# VULTURE SCAVENGING OF PIG REMAINS AT VARYING GRAVE DEPTHS

THESIS

Presented to the Graduate Council of
Texas State University-San Marcos
in Partial Fulfillment
of the Requirements

for the Degree

Master of ARTS

by

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San Marcos, Texas
August 2013

VULTURE SCAVENGING OF PIG REMAINS AT VARYING GRAVE DEPTHS

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**ACKNOWLEDGEMENTS**

All of my thanks go to my committee members, without whom the completion of this project would not have been possible. I am especially grateful for the help from Dr. Michelle Hamilton. She went above and beyond and was always available when I needed help or encouragement, the Jedi Master that guided me throughout my research and schoolwork. The advice from Dr. Kate Spradley, Dr. Elizabeth Erhart, and Dr. Randy Simpson in the writing of my thesis has been invaluable.

To my parents: Thank you for your unconditional love and support while I have been so far from home, especially during my most stressful moments. The level of your support as my hometown cheerleaders (i.e., printing and displaying my defense dates at work and reading any and all drafts I had!) has been exceptional. I could not have finished this without the both of you.

To my graduate cohort and friends new and old: I thank you for being available to commiserate and brainstorm about our schoolwork and respective research projects. I owe my sanity to you. Reina Garcia, Gabrielle Lavallo, and Katie

Phalen, you were always there for me when I needed help and kept me on my toes. Thank you to Nathan Heep for utilizing his magical computer powers to help with thesis formatting. I am so thankful to have gone through all of this with you as my friends.

Lastly, I'd like to thank David Macias. You were always available to talk or help at any time and I am forever thankful for your advice, caring, and love. You made my time in graduate school a thousand times better and I'm so happy to have met you. See you soon!

This manuscript was submitted on May 17, 2013.

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# CHAPTER 1

## INTRODUCTION

Forensic anthropologists occasionally encounter human remains in burial scenarios such as shallow graves (i.e., 1 m. deep or less) that show signs of vultures having disturbed the scene (Rodriguez and Bass 1985; Morton and Lord 2006; Enwere 2008). Vultures have been reported to unearth shallow burials and scavenge carrion both anecdotally and in the literature (Reeves 2007; Enwere 2008; Spradley et al. 2011).

The purpose of this research is to examine how vultures respond to and modify shallow graves of varying depths. This experiment compares how and when vultures detect graves, disturb the area, remove, disarticulate and skeletonize remains, and finally abandon the different graves in comparison to a surface deposition. In addition to evaluating vulture interest in the graves, the research will use information regarding the temperature measured in accumulated degree days (ADD), humidity, and wind speed. These data will be recorded to examine the different

environmental and climatic factors that may affect the timing of vulture activity. This study will utilize past research regarding vulture scavenging and burial scenarios, as briefly summarized below.

### 1.1 Enwere 2008 Study

Enwere (2008) conducted a study to investigate the taphonomic processes involved in the decomposition of child-sized remains found in shallow grave or surface deposit environments. Child-sized pig carcasses wrapped in baby blankets were buried in the summer at the Texas State University Forensic Anthropology Research Facility (FARF) and visually examined to document the presence of taphonomic processes. The depth of the burials was 0.30 m. (approximately 1 ft). Signs of vulture scavenging activity were present on the carcass deposited on the surface as well as on the burials. The graves were not observed using 24-hour surveillance technology such as a motion sensing camera; therefore it was difficult to ascertain the scavenging patterns and behaviors of vultures that unearthed the burials.

### 1.2 Reeves 2007 Study

From July through September 2007, three pig carcasses (weighing between 27 and 63 kg) and a goat carcass were placed outside at FARF. A surrounding fence excluded mammalian scavengers while avian scavengers were allowed access. A fourth pig carcass served as a control for the rate of decomposition and was placed in a cage that prevented terrestrial and avian animal access. Modification of the carcasses was recorded through the use of two motion sensing cameras used for tracking game and daily on-site observations. Black Vultures (*Corgyps atratus*) and Turkey Vultures (*Cathartes aura*) waited approximately 24 hours before beginning to scavenge and had completely skeletonized the carcasses in 3 to 27 hours of feeding, leaving light scratches on the bones. Conditions for this study were rigorously maintained to avoid any confounding variables through the use of the neutral area where the pigs were placed and the fencing placed around the carcasses.

### 1.3 Spradley et al. 2011 Study

This research acted as a pilot study to examine the effects of vulture scavenging on human remains. A donated human body was placed at FARF and the effects of vulture

scavenging, as well as the rate of skeletonization and the amount of disarticulation and scattering of the bony elements were observed using GPS (Global Positioning System) and motion sensing camera equipment. Results showed that initial scavenging took place 37 days after placement at FARF (Spradley et al. 2011). This delay in scavenging differed from previous vulture research done at FARF, including Reeves's (2007) study. However, after the onset of scavenging, the body was skeletonized within only 5 hours.

The purpose of the current thesis research is to examine scavenging responses of two of Texas's primary avian scavengers, the American Black Vulture and the Turkey Vulture, to pig carcasses placed on the surface as controls and in graves of varying depths. These vulture species have the ability to skeletonize a fully-fleshed pig carcass deposited on the surface in less than 12 hours, creating an altered postmortem interval (PMI), thus confounding time since death estimations (Reeves 2009; Spradley et al. 2011). For this study, five pig carcasses, weighing between 16 and 20 kg were used: one deposited at the soil surface as a control and four buried in shallow graves of varying depths. Graves were monitored via motion sensing cameras

and first-hand observation to measure how long it took vultures to detect and disrupt the graves, skeletonize the pig carcasses, and to determine when vultures were no longer attracted to the graves. Observations of vulture behavior regarding attraction to the graves, as well as time, temperature, humidity, and wind speed were recorded and analyzed using accumulated degree days (ADD) as a standard to determine onset and extent of vulture scavenging activity. These data were collected because they could be of potential use to help law enforcement personnel to determine if a shallow burial has been disturbed by vultures, as well as estimate a tentative postmortem interval.

**1.4 Postmortem Interval**

The postmortem interval (PMI) or time since death is a crucial measurement that allows forensic anthropologists to estimate the time elapsed since an individual has died. It can also refer to the stage in decomposition (Rodriguez and Bass 1985). Information about PMI may enable law enforcement personnel to compile an applicable list of missing persons or to corroborate the findings with a suspect's accounts and order of events (Spradley et al. 2011). Estimating PMI has already proven to be a difficult

measurement to acquire due to the many contributing factors such as seasonality and temperature, presence of trauma, and location of the deposition, and it is made even more difficult to estimate PMI when animal scavengers have disturbed the remains (Rodriguez and Bass 1985; Dent et al. 2004; Anderson 2011; Spradley et al. 2011).

### 1.5 Scavenging of Remains

Scavengers that feed on carrion include invertebrates and vertebrates such as mammals and birds (Morton and Lord 2006; Reeves 2009; Anderson 2011; Spradley et al. 2011). Primary avian scavengers in Central Texas include two species of vulture: American Black Vultures and Turkey Vultures (Reeves 2009; Spradley et al. 2011). In studies using animal carcasses, these vultures tended to wait 24 hours before feeding on non-human carrion (Reeves 2009). Once scavenging has begun, these vultures flock en masse to the carcass and feed voraciously. Reeves (2009) reported that vultures can completely reduce a fully-fleshed pig carcass (27 to 63 kg) deposited on the surface to skeletonized remains in less than 12 hours of feeding. This information illustrates the fact vulture scavenging activity creates an altered PMI. This causes remains to appear as if they have been out in the elements longer than

they actually have which conflicts with the normally understood sequences of skeletonization. In regions of the Southwestern United States, skeletonization typically begins after an average 2 months of exposure without the aid of such scavenging (Galloway 2006). However, pilot studies conducted in Central Texas have found this is not so; skeletonization has been noted to occur in remains after approximately 9 months (Parks 2009; Suckling 2011). Previous studies in vulture scavenging activity stress the possibility for errors in PMI estimates made for remains that have been altered by vultures (Galloway 2006; Reeves 2009; Spradley et al. 2011).

Knowing the extent to which vultures will scavenge remains can help investigators determine whether or not vultures had been at the scene and how much they have disturbed the remains. Some questions considered in this study include the time it takes for the birds to detect the buried carcasses, the depth that allows or prevents access to the remains, the time it takes for them to unearth and skeletonize the remains, and the period after which the birds are no longer interested in the remains. In Enwere's study (2008), vultures began to investigate and land on the shallow graves by day 3, and by day 4, the pigs had been

unearthed by vultures. The graves in the study were 0.30 m. (approximately 1 ft.) in depth. In 2008, the body of a Texas woman was discovered in a shallow grave when local residents noticed vultures feeding in the area, indicating that the birds had disturbed the shallow grave in order to scavenge (Cerota 2008).

### 1.6 Vulture Scavenging and Behavior

Vultures are ubiquitous taphonomic agents in many areas, but very little is known about these birds and their interaction with decomposing human remains; literature in published research about the behavior and feeding habits of Turkey and Black Vultures is scant (Buckley 1996; Reeves 2007; Spradley et al. 2011). But anecdotally, vulture feeding behavior has been noted on

**Figure 1. Turkey Vulture. Image: http://bna.birds.cornell.edu/bna/species/339/articles/introduction**

**Figure 2. Turkey Vulture Range: Green = year-round range. Yellow = summer range. Image: http://en.wikipedia.org/wiki/File:Turkeyvulturerange.jpg**

bird enthusiast websites (e.g., Arizona-Sonoran Desert Museum 2013; Hawk Mountain Sanctuary 2013; Loudon Wildlife Conservancy 2013). In a study done in southern Texas, Buckley (1996) observed the foraging behavior of the Turkey and Black Vultures. Both species are exclusively diurnal foragers and generally are searching actively for food from a couple of hours after dawn until a couple of hours before dusk (Buckley 1996). Black Vultures especially will travel from their communal roosts to known carcasses at first light and often do not return to roost until just before dark (Buckley 1996). Turkey Vultures (Figures 1, 2) have an acute sense of smell and are almost always the first species to arrive at carcasses (Kirk and Mossman 1998). The olfactory organs are unusually well-developed; the relative size of the brain's olfactory bulb is ninth largest of 108 avian species (Bang and Cobb 1968). Experimental and anecdotal observations demonstrate they are able to locate food by smell (Stager 1964). Birds were caught in traps well hidden from view or baited with scent only (Stager 1964). Turkey Vultures have the ability to smell ethyl-mercaptan and other odors associated with decomposition (Kirk and Mossman 1998). Natural-gas companies have introduced this odorant into pipelines and

discovered leaks where Turkey Vultures were found circling or on the ground (Stager 1964).

Unlike Turkey Vultures, Black Vultures (Figures 3, 4) lack a highly-developed sense of smell and cannot find carrion by scent alone (Buckley 1999). However, they

**Figure 3. American Black Vulture. Image courtesy of http://bna.birds.cornell.edu/bna/species/411/articles/introduction**

**Figure 4. American Black Vulture Range. Image courtesy of http://en.wikipedia.org/wiki/File:AmericanBlackVultureMap.png**

exploit the superior food-finding skills of Turkey Vultures by following them to carcasses. Once a carcass is located, Black Vultures often congregate rapidly and displace Turkey Vultures from the food (Buckley 1999). The sight of one vulture descending to a carcass draws others from over a large area and dozens may assemble at a single carcass.

Buckley (1996) observed that Turkey Vultures visited carcasses of all sizes frequently, but Black Vultures were more likely to visit large carcasses (larger than 5 kg (11 lbs.) in weight) rather than smaller ones. In addition, at very large carcasses (larger than 100 kg (220 lbs.) in weight), Black Vultures outnumbered Turkey Vultures. Turkey Vultures depended primarily on smaller carcasses, which they can consume quickly before Black Vultures intervene (Buckley 1996).

Turkey Vultures prefer relatively fresh carrion but cannot open thick skin and must wait until a large carcass is putrid or is opened by mammals or larger vultures (Kirk and Mossman 1998). When feeding, Turkey Vultures typically pick tissue from a carcass deftly but quickly, and in a chicken-like manner, usually holding down the carcass with one or both feet (Kirk and Mossman 1998). Black Vultures cannot open large carcasses on their own either, and also must depend on decomposition or larger scavengers to do so (Buckley 1999). An individual vulture will often work persistently at an opening, gradually working its way in, and frequently inserting its head completely inside the carcass (Buckley 1999). Unlike Turkey Vultures, Black Vultures typically do not use their feet when feeding

(Buckley 1999). Once a sufficiently large opening has been made, viscera can be extracted. This extraction usually prompts a rush of birds, which rapidly pull the material apart (Buckley 1999).

Past studies have examined vulture scavenging of surface deposits and shallow graves of the same depths (Morton and Lord 2006; Enwere 2008; Reeves 2009; Spradley et al. 2011). While studies have examined how vultures respond to and modify burials at a consistent depth (0.30 m. in Enwere's (2008) study) and on surface deposits, little is known about vulture scavenging behavior or how vultures respond to remains in shallow burials of varying depths. In Enwere's (2008) study of the taphonomic effects of shallow child-sized burials, the possibility of vulture scavenging activity was not considered, and it was unanticipated that they would disturb the graves. Enwere intended to examine shallow grave taphonomy when vultures unexpectedly acted as an intervening variable by unearthing and skeletonizing pig carcasses.

This study will use Enwere's thesis as a springboard to determine if burying carcasses at different depths will have an effect on time needed for a vulture to find a burial and begin scavenging. Since the 0.30 m. graves in

Enwere's (2008) study were disturbed by vultures within 4 days, it is assumed that it would take longer than 4 days for vultures to disturb the maximum grave depth of 0.60 m. in this study. It will also examine the time needed for vultures to completely skeletonize the remains and at what period are they no longer interested in the carcasses. Knowing this information can perhaps aid law enforcement personnel in the future with the determination of whether a shallow grave has been disturbed by vultures, as well as estimate a tentative postmortem interval for shallow grave burial cases that show signs of vulture scavenging.

# CHAPTER 2

## MATERIALS AND METHODS

### 2.1 Materials

Pig Carcasses

Domestic pig (*Sus scrofa*) carcasses have been used as comparative decomposition and taphonomy models (Rodriguez and Bass 1985; Dent et al. 2004; Morton and Lord 2006; Enwere 2008; Reeves 2009; Anderson 2011). For this study, five euthanized juvenile pigs, weighing between 16 and 20 kg, were acquired from a nearby commercial farm (an IACUC protocol was not required when obtaining previously euthanized pig carcasses from an independent supplier). Whole pigs were used in this study because use of partial carcasses might act as a confounding variable; cut and/or exposed tissue could act as a catalyst to speed up decomposition, thus altering results. The pig carcasses were placed on ice to prevent early decomposition and, less than twelve hours after death, were deposited at the Forensic Anthropology Research Facility at Texas State University-San Marcos. The pigs were placed in a second

gated section isolated from the main part of the facility where human donations were located. Four of the five pigs

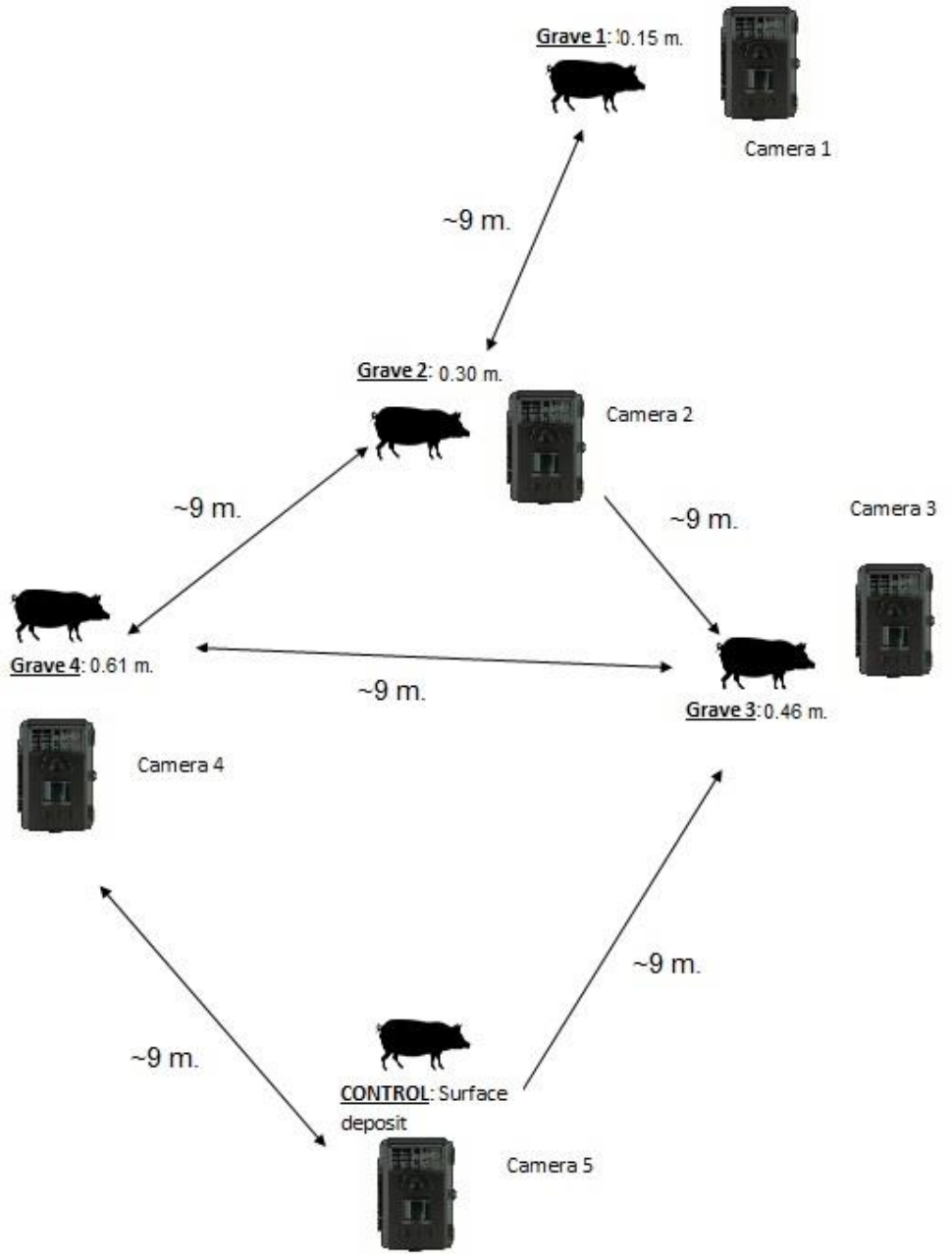


**Figure 5. Layout of grave placement**

were buried; one in each of the shallow graves, and fill from each grave was then placed on top of the pigs. The fifth carcass acted as a control specimen for observations

and was placed on the surface at least 9 m. away from the shallow graves (Figure 5).

Graves

In November, four shallow graves 1 m. long and 0.50 m. wide were dug at a minimum distance of 9 m. apart (Figure 5). The distance was determined to reduce the amount of overlap from any taphonomic processes that might occur between each of the graves and to avoid commingling of the remains. These graves varied in depth:

- Grave 1 (Figure 6) was at a depth that allowed for 0.15 m. of fill from the top of the pig to the surface.
- Grave 2 (Figure 7) was at a depth that allowed for 0.30 m. of fill from the top of the pig to the surface.
- Grave 3 (Figure 8) was at a depth that allowed for 0.46 m. of fill.
- Grave 4 (Figure 9) was at a depth that allowed for 0.61 m. of fill from the top of the pig to the surface.
- A surface deposit (Figure 10) acted as the control and was placed on top of the ground surface.

Each grave was marked with a numbered stake for identification during the study.

**Figure 6. Grave 1, Pig and Burial, Depth: 0.15 m.**

**Figure 7. Grave 2, Pig and Burial, Depth: 0.30 m.**

**Figure 8. Grave 3, Pig and Burial, Depth: 0.46 m.**

**Figure 9. Grave 4, Pig and Burial, Depth: 0.61 m.**

**Figure 10. Control, Surface Deposit**

Equipment

During the experiment, five motion sensing cameras (Bushnell 8MP Trophy Cam Night Vision Trail Camera) were used to monitor the experiment. The set-up utilized the protocol and standards developed by Reeves (2007). A camera was placed in front of each grave and was programmed to take still pictures. A fifth camera taking stills was placed in front of the control as well (Figure 5). All cameras were programmed to take three pictures every time the infrared sensor was triggered. All cameras operated continuously day and night. Additional photos were taken via digital camera (Canon PowerShot SD1000) to document initial set-up and individual once-daily observations of the graves for the duration of the study. It is important to note that in a previous study, vultures were observed returning to scavenge a short time (~10-20 minutes) after being disturbed by researchers working at FARF (personal communication Sophia Mavroudas, 2012). Disturbing the vultures therefore should only minimally affect the time frame and efficiency of the vulture scavenging.

Since decomposition and scavenging activity may be affected by and dependent upon weather conditions, the average daily humidity, wind speed, and temperature of the

site was recorded from the Texas A&M weather station at Freeman Ranch for the duration of the experiment. Using ADD (accumulated degree days) allowed for a way to standardize time and temperature in a measurement that represents the time it took for vulture activity to occur. Average daily humidity and wind speed were recorded in a chart for reference (Table 1).

**2.2 Methods**

After all carcasses were deposited, the motion sensing cameras were set up to take photos. The site was also physically observed once daily in the evening for the duration of the study. During these observations, photographs using a digital point-and-shoot camera were taken first of the graves and surface deposition at the initial setup, and then of each deposition for evidence of scavenging activity. Elements of analysis included: evidence of bird presence (feathers, droppings, birds seen on camera or in person), ground disturbance and evidence of digging (disturbed soil, partially or fully-exhumed carcasses or birds seen on camera digging at the graves), and removal of the carcass from the graves (see Appendix 1).

Additionally, specific questions regarding the vultures' scavenging behavior were intended to be addressed by visiting the site daily and examining the photographic data from the game cameras for the following (See Appendix 1):

- Which vulture species (Black Vulture or Turkey Vulture) arrives at the graves first
- Do both species scavenge equally, or does one scavenge more than the other
- Maximum number of vultures recorded in the camera frame at each grave
- Average number of vultures recorded in the camera frame at each grave at any given time
- Which vulture species is seen more often at each grave
- How do the vultures exhume the remains
- How does the ratio of the two vulture species change over the course of the study

The study would be considered concluded when vultures no longer visited the graves to feed. Each photo, from both motion sensing cameras as well as the handheld digital camera, was examined for evidence of vulture activity coinciding with time and date stamps.

# CHAPTER 3

RESULTS

## 3.1 Control Results

Several Black Vultures were observed in flight in the area during initial deposition on November 16, 2013, but it


**Figure 11. First investigation by vultures**

was not until approximately 24 hours later at 11:21 that

two Black Vultures were captured on the game camera landing to investigate the surface carcass (Figure 11). Within the hour, at least four more Black Vultures were seen on camera feeding on the carcass. A maximum of five vultures continued to visit the deposition to scavenge throughout


**Figure 12. Initial vulture scavenging**

the day (Figure 12). The vultures left the surface deposit an hour after sunset (20:00) and arrived at sunrise the next morning (07:00).

Within 12 hours of total feeding, the carcass was reduced to skin, bones, and connective tissue that held the

elements together. During the course of the scavenging, cameras captured the speed and deftness by which vultures were able to manipulate and drag the carcass, frequently out of the frame. The Black Vultures frequently pulled and dragged the carcass across the ground as they pulled tissue from bone. During daily observations, the carcass had to be moved back within the frame of the game camera. Vultures returned to the deposition approximately 20 minutes to half an hour after the researcher and other members of the department had left the immediate area. The majority of flesh had been consumed in approximately 72 hours after placement of the carcass. After this time, Black Vultures were captured on camera infrequently visiting the skeletonized remains during the early evening hours until the end of the study on January 29, 2013.

**3.2 Burial Results**

For the duration of the study (approximately two and half months), from the day of initial placement and burial on November 16, 2013, until January 29, 2013, no vultures investigated the graves. While only Black Vultures were seen landing and scavenging the control carcass, no vultures landed at or showed any interest in any of the burials. During daily visits, it was noted that all buried

carcasses showed signs of decomposition, including bloating as evidenced by a localized, raised surface topography where the ground was raised, aerated, and springy to the touch, evidence of flies and maggots, and moderate odor emanating from surface of the burials.

*Temperature, Wind Speed, and Humidity*

Temperature data for the postmortem interval were collected from the Texas A&M Weather Station (unpublished data from Dr. Heilman, Texas A&M University, 2013). All temperatures were calculated as daily averages (the average of the daily high and low air temperatures). Accumulated degree days (ADD) represent heat energy used to drive insect larvae growth (Megyesi et al. 2005). To calculate ADD, all daily temperatures above 0°C for all days were summed. Temperatures below 0°C were recorded as zero rather than negative values. Final ADD for the duration of the study was 837.3515.

Wind speed in the form of meters per second and daily average humidity percentages was also calculated (Table 1).

**Table 1: Daily Humidity (%) and Daily Wind Speed (m/s) at FARF**

| Date | Daily Humidity (%) | Daily Wind speed (m/s) |
|---|---|---|
| 11/16/2012 | 53.69520833 | 1.059229 |
| 11/17/2012 | 62.37833333 | 0.474229 |
| 11/18/2012 | 66.8975 | 1.042813 |
| 11/19/2012 | 75.87229167 | 0.634521 |
| 11/20/2012 | 72.4975 | 0.372188 |
| 11/21/2012 | 74.594375 | 0.401125 |
| 11/22/2012 | 74.33770833 | 0.997104 |
| 11/23/2012 | 64.83395833 | 1.612229 |
| 11/24/2012 | 38.91645833 | 0.965167 |
| 11/25/2012 | 67.60041667 | 1.121104 |
| 11/26/2012 | 70.68604167 | 1.54475 |
| 11/27/2012 | 62.655 | 2.268063 |
| 11/28/2012 | 75.64270833 | 0.483167 |
| 11/29/2012 | 77.00854167 | 0.619438 |
| 11/30/2012 | 80.86583333 | 0.82125 |
| 12/1/2012 | 77.82645833 | 1.978604 |
| 12/2/2012 | 79.85479167 | 1.796958 |
| 12/3/2012 | 77.98416667 | 1.587625 |
| 12/4/2012 | 75.76895833 | 0.61325 |
| 12/5/2012 | 47.51333333 | 1.127458 |
| 12/6/2012 | 78.74520833 | 0.708354 |
| 12/7/2012 | 83.0625 | 0.540125 |
| 12/8/2012 | 81.31 | 0.780292 |
| 12/9/2012 | 77.18791667 | 1.649167 |
| 12/10/2012 | 42.21895833 | 3.131417 |
| 12/11/2012 | 51.240625 | 0.76075 |
| 12/12/2012 | 55.639375 | 0.496229 |
| 12/13/2012 | 59.449375 | 1.091896 |
| 12/14/2012 | 75.455 | 1.853688 |
| 12/15/2012 | 71.46166667 | 0.556583 |
| 12/16/2012 | 73.76979167 | 0.505375 |
| 12/17/2012 | 47.809375 | 1.499229 |
| 12/18/2012 | 61.06229167 | 1.112917 |
| 12/19/2012 | 76.62416667 | 2.43275 |
| 12/20/2012 | 25.97583333 | 3.980604 |
| 12/21/2012 | 46.34979167 | 0.621021 |
| 12/22/2012 | 61.070625 | 1.425813 |
| 12/23/2012 | 78.381875 | 1.129729 |
| 12/24/2012 | 56.81416667 | 1.071604 |
| 12/25/2012 | 44.91625 | 3.791479 |
| 12/26/2012 | 51.61229167 | 2.375688 |
| 12/27/2012 | 80.781875 | 0.314229 |
| 12/28/2012 | 68.99625 | 2.461688 |
| 12/29/2012 | 45.846875 | 1.302708 |

**Table 1-Continued**

| | | |
|---|---|---|
| 12/30/2012 | 63.07375 | 0.818583 |
| 12/31/2012 | 95.96041667 | 0.36025 |
| 1/1/2013 | 89.04375 | 1.901854 |
| 1/2/2013 | 70.84291667 | 1.759167 |
| 1/3/2013 | 65.5575 | 1.589688 |
| 1/4/2013 | 85.93166667 | 1.1495 |
| 1/5/2013 | 81.86708333 | 0.237792 |
| 1/6/2013 | 68.7125 | 1.116771 |
| 1/7/2013 | 73.82354167 | 0.718354 |
| 1/8/2013 | 94.95416667 | 1.082792 |
| 1/9/2013 | 92.58333333 | 1.720854 |
| 1/10/2013 | 75.83854167 | 1.147375 |
| 1/11/2013 | 85.06708333 | 1.266792 |
| 1/12/2013 | 84.42020833 | 1.640208 |
| 1/13/2013 | 54.486875 | 3.307354 |
| 1/14/2013 | 57.55833333 | 2.72625 |
| 1/15/2013 | 81.92416667 | 2.651583 |
| 1/16/2013 | 50.47583333 | 1.705458 |
| 1/17/2013 | 57.30791667 | 1.278833 |
| 1/18/2013 | 65.85354167 | 0.607354 |
| 1/19/2013 | 72.31291667 | 0.786375 |
| 1/20/2013 | 73.41729167 | 0.521521 |
| 1/21/2013 | 72.93333333 | 0.325208 |
| 1/22/2013 | 70.116875 | 0.781854 |
| 1/23/2013 | 78.17270833 | 0.767833 |
| 1/24/2013 | 80.104375 | 1.117625 |
| 1/25/2013 | 78.09916667 | 1.484313 |
| 1/26/2013 | 84.14645833 | 0.782979 |
| 1/27/2013 | 83.75895833 | 2.396854 |
| 1/28/2013 | 81.408125 | 3.170125 |
| 1/29/2013 | 62.48479167 | 3.210021 |

# CHAPTER 4

DISCUSSION

## 4.1 Vulture Seasonality and Turkey Vulture Presence

The results, contrary to those expected, showed that during this project, vultures in Central Texas did not locate and unearth pig carcasses in shallow burials. The vultures did not land at any of the burials for the duration of the study and it is postulated that this may be explained by a number of potential causes.

One reason could perhaps be attributed to seasonality and home range of Turkey Vultures. As Figure 13 shows, the location of the Forensic Anthropology Research Facility (FARF) is at the very edge of the range for summer versus year round Turkey Vulture activity; San Marcos may be in such a location that it might not have been the right season for Turkey Vultures (Kirk and Mossman 1998). Higher densities of Turkey Vultures are seen in Texas during the summer months as opposed to when this study took place (Kirk and Mossman 1998). Moreover, Turkey Vultures have a more advanced olfactory sense than that of Black Vultures

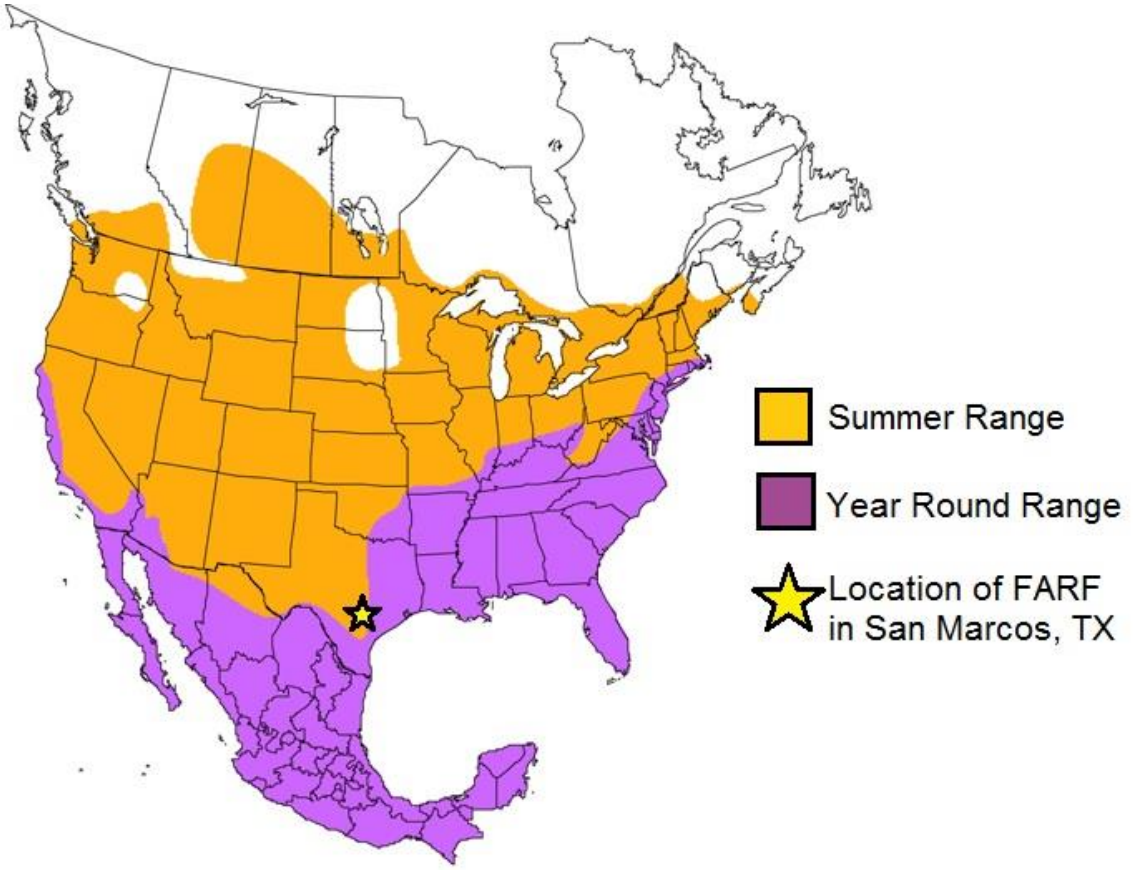


**Figure 13. Turkey Vulture Range with location of FARF. Modified from: http://askabiologist.asu.edu/aab_tools/_media/maps/turkey_vulture_L_M.gif**

(Bang and Cobb 1968). The long, low flights of Turkey Vultures may offer them better opportunity for location of carrion by sight and olfaction (Coleman and Fraser 1987; Lemon 1991). The high altitude flight of Black Vultures may permit them to see other vultures at great distances feeding on carcasses (Coleman and Fraser 1987; Lemon 1991). Turkey Vultures are the first species to discover a carcass and Black Vultures cue on the presence of Turkey Vultures to lead them to feeding opportunities (Lemon 1991; Buckley

1999). If Turkey Vultures were not present to detect the decomposition odors coming from the burials, Black Vultures may therefore not be signaled to land and scavenge. It is explained in the literature that Black Vultures do not use their feet while feeding (Houston 1988; Buckley 1999). The presence of Turkey Vultures may be necessary to initiate the exhumation of the burials to instigate scavenging, but it is unclear whether or not Turkey Vultures are capable of digging either (Buckley 1999). More research is required concerning migration and seasonality of Turkey Vultures, scavenging behaviors, and interactions between Turkey and Black Vultures.

### 4.2 Vulture versus Human Interaction and Feeding Stations

Another factor that would potentially affect the scavenging behavior of the vultures could be the human presence and intervention at FARF. FARF itself could be seen as an area that promotes confusion for vultures based on 1) deceased humans present (both visually and olfactorally) but inaccessible under bird-proof chain link cages, and 2) constant live human presence with cars, trucks, and groups of people visiting FARF for hours at a time, multiple times daily for research purposes. In natural settings, vultures typically show shy behavior and

escape by taking flight if approached by humans (Zuberogoitia et al. 2009). Because of this, vultures modify their foraging behavior depending upon food availability and the risk of perceived threats, humans being the main disruptive element (Zuberogoitia et al. 2009). Extended human presence could be seen as a deterrent, thus causing the vultures to mostly avoid the area. Studies have demonstrated that in natural conditions, to ensure the absence of threats, it may take vultures more than a day to land near a carcass deposited on the surface (Reeves 2009; Zuberogoitia et al. 2009; Spradley et al. 2011). A carcass in a burial scenario, already more difficult to detect, compounded with the constant risk of human intrusion, may introduce an unknown delay to the time it takes for vultures to detect and land at a carcass.

Previous studies have shown that behavioral change can occur depending on the food availability and vulture state of hunger (Deygout et al. 2009; Zuberogoitia et al. 2009). The vultures have learned that there is always food available at FARF and are perhaps only willing to scavenge from carrion opportunities that are quick and easy to access. Because of this, they do not utilize time or energy to access a burial if there is a surface deposit offered with the added complication of constant threat of human

intrusion. In a scenario where feeding stations or "vulture restaurants" (Donazar et al. 2010; p. 613) were abundant, vultures were likely to find food quickly and stop before all resources were found. Scavenging efficiency is reduced when the number of stations containing resources was high (Degout et al. 2009). Moreover, vultures are drawn to areas where the availability of resources is predictable (Donazar et al. 2010). Vultures that scavenge at FARF have found that most of the food has been relatively inaccessible under cages, but surface deposits, when present, appear to be the easiest means of getting food. Perhaps the daily presence of researchers has so modified vulture behavior that it is now altering vulture studies at FARF. There might be so much human disturbance that the vultures have moved on to more secluded and reliable sources of food; they will only scavenge surface deposits at FARF because they can quickly eat and fly away before being disturbed by approaching humans.

**4.3 Human Activity at FARF**

The Forensic Anthropology Research Facility (FARF) at Texas State University–San Marcos is an outdoor decomposition research facility comprised of 26 acres of wooded and open land (Forensic Anthropology Center – Texas State, 2013). Approximately 3 to 4 students and researchers

visit the facility per day. The main activity being performed is photographing and documenting the decompositional phases of more than the average of 20 human donations at a time that are placed under cages, making them inaccessible to vulture scavenging. Researchers visit the facility in small groups at any time from 9 am to 5 pm and spend approximately 2 hours per visit. Human donation placements occur, on average, about twice a week. These placements take place from approximately 14:00. to 18:00. and are comprised of about 4 individuals that drive into the facility and stay for half an hour to an hour at a time.

Vultures seen at the facility are shy and remain at a safe distance (about 10 yds.) from humans; if approached, the birds will fly away (personal communication Dr. Michelle Hamilton 2013). Since the opening of FARF in 2008, anecdotal evidence indicates the vultures have become more timid and less tolerant of human presence (personal communication Dr. Michelle Hamilton, 2013). It can be inferred that the increase of human incursion at FARF has affected the behavior of vultures attempting to scavenge in the area. Small groups of human foot traffic have likely deterred vultures from frequently visiting FARF. These disturbances are a constant threat to peak times in vulture

activity, although past research shows that human activity is not a deterrent when access to food is safe and unobstructed (Reeves 2009; Spradley et al. 2011).

The results of this study likely have implications for scenarios in which humans are buried in shallow graves. As noted in previous studies utilizing animal remains, Black Vultures are more likely to scavenge when carrion is within sight or when Turkey Vultures are spotted feeding (Stager 1964; Bang and Cobb 1968; Houston 1986; Coleman and Fraser 1987; Houston 1988; Lemon 1991; Buckley 1996; Smith et al. 2002; Deygout et al. 2009; Donázar et al. 2010; Zuberogoitia et al. 2010). Furthermore, remains that are placed in high-traffic areas and areas in which some resources are easier to access than others can affect vulture activity and scavenging behavior (Stager 1964; Bang and Cobb 1968; Houston 1986; Coleman and Fraser 1987; Houston 1988; Lemon 1991; Buckley 1996; Smith et al. 2002; Deygout et al. 2009; Donázar et al. 2010; Zuberogoitia et al. 2010). It can be strongly inferred that decomposing human bodies that are deposited in secluded areas far from human activity will be more likely to attract vultures. In urban settings and settings with high occurrences of human interference, vultures are more likely to avoid scavenging. It can also be inferred that bodies will be more likely to

attract vultures when they are deposited during times of the year that have the highest frequency of both species of vultures.

# CHAPTER 5

## CONCLUSION

Vultures are a common taphonomic agent in Central Texas and have been known to quickly and efficiently alter remains when carcasses are deposited on the surface; however, forensic anthropologists sometimes are presented with cases in which human remains are found in shallow grave scenarios. The purpose of this study was to examine the scavenging responses of Black and Turkey Vultures to pig carcasses placed on the surface and in shallow graves of varying depths. It was expected that vultures would be able to detect the graves and begin to unearth the carcasses, but this was not found to be the case during the study duration.

Vultures in this study did not locate or unearth the pig carcasses in the shallow burials and this may be explained by vulture seasonality and migration, feeding behavior regarding digging, and most importantly, the presence of human disturbance. Season may have an effect on the migration patterns of Turkey Vultures, especially because the location of the study was conducted in the

early winter at the edge of the summer Turkey Vulture range. Lack of Turkey Vulture involvement may have created an intervening variable in which Black Vultures would not and could not access the carcasses. Black Vultures do not use their feet while feeding and it is unknown as to whether or not Turkey Vultures have the ability to dig to unearth carrion. Consistent human presence at FARF influenced vulture behavior and is likely another limitation to the study. Vultures may have moved on to more consistent and secluded sources of food; vultures are not as likely to scavenge in scenarios in which carrion is difficult to access and there is a constant risk of human activity to deter the birds.

It is suggested that future research should be done in a location that is not frequented by humans and/or during a season when Turkey Vultures are more prevalent, thereby allowing for the possibility to attract other vultures to the depositions. More information is needed regarding vulture seasonality, feeding habits, and the digging abilities of Turkey Vultures. Finally, it is suggested that any future vulture research at FARF should be conducted in a location that is secluded and as close as possible to conditions found in nature. Continued use of motion-sensing game cameras and limited human activity in the area may aid

in the accurately answering future questions regarding vulture scavenging of surface and sub-surface deposits.

**APPENDIX A**

Data Sheet for Criteria Used During Daily Observations and Photo Analysis

| **Element of Analysis** | **Description** |
|---|---|
| Bird Presence - feathers | Flight feathers (wing or tail feathers) from Black or Turkey Vultures. |
| Bird Presence – droppings or vomit/pellets | Large, white-streaked droppings or evidence of contents of crop and stomach. |
| Bird Presence – sighting | Black or Turkey Vultures seen in flight or on ground, on camera or in person. |
| Ground Disturbance – disturbed soil | Soil on and near grave that has been turned up. Includes ruts, divots, scratches, furrows, holes, and piles of dirt. |
| Ground Disturbance – partially exhumed carcass | Parts of pig carcass visible in fill of grave. |
| Ground Disturbance – fully exhumed carcass | Majority of or entire pig carcass visible. |
| Ground Disturbance - digging | Vultures seen digging at graves on camera or in person. |
| Removal of Remains | Pig carcass completely removed from grave and relocated, with evidence of scavenging, or skeletonized |

Further analysis questions:

- Vulture species first at grave:_____
- Vulture species that scavenges more/less: _____
- Maximum number of vultures recorded in the camera frame at each grave: _____
- Average number of vultures recorded in the camera frame at each grave at any given time: _____
- Vulture species seen more: _____
- Manner by which remains are exhumed: _____
- Change in ratio of vulture species over course of study: _____

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**VITA**

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