Most ABB sampling in Oklahoma is limited to surveys in areas planned to be modified for energy development. During these surveys, upon discovery of a beetle, the traps are pulled and sampling ends. This technique is useful for the companies funding surveys, but is not useful for gauging population size. Therefore, in accordance with Fish and Wildlife's established ABB protocol (first proposed by Bedick, et al. 2004), trap weeks consisted of a minimum of 5 consecutive nights setting nocturnal traps, checked no later than 10:00AM the following morning

(J.C. Bedick, Ratcliffe, & Higley, 2004). Invalidation of a night occurs under the following conditions in accordance with Oklahoma's USFWS protocol:

- Nighttime temperature falls below 55ºF (during the survey period)
- Wind speed is greater than 10 mph in excess of 20% of the time between 9:00 p.m. and 4:00 a.m. (1 hour 24 minutes)
- Precipitation exceeds 0.5 inches between 9:00 p.m. and 4:00 a.m.

A 5-day week is invalidated in its entirety by 3 days of unsuitable conditions (USFWS, 2016). Beetle sampling was conducted under the license of Dr. W. Wyatt Hoback in the summer of 2017.

Traps utilized were a modification of the Fish and Wildlife's *5-gallon above-ground Bucket Trap* design used by OSU's Entomology department (USFWS, 2015). Compared to below-ground pitfalls utilized in Nebraska, above-ground traps are utilized in Oklahoma to avoid ants, which can kill captured Silphidae and because the soil is often rocky or heavy clay. This redesign of a traditional pitfall trap consists of a 5-gallon bucket partially filled with peat moss and topped with a lid with a funnel sloping inward, sealed to prevent escape and lashed to a tree or post with a bungee cord. This design ensures that carrion beetles can detect the scent of the bait, but are incapable of flying out of the trap. The bait consisted of a previously frozen rat carcass, allowed to thaw and heat in the sun for three days prior to beginning sampling. Each trap was rebaited with a similarly-rotted rat halfway through sampling. The traps lids used for this project were built by Dr. James Hardin (Figure 1).

<u>Investigate presence of ABBs in different agricultural and environmental conditions</u>

The goal of these surveys was to fill this gap in our understanding of how the species responds to human land management by investigating two types of land usage highly prevalent in Eastern Oklahoma.

The first was *cattle pastures*, where large areas of land are covered by nonnative plants and are frequently scoured and flattened by the presence of livestock. The USDA reported 4.85 million head of cattle and calves on Oklahoma farms and ranches at the start of 2016. The second land use investigated was pecan *orchards*, where previous land is converted to support and maximize production of native and crossbred pecans, and local wildlife is discouraged. 6,500 tons of pecans were produced during 2016, and USDA's National Agricultural Statistics service reports a 2016 survey showing 94,000 acres bearing Pecans in Oklahoma (USDA-NASS, 2018; USDA-NASS & ODAFF, 2016). Both represent economic importance to Oklahoma, both require large areas of land, and both have the potential to support ABB and other *Nicrophorus* populations. Given the presence of cattle and pecans around eastern Oklahoma and within ABB's current range, these surveys intend to expand upon our understanding of how the species reacts to a wider range of environments.

The locations for these sampling weeks were determined by availability of pecan orchards in proximity to cattle pastures, within or on the edge of currently known ABB range (Figure 2). Prior to sampling, private landowners who maintained pecan orchards personally or professionally were contacted and alerted to the nature of the sampling. Some were contacted with the help of Dr. Phil Mulder in collaboration with the Pecan Growers' Association of eastern Oklahoma. When granted approval from the landowner, traps were placed within the property.

OSU-owned property was also sampled with permission, contacted with the aid of Dr. Justin Talley (Table 2).

In all other cases, traps were set along public rights-of-way to avoid concerns of trespassing and alleviate public concerns about potential additional regulation by the Fish and Wildlife Service. USFWS protocol suggests a distance of 1.0 mile (1.6 km) between each trap to account for the most effective survey radius, due to the ability of the beetles to fly up to 0.5 miles in a single night in pursuit of food (USFWS, 2015). This, along with the survey time limit, limited each sampling week to a maximum of 20 traps. In addition to being designated as Cattle Pasture and Pecan Orchard, each trap was noted for its proximity (within 0.5 miles) to forest, prairie, bodies of water, large roads, and human residences (Table 1).

Determine possible habitat association and correlation between habitat and ABB Population

Upon checking each trap, all Silphidae were counted and recorded, before being returned to the environment. In the event of the capture of an ABB, the beetle's sex, age (teneral/senescent), and size of pronotum was recorded. To ensure the population of ABBs is properly gauged, each beetle was marked using a surgical cauterizer before release. Depending upon the day, the mark was placed on one of the four orange elytral markings or the bright pronotum, to not only show previous capture, but the date of capture. This technique ensures a permanent indication of the beetle's capture that extends past the end of the 5-day sampling period, and may be used in future surveys, without impeding the beetle's reproductive success (Jenkins et al., 2016). At the end of the survey period, all beetle data were assembled and compared between habitat types to determine any possible correlation. In the absence of ABBs, the closely related *Nicrophorus orbicollis* was considered as a proxy when assessing suitability of land use to *Nicrophorus* occurrence.

Once data were gathered, a Chi Squared Goodness of Fit test was conducted with captured ABBs. This test was used to compare between expectations and observations of the distribution of ABBs across both pecan orchards and cattle pastures.

E. RESULTS AND DISCUSSION:

Surveys to Determine Presence of ABBs Throughout Current Delineated Range

Beginning on May 30, 2017, and ending on August 20, 2017, 5-day sampling periods occurred at 7 locations, with a collective total of 125 traps (Figure 3). These traps covered 11 counties in total (Figure 4). These 35 total days of sampling yielded 599 successful trap nights (26 trap nights were lost due to trap disturbance). The summer yielded 1,738 captures of Silphidae, comprising 8 species. In addition to ABB, *Nicrophorus orbicollis, Nicrophorus carolinus, Nicrophorus tomentosus, Nicrophorus pustulatus, Nicrophorus marginatus, Necrophila americana,* and *Necrodes surinamensis* were recovered (Table 3).

Across the entire sampling, 53 ABBs were captured. From this, there were 2 recaptures, resulting in 51 unique captures. All ABBs were captured on Week 5 in 10 traps located near Muskogee and Haskell on or near Highway 62 (Figure 5). Of these, 33 were male and 18 were female. Twenty-seven were tenerals (2017 brood) and 25 were senescent beetles that had emerged in early May (Table 6).

Despite over 2 collective months' worth of sampling, ABBs were only found in one survey area, the Muskogee transect. This site is located north of Camp Gruber in Braggs, OK, home to one of the highest ABB concentrations in the state, where the species flourishes. Outside of this grant, a separate OSU sampling trip at Camp Gruber occurred during this sampling week and researchers caught 449 ABB individuals.

Investigate Presence of ABBs in Different Agricultural and Environmental Conditions

Of the 125 traps, 22 were categorized as "Pecan Orchard", 55 were categorized as "Cattle Pasture", and 15 were categorized as both (Table 1). No ABB were captured on pecan orchards (Table 5). Captured *N. orbicollis* were not marked or recorded for recapture, so these numbers cannot be used to accurately gauge population. However, they are closely-related to ABB and are nocturnally active. They may be used as a proxy. A majority of *N. orbicollis* were found on cattle pastures in most locations, with notable exception on weeks 3 and 6, where traps set in areas with both cattle and pecans had higher numbers (Table 4).

The data suggests that the ABB favors cattle pastures when compared to pecan orchards and native forest. Even when analyzing the 5 locations where ABB was absent, *N. orbicollis* was found more often in areas with cattle, with the exception of Week 6 sampling (Figure 6).

There are multiple possible explanations for the difference in population between the two land use types. Pecan growers may be limiting potential carrion sources to increase yield. When interviewed, producers stated that they actively killed squirrels in their orchards, but did not allow the carcasses to remain in the orchard, which may keep beetles from occurring in what could be acceptable land. Another possibility is the pesticides used by pecan growers that are absent on a cattle pasture. Of note, Trap #10 from Week 3 was placed on an older pecan tree within the OSU Mac Lindley Research Station near Valiant, OK, and yielded 160 *N. carolinus* and 63 *N. pustulatus* over the 5-day period, substantially more than other traps set in or nearby the same station. Of note, this tree was reportedly not sprayed with any insecticidal compounds, and was only administered a light herbicide.

Regardless of all the factors that may limit occurrence of ABB in pecan orchards, cattle grazing may allow their persistence. Some pecan growers will raise cattle inside their orchards as a way of compacting soil and controlling undergrowth with grazing to increase pecan yield. In terms of the data, however, it did not appear to make a difference with ABB. With *N. orbicollis*, the difference seems more notable, suggesting *Nicrophorus* survive better in the presence of cattle grazing.

Determine Possible Habitat Association and Correlation Between Habitat and ABB Population

The Chi-Square Goodness of Fit test is represented with the following equation, where O = observed value, E = expected value.

$$X^2 = \left[\frac{(O-E)^2}{E}\right]$$

Only ABBs caught on either cattle pastures or pecan orchards were considered (n=50). We ran the test between the two environments and found the two to be statistically significant (Table 7).

Therefore, we conclude that there is a significant difference in populations of ABB found on Cattle Pastures compared with Pecan Orchards in the same area (α=0.01, X^2=50, P<0.001).

F. SIGNIFICANT DEVIATIONS:

No significant deviations.

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Date: June 1, 2018

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APPENDIX

Figure 1. OSU's above-ground American Burying beetle trap, hung in April 2018.

Figure 2. Current American Burying Beetle range, from USFWS 2016 data

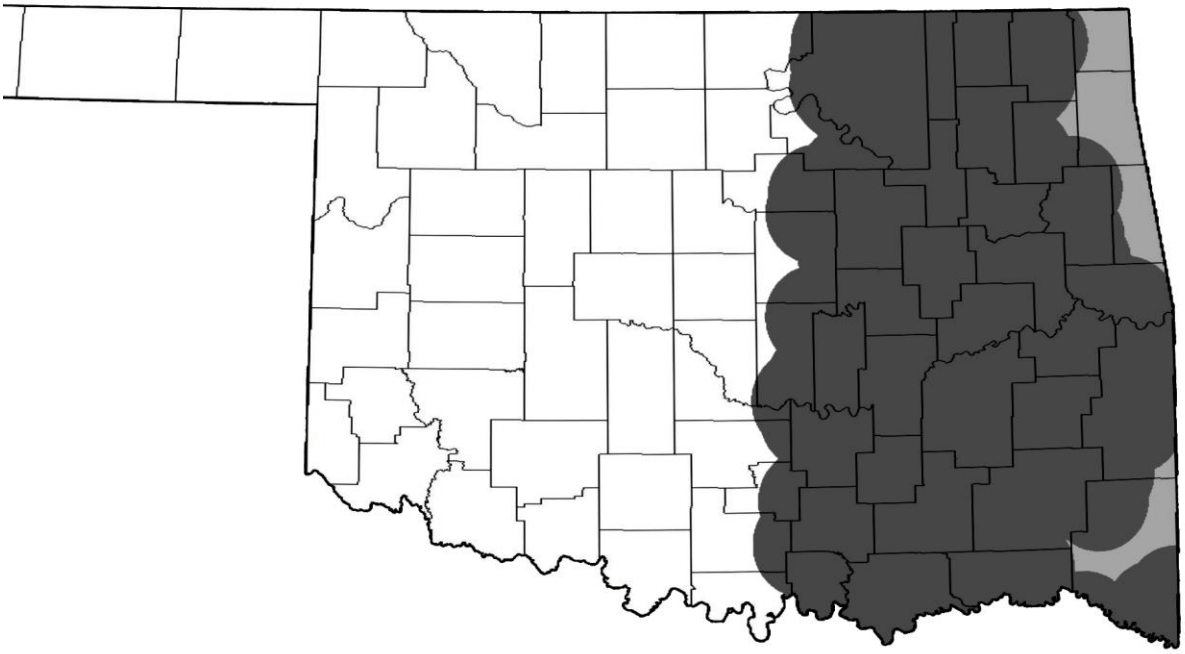

Figure 3. Location of all traps set during summer 2017 sampling

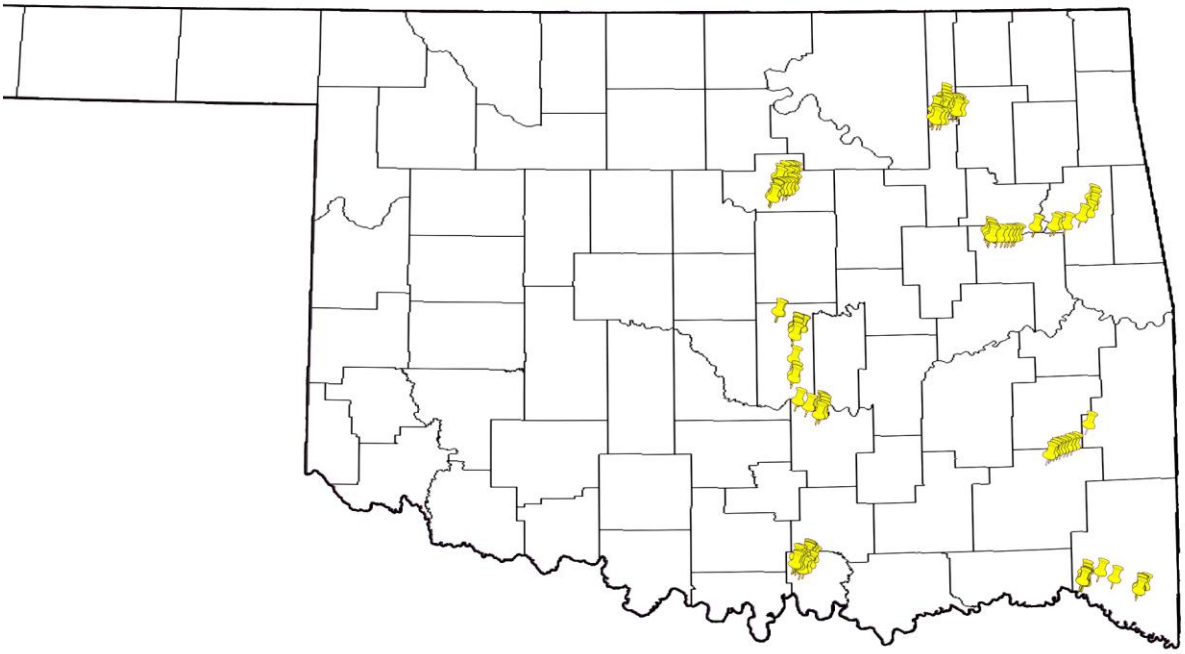

Figure 1: Total number of counties sampled within during summer 2017 sampling.

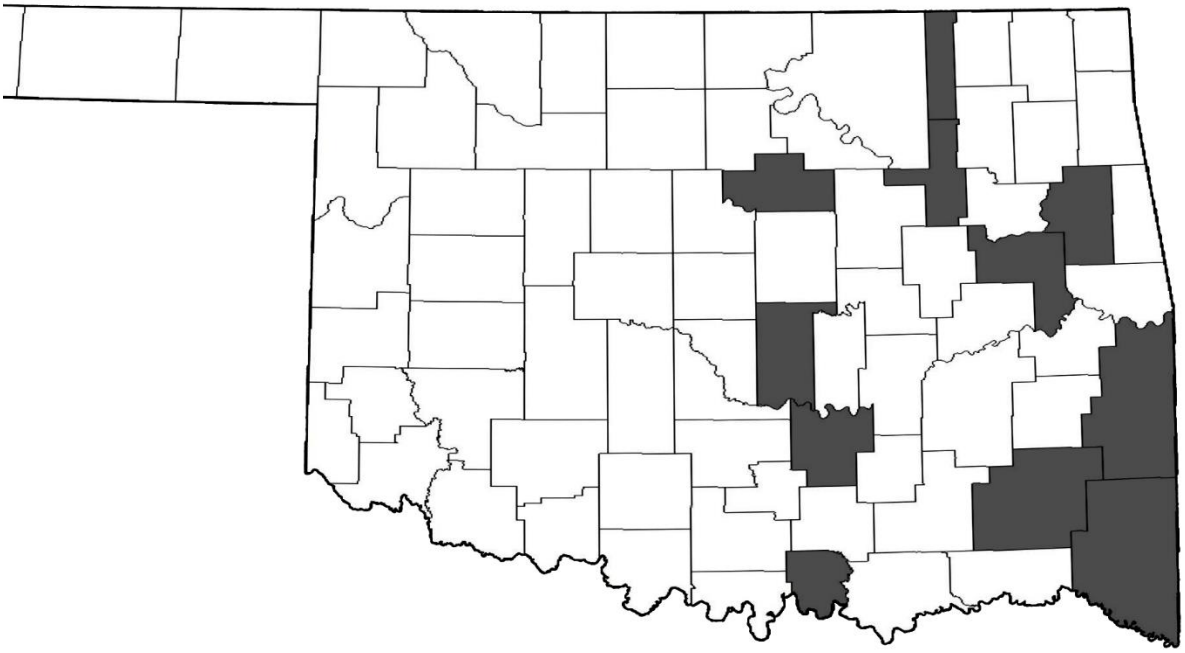

Figure 2: Map of trap locations set in week 5 of sampling, running from Tahlequah, to Muskogee, to Haskell. Green indicates a location positive for American Burying Beetle.

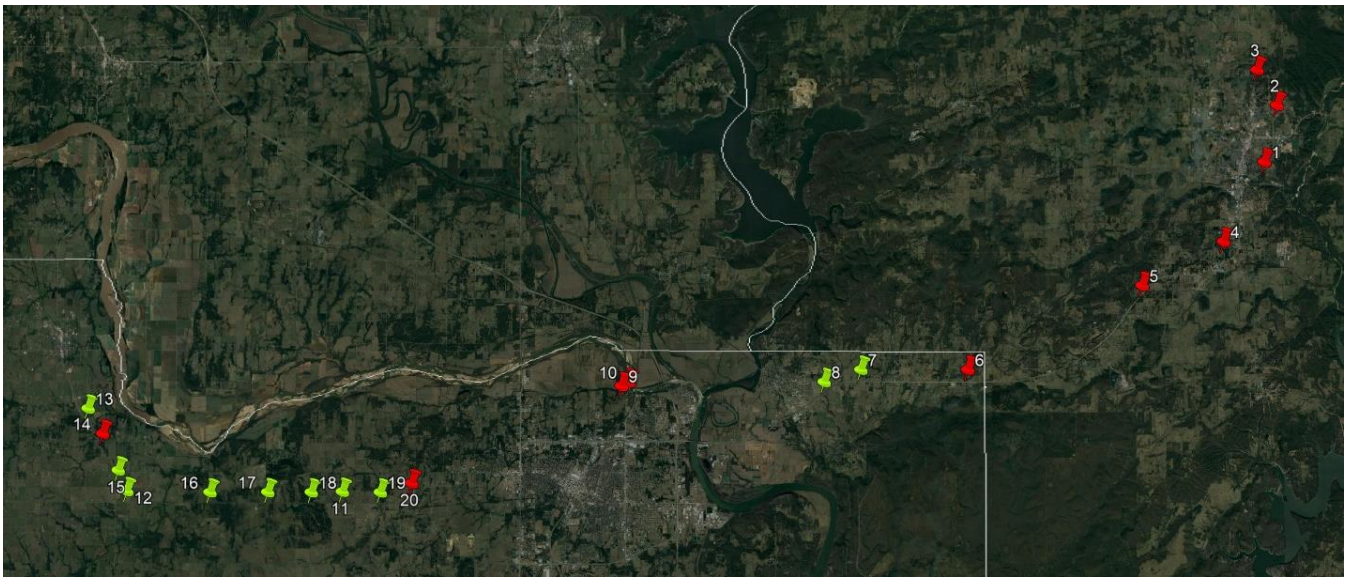

Figure 3: Weekly captures of *Nicrophorus orbicollis*, a congeneric species to *N. americanus*, by week and habitat designation during summer 2017 sampling.

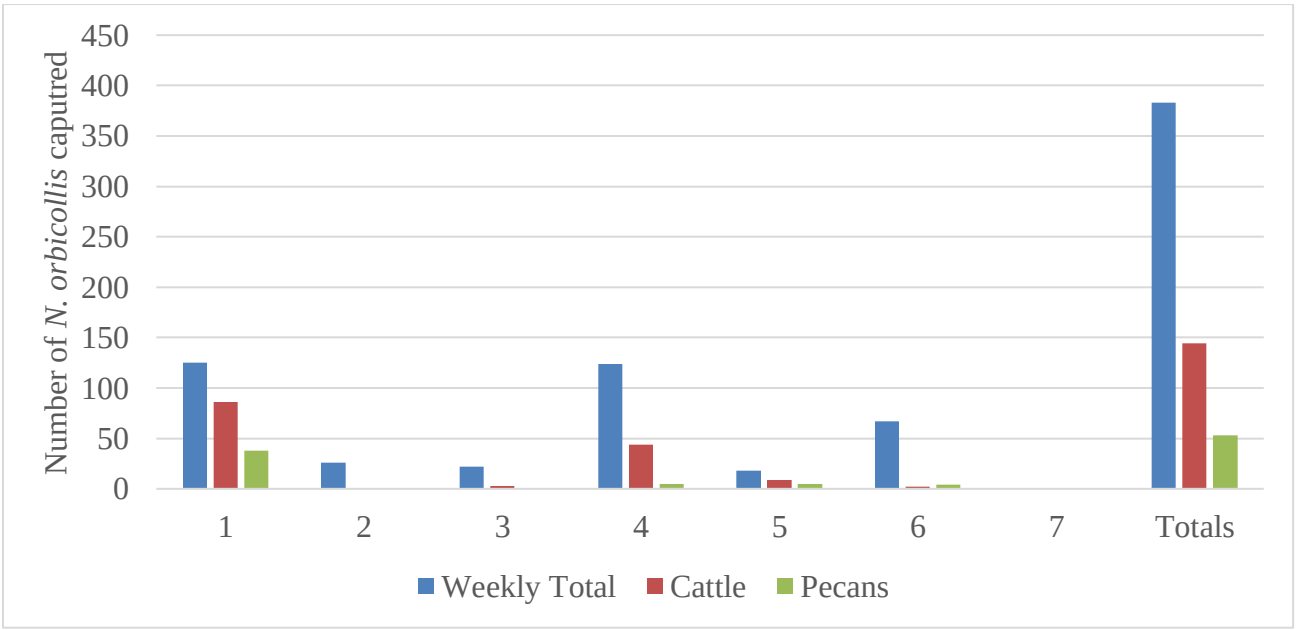

Table 1: Traps by location and habitat designation. Green highlights indicate a trap that falls under the both cattle and pecan distinctions. (P=Pecans; C=Cattle; Pr=Prairie; F=Forest; W=Water; R=Road or Highway; Re=Residence)

Week	Trap	Latitude	Longitude	P	C	Pr	F	W	R	Re
1	1	34.110676	-96.863236	X		X			X	
	2	34.110851	-96.857191		X					
	3	34.101074	-96.85975	X						
	4	34.117156	-96.863492	X			X		X	
	5	34.100102	-96.867653	X	X		X		X	
	6	34.071396	-96.898597	X						
	7	34.070839	-96.913904	X				X	X	X
	8	34.079947	-96.922722	X						
	9	34.09293	-96.918386		X		X			
	10	34.092164	-96.93331	X					X	
	11	34.060075	-96.925923	X						
	12	34.056354	-96.938378		X		X			
	13	34.050852	-96.914935	X		X	X			
	14	34.056288	-96.895882	X			X	X	X	
	15	34.028645	-96.893757		X				X	
	16	34.032961	-96.871283		X	X			X	
	17	34.055745	-96.84572		X	X			X	
	18	34.085579	-96.826318		X	X			X	
	19	34.094658	-96.845701		X	X			X	X
	20	34.107644	-96.850427		X				X	X
2	1	34.59486	-95.30636				X			
	2	34.60463	-95.28788				X			
	3	34.61533	-95.27691				X			X
	4	34.61552	-95.25913				X			
	5	34.62169	-95.23858				X		X	X
	6	34.62477	-95.21974			X	X		X	
	7	34.6343	-95.1903				X		X	
	8	34.63661	-95.16894			X	X			X
	9	34.64316	-95.14463			X	X			X
	10	34.74952	-95.04475							X
3	1	33.94029804	-94.91218598		X				X	
	2	33.97910204	-95.00153303		X		X		X	
	3	33.97709001	-95.104412						X	
	4	33.955872	-95.10432298						X	
	5	33.93306397	-95.10427497	X	X				X	
	6	33.93933203	-95.10532604		X					
	7	33.93936597	-95.11703402		X			X		
	8	33.933921	-95.11729104	X	X			X		
	9	33.932775	-95.11273598	X	X			X		

	10	33.928539	-95.10416298	X						
	11	33.87305801	-94.75666103		X		X		X	
	12	33.89556301	-94.72328603		X				X	
	13	33.89364801	-94.75000298				X			
	14	33.89054801	-94.75572299				X			
	15	33.894981	-94.75445497				X			X
4	1	36.087741	-96.919765		X		X		X	
	2	36.087611	-96.93779		X	X			X	
	3	36.08734	-96.956627	X	X			X	X	
	4	36.087327	-96.991345		X			X		
	5	36.072545	-97.019798		X	X	X			
	6	36.058102	-97.014824		X	X				
	7	36.056728	-96.964774			X				
	8	36.05845	-96.933478		X	X		X		
	9	36.058688	-96.914213			X			X	
	10	36.02292	-96.921801					X	X	
	11	36.021888	-96.944738		X		X		X	
	12	36.0018	-96.94491		X				X	
	13	36.000388	-96.965783		X	X	X			
	14	35.99976	-96.993101			X	X			
	15	35.999854	-97.016816		X					
	16	35.99535	-97.037038	X						
	17	35.992737	-97.042363	X						
	18	35.989776	-97.037466	X						
	19	35.970874	-97.059133			X				X
	20	35.961911	-97.051106			X				
5	1	35.89815204	-94.96292997			X	X		X	
	2	35.92544398	-94.95506897				X	X	X	X
	3	35.94252097	-94.96674299			X	X		X	
	4	35.85992702	-94.987626	X				X		X
	5	35.83894903	-95.03610302		X			X	X	
	6	35.79883802	-95.13974003		X	X			X	
	7	35.79890402	-95.20310402		X	X			X	
	8	35.793045	-95.22482301		X				X	X
	9	35.79111303	-95.34480301	X						X
	10	35.79297797	-95.34051101	X						X
	11	35.74033898	-95.50968499		X				X	
	12	35.74033203	-95.63732496		X				X	
	13	35.77979201	-95.66062699		X	X	X		X	
	14	35.76778199	-95.65185101		X				X	X
	15	35.75023897	-95.642474		X				X	
	16	35.73987702	-95.588031		X	X	X		X	
	17	35.740066	-95.553805		X				X	
	18	35.74004698	-95.52806001				X		X	

	19	35.74008799	-95.48724196		X			X	X	
	20	35.74449199	-95.46872301		X	X	X		X	
6	1	34.85136402	-96.75567302			X	X			X
	2	34.88328798	-96.77271202	X		X	X	X		
	3	34.876024	-96.76339601	X	X	X				
	4	34.86727597	-96.754601		X	X				
	5	34.83285899	-96.757215			X	X			X
	6	34.82698397	-96.77751602		X	X				
	7	34.87038398	-96.84136102		X			X		
	8	34.90038603	-96.90732397		X	X				
	9	35.01869001	-96.93102898				X			
	10	35.03809697	-96.93129902				X			
	11	35.11821703	-96.93203002				X	X		
	12	35.23977003	-96.92188899		X		X	X		
	13	35.28987496	-96.91967604	X						
	14	35.29314402	-96.921093	X	X					
	15	35.27144199	-96.92309603	X	X					
	16	35.26544998	-96.92252801	X	X	X				
	17	35.28242301	-96.87777398	X						
	18	35.28006602	-96.88327396	X	X					
	19	35.36421097	-97.01881703	X	X					
	20	35.36559396	-97.026861	X	X					
7	1	36.36606698	-95.97854903	X	X	X	X			
	2	36.38007977	-95.97819502	X	X					
	3	36.38184997	-95.99136298			X	X			X
	4	36.42352798	-95.98250896				X			X
	5	36.42365104	-95.96264599		X					X
	6	36.42359204	-95.92581598		X	X				
	7	36.43808102	-95.91484096		X	X	X			
	8	36.43815401	-95.89198502		X					
	9	36.43819901	-95.86827704		X		X	X		
	10	36.43814003	-95.84823998		X	X				
	11	36.43812999	-95.83170198	X						
	12	36.42160401	-95.84840099		X					
	13	36.409115	-95.841139		X					X
	14	36.42352798	-95.98250896	X	X					
	15	36.40953901	-95.81322799	X				X		
	16	36.36593897	-95.92883689			X			X	X
	17	36.36585994	-95.94939338		X					
	18	36.49386622	-95.92082621		X				X	
	19	36.47643849	-95.92078527		X		X			
	20	36.4571821	-95.92083886		X		X			
Totals	**125**			**37**	**70**	**40**	**46**	**19**	**48**	**23**

Table 2: List of counties sampled by week in 2017, with OSU-owned properties included when utilized.

Week	Counties	OSU properties utilized
1	Marshall	
2	Pushmataha, Le Flore	
3	McCurtain	Mac Lindley Research Station, Kiamichi Research Station
4	Payne	Cimarron Valley Research Station
5	Cherokee, Muskogee	Haskell Research Station
6	Pontotoc, Pottawatomie	
7	Tulsa, Washington	

Table 3: Total Trap nights and Silphidae captures by location in 2017.

Trap Week	Trap Nights	N. americanus	N orbicollis	Other *Nicrophorus*	*Silphinae*
1	*92*	0	125	251	37
2	45	0	26	40	76
3	*72*	0	22	331	18
4	*99*	0	124	206	52
5	*100*	53	18	27	43
6	*99*	0	67	84	95
7	*92*	0	1	18	35
Totals	***599***	***53***	***383***	***957***	***356***

Table 4: List of captured *N. orbicollis* by habitat designation and location, using Pecan and Cattle designations found on Table 1.

Sampling Week	Total *N. orbicollis*	Cattle	Pecans	Both	Prairie	Native Forest	Both
1	125	86	38	5	1	74	13
2	26	-	-	-	0	14	8
3	22	3	1	14	0	4	0
4	124	44	5	8	82	12	23
5	18	9	5	0	1	3	4
6	67	2	4	35	0	18	4
7	1	0	0	1	0	0	1
Totals	383	144	53	63	84	125	53

Table 5: Table of Trap designations and ABB capture statistics from Week 5, covering Cherokee and Muskogee counties. Individual ABB were beetles not previously captured, and not considered for population count.

Week #	Trap#	Pecans	Cattle	Individual ABB	Recaptured ABB
5	1			0	
	2			0	
	3			0	
	4	X		0	
	5		X	0	
	6		X	0	
	7		X	1	
	8		X	1	
	9	X		0	
	10	X		0	
	11		X	4	
	12		X	2	
	13		X	4	
	14		X	0	
	15		X	4	
	16		X	22	1
	17		X	11	1
	18			1	
	19		X	1	
	20		X	0	

Table 6: Date, location, and characteristics of ABBs caught in Week 4 of sampling. Two beetles captured had been previously marked.

Date	Daily Capture #	Trap	Sex	Age (T/S)	Pronotal Width	Recapture
7/15/2017	1	11	M	T	7.31	
	2	13	F	T	7.71	
	3	16	M	T	7.11	
	4	16	F	T	10.44	
7/16/2017	1	11	M	T	8.11	
	2	11	M	S	9.12	
	3	12	F	S	9.94	
	4	16	F	T	7.15	X1
	5	16	F	S	8.32	
	6	17	M	T	8.21	
	7	17	M	S	7.97	
7/17/2017	1	15	F	S	10.13	
	2	15	M	S	9.03	
	3	16	M	S	8.25	
	4	16	F	S	9.26	
	5	16	M	T	9.24	
	6	16	F	S	7.41	
	7	17	F	T	10.01	
7/18/2017	1	7	M	T	6.75	
	2	11	M	S	10.25	
	3	13	M	S	10.09	
	4	15	M	S	9.77	
	5	16	M	S	8.9	
	6	16	M	T	11.38	
	7	16	M	T	10.26	
	8	16	M	S	9.23	
	9	16	M	T	9.96	
	10	16	F	T	10.29	
	11	17	M	T	10.2	
	12	17	F	S	9.72	
	13	17	F	S	8.52	
	14	17	M	T	9.57	
	15	17	M	T	9.67	
	16	17	M	T	9.38	
	17	17	M	T	10.32	
	18	17	M	T	9.56	
7/19/2017	1	8	F	S	10.83	
	2	12	M	S	9.37	
	3	13	F	T	8.76	
	4	13	M	T	9.99	

	5	15	M	S	9.35	
	6	16	M	S	9.59	
	7	16	M	T	9.63	
	8	16	F	T	9.26	
	9	16	F	T	9.3	
	10	16	M	T	9.99	
	11	16	F	S	11.71	
	12	16	F	T	7.57	
	13	16	M	S	9.24	
	14	16	F	S	7.6	
	15	17	M	S	9.18	X1
	16	18	M	S	9.73	
	17	19	M	T	9.25	

Table 7: Table showing results of Chi-Square Goodness of Fit test.

ABB	Observed	Expected	$(O-E)^2 / E$
Cattle	50	25	25.00
Pecan	0	25	25.00
			$X^2 = 50.00$