Investigator Disturbance and Buried Remains: An Experimental Study on Buried Nonhuman Decomposition

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Abstract

The experimental study of buried remains presents a unique set of problems for the investigator. With uncovered remains, visual and non-invasive/non-destructive methods alone can be utilized with no direct interaction between the investigator and the body, and thus allows for the repeated use of that body throughout the study. Usually presented as a group of categories or stages of decomposition, these methods are used as a basis for comparison among the sample and between studies. Buried remains, however, cannot be assessed, either visually or through other methods, without intentional disruption of the grave environment by the investigator. The removal of the soil above the remains, exposure to sunlight, and other above-ground variables are expected to impact the decomposition of the remains. Thus, experimental studies often group their subjects so that a body or set of remains is only sampled once at a predetermined point in the entire study.

In the present experiment, the soil was separated by a cage from six pig carcasses in separate graves in an attempt to limit the amount of investigator disturbance during data collection, and thus assess whether repeatedly exposing remains affected their decomposition and the resulting accumulated degree-days and date-of-placement estimations. Pig 1 had significantly decomposed by the first uncovering 28 days after burial. On day 61, when Pig 1 and Pig 2 were disturbed, it was noticed that Pig 1 had developed decomposition fluid at the foot of its grave while Pig 2's grave was dry. This pattern continued to an extent throughout the experiment. Throughout the study, the grave walls and the cage containing the soil also became increasingly unstable.

The results indicate that isolating the soil and uncovering the buried remains for assessment will affect decomposition. However, it is unclear whether it is the isolation of the top

soil or the act of uncovering the remains that caused the different decomposition between subjects. A number of improvements for future studies are recommended.

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Introduction

While several early publications focused on variables associated with decomposing nonhuman remains (i.e. Reed 1958, Payne 1965, Payne and King 1968), human decomposition research did not begin until the founding of the University of Tennessee's Forensic Anthropology Center (FAC) in 1981 and subsequent publications and presentations on research were completed at the FAC (i.e. Rodriguez and Bass 1983, 1985, Bass et al.1988). While interest in taphonomy and human decomposition steadily increased, it was only within the last fifteen years that publications on decomposition have become increasingly more prevalent in academic forensic journals.

Studies of decomposition of buried remains, while not as prevalent as the study of the decomposition of surface remains, were also published early on. Payne and King's 1968 study on decomposition of buried pig remains was one of the first to document rate of decay in pigs (assessed by observing rate of buried carrion removal). Rodriguez and Bass' (1985) study on rates of buried human cadavers was the second publication under the subject "decomposition" in the subject index of the *Journal of Forensic Sciences (JFS)*, with subsequent studies published throughout the next few decades (i.e., Galloway et al. 1989; Turner and Wilthsire 1999; Wilson et al. 2007; Simmons et al. 2010a, 2010b) in *JFS* and *Forensic Science International*.

Great progress has been made towards the growing knowledge of the decomposition of human remains. Very recently, however, a small number of researchers have turned towards studies of what Adlam and Simmons (2007) have coined as "investigator disturbance," which is the unavoidable disturbance of the remains in order to gather data. Thus, they tested the effects of investigator disturbance on surface remains (rabbits) by collecting data on mass, corpse and soil temperature, and decomposition. While there have been several other studies that have

investigated similar influences of the researchers on the remains, Adlam and Simmon's (2007) study was the first, and to date, the only research that studies the direct effects of common data collection techniques on surface remains.

Buried remains offer a difficult challenge in studying the effects of investigator disturbance in that there is no way to study these remains without removing the soil, which affects the remains. Thus, this pilot study aimed to test a method that would facilitate the study of decomposition on buried remains that disturbed the remains as little as possible. In this method, the top soil was isolated from the remains by a cage that was placed into the grave, and could be easily removed without causing any damage to the remains. The remains were assessed visually, temperature data was recorded using data loggers, and accumulated degree-days were calculated. The conditions of the graves and cages were also recorded for the use of improving the method for future studies.

Chapter 1: Literature Review

The traditional focus of forensic anthropologists has been on determining the biological profile of a set (or numerous sets) of remains (after determining if the remains are human), which includes determining the number of individuals, and the estimation of the sex, age, stature, and ancestry of the remains (Stewart 1979). The opening of the Anthropological Research Facility (ARF) at the University of Tennessee in Knoxville in 1981 at its present site and gave the first designated space in which researchers could study the postmortem changes of human remains in a controlled environment (e.g. Mann et al. 1990; Micozzi 1986; Rodriguez and Bass 1983, 1985). This new research focus indicated a slow but decisive shift in the interest of a small number of forensic anthropologists to the processes that human remains underwent after death (Haglund and Sorg 1997a) in addition to the estimation of the biological profile.

Taphonomy was first defined by Efremov (1940) as “the study of the transition (in all its details) of animal remains from the biosphere into the lithosphere,” with the biosphere referring to the surface and atmosphere of the earth and the lithosphere as the crust or mantle of the earth. Haglund and Sorg (1997b:3) defined taphonomy as "the study of postmortem processes which affect (1) the preservation, observation, or recovery of dead organisms, (2) the reconstruction of their biology or ecology, or (3) the reconstruction of the circumstances of their death." Taphonomic models, particularly those that focus on the analysis of the depositional context, the determination of peri- versus postmortem modifications, and the postmortem interval have been incorporated into the forensic anthropology discipline (as forensic taphonomy) from related fields such as paleontology, archaeology, paleoanthropology (Haglund and Sorg 1997b), entomology, and others (Rodriguez and Bass 1983). Since the introduction of its founding models, forensic taphonomic studies regarding disarticulation (Hill 1979) and decomposition

(discussed in more depth below), scavenging (e.g. Haglund 1991; Haglund 1997a; Haglund 1997b), weathering/modification of bones (e.g. Behrensmeyer 1978; Lyman and Fox 1997; Thompson 2005; Ubelaker and Sperber 1988), and mycology and palynology in forensic contexts (e.g. Carter and Tibbett 2003; Hawksworth and Wiltshire 2011; Tibbett and Carter 2003) have been greatly advancing the understanding of postmortem processes.

Decomposition

The first changes to remains begin within the first two hours of death due to a lack of oxygenated blood pumping through the body and resulting in a loss of skin color (Clark et al. 1997). The blood becomes acidic due to the accumulation of carbon dioxide and other chemicals, alterations to both the external and internal portions of the eye take place, skeletal muscle relaxes, and intrinsic fibroinolsins are activated. This causes the reliquification of the blood that quickly leads to late postmortem changes, which consist of rigor mortis, algor mortis, and liver mortis (Clark et al.1997).

Rigor mortis is an acidic chemical change in the pH of muscle protoplasm that causes the muscles to become rigid (Gonzales et al. 1954; Gill-King 1997). Rigor mortis usually begins 2-3 hours after death and is usually fully developed within 10-12 hours (Gonzales et al. 1954). The muscle stiffening dissipates after approximately 12-36 hours as the pH in the muscle tissues become Alkaline (Gonzales et al. 1954; Clark et al. 1997). Onset and duration of rigor are heavily determined by the ambient temperature and the metabolic state of the individual at the time death (Gill-King 1997).

Algor mortis is the natural cooling of the body as the body heat of the remains equilibrates with the ambient temperature with the surrounding environment (Clark et al. 1997).

The body usually cools between 1.5 – 2.0 degrees fahrenheight per hour during the first twelve hours; after which, the body cools at a rate of 1.0 degrees fahrenheight until it reaches ambient temperature (Clark et al. 1997).

Livor mortis (also defined as lividity or livor) is the pooling of blood in the capillary beds in dependent parts of the remains due to gravity (Clark et al. 1997). Lividity is usually seen within or around two hours after death, and fixation usually occurs at 4-6 hours (Clark et al. 1997).

The destruction of the body tissues occurs through autolysis and putrefaction. Autolysis is the process by which cells begin to self-destruct through enzymatic self digestion (Gill-King 1997). Autolysis is broken down into two stages: stage 1 consists of the failure of ATP-driven biosynthesis and homeostasis mechanisms; and stage 2, where the cell begins to leak hydrolytic enzymes into the cytoplasm. The hydrolytic enzymes digest proteins and carbohydrate (Gill-King 1997, Clark et al. 1997). Autolysis usually begins within organs associated with digestion and circulation, followed by organs associated with respiration, then kidneys, bladder, the brain and nervous tissue, skeletal muscles, and finally connective tissues and integument (Gill-King 1997).

At the end of autolysis, the host environment has become anaerobic, which results in the rapid growth of bacteria (Gill-King 1997, Clark et al. 1997). Bacterial carbohydrate fermentation creates a number of gases, such as methane, hydrogen, hydrogen sulfide, and carbon dioxide. This results in the swelling and bloating in certain body areas, such as the face, lips, and abdomen. The degradation of hemoglobin and conversion of heme to bile pigments causes the color of the remains to change, often beginning with a greenish discoloration in the abdominal area just a few hours after death (Gill-King 1997, Clark et al. 1997).

If the conditions are correct, adipocere, also known as “grave wax” or “corpse wax,” can appear. Adipocere usually forms in warm, moist conditions and in individuals who have a high fat component (Gill-King 1997). Adipocere formation is characterized by the hydrolysis and hydrogenation of fatty tissue in saturated fatty acids, consisting mostly of myristic, palmatic, and stearic acids (Forbes et al. 2005a, 2005b). Adipocere can be formed from several different components depending upon the stage of decomposition. During early stages, adipocere utilizes sodium from the interstitial fluid and sodium salts. During later stages, potassium from failing cell membranes will be utilized (Forbes et al. 2005a, 2005b). Forbes et al. (2004) noted a lack of correlation between the stage of adipocere formation and the decomposition interval. The authors argue that this indicates that the formation of adipocere is not dependent upon the decomposition itself, but on environmental factors.

Extrinsic Influences on Taphonomy

There are a myriad of variables that affect decomposition. These include temperature, access of the remains by insects, burial and depth, access by carnivores or rodents, trauma, moisture, body size and weight, clothing, and soil pH, among others (Mann et al. 1990, Vass 2011, Clark et al. 1997). Temperature is affected by other variables, such as seasonality, presence of water, and air movement, among others. Temperature is linked to decomposition by Van't Hoff's Law, which states that "the speed of chemical reactions (enzymatic or catalytic decomposition, etc.) increases two or more times with each 10°C rise in temperature" (Vass 2011). Moisture includes humidity, rainfall, or the body itself (Vass 2011). All variables are often highly interrelated; for example, the ambient temperature affects insect activity, and the

resulting maggot mass generates its own heat and further influences the remains (Haskell et al. 1997).

For buried remains, there are several other factors that affect decomposition. Grave depth has been shown to affect the amount of time it can take for remains to decompose, with remains decomposing up to eight times slower than remains on the surface (Rodriguez 1997). Rodriguez (1997) argues that, at a depth of two feet, thermal stabilization occurs so that the temperature does not fluctuate. The depth of the remains and the soil compactness can affect the amount of insect access to the remains as described by Simmons et al. (2010b). They discovered that surface remains that had no insect access decomposed more slowly than remains that were allowed a small window of insect access. The surface remains with no insect access decomposed more slowly than buried remains that were allowed constant insect access. The soil environment is also an incredibly important factor, as the soil protects the remains from solar radiation, ambient temperature, and moisture fluctuations (Rodriguez 1997). Tibbett (2008) argues that the physical texture (whether the soil is "sandy, silty, or clayey"), the pH or chemistry, and biological activity of the soil will affect decomposition. The types of soil (Forbes et al. 2005a) and the method of burial (Forbes et al. 2005b) also affects adipocere formation.

Decomposition Stages

While the decomposition process is a continuum, numerous researchers have broken down the process into phases defined by the gross observation of certain characteristics. Many of these earlier schemes detail the decomposition phases of nonhuman mammals (Johnson 1975; Payne 1965; Reed 1958; Weigelt 1927). More recent schemes categorize phases in human decomposition (Bass 1997; Clark et al. 1997; Galloway 1997; Micozzi 1991). These schemes

vary depending upon the location for which the schemes are detailing phases; for example, Galloway's (1997) scheme, which is based off of cases from the Arizona-Sonoran Desert, has a category for mummification, which is not always present in other areas. Recently, Megyesi et al. (2005) introduced a visual classification scheme based on Galloway's (1997) scheme that ranked observations and gave a score for body areas separately, before quantifying them into a total body score (TBS). It is important to note that all of these schemes pertain to surface remains, and may not accurately reflect the pattern of decomposition (particularly when using these schemes to the perimortem interval (PMI) in buried or submerged remains.

Decomposition research has now moved beyond simple observational decomposition schemes as the only method to estimate PMI. Many researchers are turning to chemical analyses (e.g. Cablk et al. 2012; Dekeirsschieter et al. 2009; Schwarcz et al. 2010; Statheropoulos et al. 2005; Swann et al. 2010; Vass et al. 2002), and others have directly investigated isolated tissue degradation under different contexts (e.g. Granrud and Dabbs 2012; Hoff-Olsen et al. 2011; Notter et al. 2009; Rogers et al. 2011). Methods focusing on the variables affecting decomposition, and using these to estimate PMI, have also been greatly improved; Megyesi and colleagues (2005) application of accumulated degree-days (ADD) to estimate PMI has been particularly useful, and has been shown to be an effective estimator for a research time-frame when used in the appropriate contexts (e.g. Adlam and Simmons 2007; Bachmann and Simmons 2010; Michaudum and Moreau 2011). There have also been a few studies recently that investigate certain methodological norms in decomposition research. For example, researchers have begun to investigate the effects of freezing on isolated tissues. Tersigni (2007) found no microscopic difference between bone that had been frozen and bone that had not been frozen.

Likewise, Stokes et al. (2009) concluded that freezing isolated skeletal tissue did not affect its decomposition, but did affect the environment.

Methods of Study for Buried Remains

In comparison to studies that report findings on methods to locating clandestine graves through ground penetrating radar or similar means (i.e., Schultz 2008, Schultz et al. 2006, Pringle et al. 2008, Ruffell et al. 2009, Kalacska et al. 2008), research on decomposition and TSD on buried remains is actually quite minimal. However, there appears to be two types of methods used to study decomposing buried remains in an experimental setting: first, data is collected several times on different days from the same specimens; second, data is taken from a set of remains only once, and then the remains are not assessed again.

Several studies have utilized methods to study buried remains. Payne and King (1968) created a coffin-like pit by lining the walls with wood boards to keep the wall from collapsing. A board was put over the pig remains and the remaining pit was filled with soil. The pigs were uncovered for data collection, so the specimens were used continuously. The focus of this study was to record carrion removal on remains beneath the soil; however, doing it in this way isolated the pig remains from the top soil. They also noted insect activity, though this may be due to access to the remains when the soil and board were removed.

A number of other studies use traditional burials, as data is collected from the particular specimen only once (e.g. Rodriguez and Bass 1985, Simmons et al. 2010, Wilson et al. 2007, Turner and Wiltshire 1999). This method of study works well when using nonhuman analogs as multiple variables can be controlled for. For example, pigs whose weights were not significantly different, had the same diet, and lived in the same conditions can be obtained easily. However,

this becomes a huge problem when studying human remains, as there is often very little choice in the human remains that are available for a specific study.

Investigator Disturbance

Recently, the effect of investigator disturbance in research has become an emerging area of interest. Two studies have investigated the repeated "carcass" enrichment and its effect on arthropod succession at the ARF due to the large succession of remains being continually placed on previously used deposition spots (Shahid et al. 2003; Schoenly et al. 2005). Both found that arthropod succession was not significantly different; however, Schoenly et al. (2005) indicated an underrepresentation of parasitic and predatory fauna. Both Adlam and Simmons (2007) and De Jong et al. (2011) investigated the effect of the repeated collection of data from carrion. Adlam and Simmons (2007) reported a significant difference in several marker variables between disturbed and non-disturbed samples, such as biomass loss and carcass temperature, but did not affect overall decomposition. De Jong et al. (2011) indicated in their study that biomass was not significantly different, but they did see consistently lower temperatures in the disturbed group. Finally, Carter and Tibbett (2008) found that the repeated use of soil for burial caused isolated skeletal muscle tissue to decay at a faster rate than in unused soil.

The extent that investigator disturbance has on the decomposition of surface remains, as indicated by Adlam and Simmons (2007:1013), is still unclear. However, surface remains can often be repeatedly visually analyzed using the decay schemes over a long period of time without actual disturbance by the researchers. While simple macroscopic observation of decay rates for the estimation of PMI is no longer the main goal, researchers still have access to the surface

remains, which makes it feasible to investigate variables that effect decomposition as well as the effect of investigator disturbance.

Chapter 2: Statement of Research Problem

Investigating the decomposition of buried remains poses a unique problem. Without physically disturbing the remains or altering the method of burial, the remains cannot be assessed. Further, studying buried remains poses a number of logistical problems over surface remains, as these studies require an increased amount of labor, time, and a larger sample size overall, which results in a larger amount of space needed.

Recent studies that investigated buried remains used a previously undisturbed set of remains for each data point (e.g. Adlam and Simmons 2007, Simmons et al. 2010, Wilson et al. 2007). This simply cannot be done for human samples, as weight, age, sex, height, diet, any medications used, and other medical statuses cannot be controlled for. These variables do have an effect on decomposition rates (e.g. Mann et al. 1990) and may inhibit an investigator's ability to make comparisons between subsamples.

This pilot study will attempt to create a method by which the same set of buried remains can be visually investigated without affecting the process of decomposition through investigator disturbance. By being able to use the same sample set throughout the length of the study, the need for a larger sample size and space can be negated and subject variables (weight, age, etc.) can be considered for that particular individual at each data collection date.

This study uses pig remains to study the effect of disturbance on buried remains. In this case, disturbance refers to the removal of the top soil covering the remains. At each data collection date, one undisturbed pig was uncovered along with the remains that had already been disturbed. The top soil was suspended over the remains in cages so that the specimens could be uncovered without any damage caused to the remains by shovel or trowel. The remains were assessed visually and through temperature data. Trends in the conditions of the graves and cages

were also recorded. The results of this study are intended to be used to improve a method by which buried human remains may be investigated without causing investigator disturbance in future research.

Chapter 3: Materials and Methods

Location

Selu Conservancy, owned by Radford University, was chosen as the site for this experiment due to space constrictions at the Anthropology Research Facility at the University of Tennessee, Knoxville (Figure 1). Founded in 1989, the conservancy spans 380 acres along the Little River and houses a number of university resources, including reconstructed Appalachian farm settlements, an observatory, and meeting rooms.

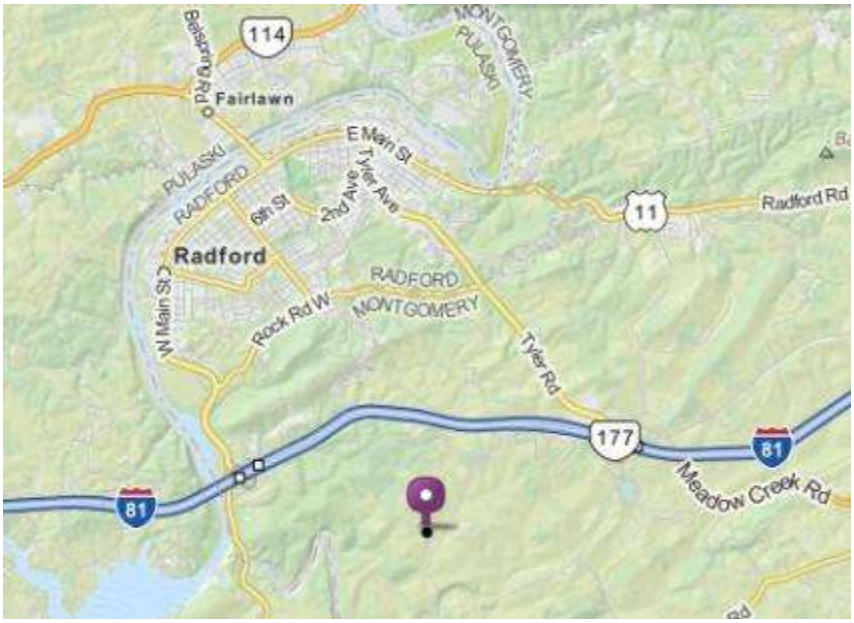


Figure 1: Map of Radford University and Selu Conservancy (from Mapquest).

The purple marker indicates the location of the Conservancy.

The specific site for this experiment was located more than 100 meters downhill away from a reconstructed Appalachian farmhouse and was only accessible by a natural deer trail. At the end of the trail, the area plateaus so that there was only a slight downward slope (Figure 2).



Figure 2: The site at Selu Conservancy before digging commenced.

Specimen

Six pigs were obtained from a local pig farmer after having been euthanized by electric shock (Figure 3). Five of these pigs weighed between 100-110 lbs., with the sixth pig weighing approximately 165 lbs. due to availability. Each pig was placed in two contractor bags with a bag of ice placed between the first and second contractor bag to slow decomposition. At burial, lividity was present in all six pigs.

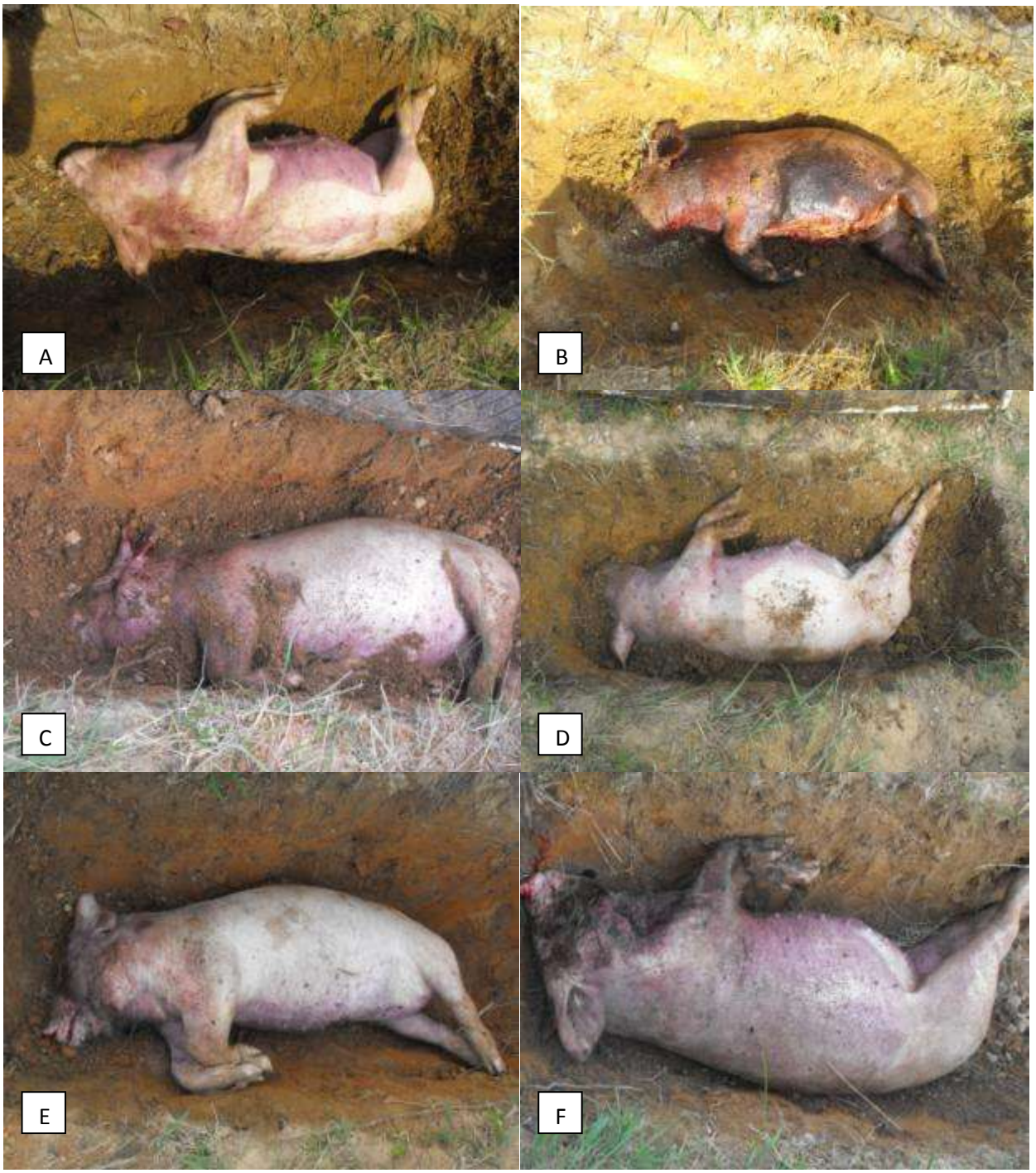


Figure 3: The Pigs at the Time of Placement.

A)Pig 1, B) Pig 2, C) Pig 3, D) Pig 4, E) Pig 5, and F) Pig 6.Pig 2 did bleed excessively from the ears and nose during transportation. Pig 6 was the largest of the sample and was thus chosen to be buried last in order to not skew results due to weight difference.

Burial Methodology

Six cages were built and six graves were dug based on estimations of average length and widths of average 100 lb. pigs. Pigs weighing exactly 100 lbs could not be guaranteed; thus, the cage dimensions were estimated to be 4 ft. x 1 ft., which allowed for the use of larger pigs if needed. The cages to hold soil were made using a PVC pipe frame lined with YARDGUARD PVC-coated welded wire fence (3 ft. x 50 ft.) and ¼ inch screen (Figure 4).

The PVC pipe frame consisted of two 1 ft pieces and two 4 ft pieces (of ¾ inch diameter) put together into a rectangle. The pieces were connected by four 3-way PVC elbow connectors so that the empty opening of each connector faced upwards. One 1-ft piece (of ½ inch diameter) was placed in each empty elbow connector.

The YARDGUARD PVC-coated welded wire fence, cut to 3 ft. x 6ft. for each cage, was placed around the PVC pipe frame to create a sturdy support for the screen. By snipping out the corners, the PVC pipes for the frame could be threaded through the mesh, eliminating any glue or other material needed to hold the frame to the fence. Over this, ¼ inch screen was laid on top of the wire to actually hold the dirt as the squares of the fencing were too large. Six to eight cable ties were used to loosely hold the screen to the fence in order to make filling the cage easier. Finally, three 1-ft pieces of PVC pipe (1/2 inch diameter) were threaded at regular intervals into the bottom of the fencing, with the result that the fencing hung 1 inch below the PCV pipe from, but did not bow. The final cages measured 1.4 ft x 4.5ft. x 1.2ft. due to added length from the elbow connectors (Figure 5).



Figure 4: The cage showing the screen and wire fencing.

The wire fencing created a strong grid for the screen. The fencing was woven one the PVC pipes to hold the wire in place. The wire was flexible which allowed the sides to be pushed up against the sides of the graves.

All six graves were dug over a period of three days, two weeks prior to burial of the pigs. This allowed for immediate burial of the pigs upon arrival. This also allowed for the cages and soil to settle to avoid excess soil falling through the screen on top of the pigs. There was approximately 2 ft. between each grave due to the limited space at the site (Figure 6). A two-person auger was used to break up the soil, but the edges and bottom of the graves were hand-straightened. The depth of each grave was two feet, while the PCV pipe frame sat 1 foot deep. To hold the cage at the desired height, the grave was narrowed slightly so that frame rested against the walls. The final graves measured approximately 1.6 ft. x 1.4ft x 1 ft.



Figure 5: Example of a cage being fit into its grave.

This was not the final design of the cage. The wire was added once the graves were finished. The rubber tubing seen here was used temporarily and allowed for easy lifting of the cage during the grave digging so as not to damage the cages during construction.

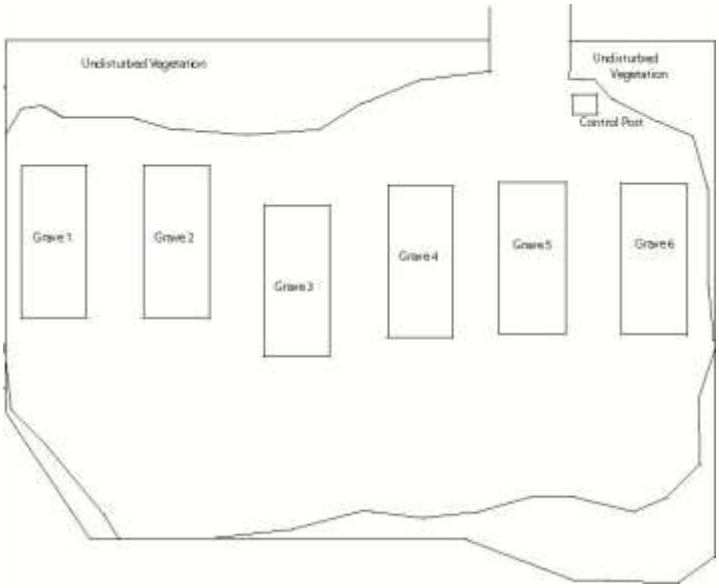


Figure 6: Map of site and grave locations.

The graves were situated on the flattest part of the site; below where the cages were dug, the land slopes unevenly. The site was bordered by large trees and shrubs, which could not be removed. Grave 3 sits slightly colder to Grave 2 than two feet due to a hump present in the middle of the field/ All graves were in direct sunlight.

Once the graves were dug, the cages were placed into the graves and the soil from each grave was shoveled back into the cages until they were full. For observation of the pigs, each cage had to be partially emptied in order to be light enough to be lifted. The soil was placed into two buckets to ensure that all of it would be returned to the cage. At least 3 inches remained undisturbed at the bottom of the fencing throughout the experiment so that any newly disturbed soil would not fall through the screen. Once partially emptied, the cages were lifted by two people, one at the head and one at the foot, using the top level of the wire grid as a handle, and were placed directly next to the grave on the ground. Once the data were observed and recorded, the cages and soil were replaced.

Upon arrival to the site, all six cages were removed from the graves. Each pig was placed in its grave and data recorded before the cages and soil were replaced. Pig 1 was buried approximately 6 hours after being euthanized, and Pig 6 was buried approximately 6 ½ hours after euthanization.

Data Collection Method

The experiment lasted for approximately six months, beginning on June 10, 2012 and ending on December 8, 2012. Data was collected every 28-30 days depending upon weather conditions. Pig 1 was disturbed a total of six times, once at each data collection day. Pig 2 was disturbed a total of five times starting at day 61, and observation continued for the rest of the experiment, and so forth, as summarized in Table 1. This was done so that, at each data collection, the previously disturbed pigs could be compared to a pig that had not been previously disturbed. Each pig remained uncovered for 10 minutes.

Table 1: Dates the pigs were disturbed.

Date (2012)	Day	Pig 1	Pig 2	Pig 3	Pig 4	Pig 5	Pig 6
July 8	28	Disturbed	N/A	N/A	N/A	N/A	N/A
Aug. 10	61	Disturbed	Disturbed	N/A	N/A	N/A	N/A
Sept. 8	90	Disturbed	Disturbed	Disturbed	N/A	N/A	N/A
Oct. 6	118	Disturbed	Disturbed	Disturbed	Disturbed	N/A	N/A
Nov. 4	147	Disturbed	Disturbed	Disturbed	Disturbed	Disturbed	N/A
Dec. 7	181	Disturbed	Disturbed	Disturbed	Disturbed	Disturbed	Disturbed

Documentation

Each grave was documented by photographs and by hand-written record. Photographs were taken by a Canon Powershot and were uploaded to a computer the same day, and written records were typed and filed on the same day. While the decomposition of the pig remains was initially the main focus of this experiment, documentation of the grave environment, soil characteristics, site vegetation, and animal life at the site were also heavily observed and documented as changes to the burial methodology were identified. Ideally, the condition of the graves, the grave environment, and the site vegetation could be scored for the creation of categorized stages, much like decomposition phases. However, the full arcs of environmental and grave changes were not documented in this study. On the last data collection date, the environment and graves were still in the process of changing. Thus, only general observations, which were used to suggest recommendations for method improvement, are presented.

Further, data from a nearby weather station in Dublin, VA, was also collected during the length of the study (wunderground.com, weather station code KPSK). While located over ten miles from the site, this was the closest weather station with records of daily precipitation, average humidity, and weather conditions available that covered the full time frame of the study.

This data was used to determine if any patterns in the weather could be identified and possibly associated with the resulting total body scores (discussed below).

Decomposition Comparisons

Megyesi et al.'s (2005) method for scoring decomposition was used to compare decomposition between pigs. For this method, the body is scored independently in three specific areas: the head and neck, the trunk, and the limbs. The decomposition scheme is divided into four categories: fresh, early decomposition, advanced decomposition, and skeletonization. Each category is further subdivided into stages based on the general characteristics of the remains, and each stage is scored ("fresh" is assigned a point value of 1; "early decomposition" is assigned a point value of 2, and so forth) (Tables 2-4). The total number of points between all portions of the body represents the accumulated decomposition, or the total body score (TBS).

Table 2: Categories and stages of decomposition for the head and neck (taken from Megyesi et al.2005).

A. Fresh	
(1pt)	1. Fresh, no discoloration
B. Early decomposition	
(2pts)	1. Pink, white appearance with skin slippage and some hair loss
(3pts)	2. Gray to green discoloration: some flesh still relatively fresh
(4pts)	3. Discoloration and/or brownish shades particularly at edges, drying of nose, ears, and lips
(5pts)	4. Purging of decompositional fluid out of eyes, ears, nose, mouth, some bloating of neck and face may be present
(6pts)	5. Brown to black discoloration of flesh
C. Advance decomposition	
(7pts)	1. Caving in of the flesh and tissues of eyes and throat.
(8pts)	2. Moist decomposition with bone exposure less than one half that of the area being scored.
(9pts)	3. Mummification with bone exposure less than one half that of the area being scored.
D. Skeletonization	
(10pts)	1. Bone exposure of more than half of the area being scored with greasy substances and decomposed tissue.
(11pts)	2. Bone exposure of more than half the area being scored with desiccated or mummified tissue.
(12pts)	3. Bones largely dry, but retaining some grease.
(13pts)	4. Dry bone.

Table 3: Categories and stages of decomposition for the trunk (taken from Megyesi et al. 2005).

A. Fresh	
(1pt)	1. Fresh, no discoloration
B. Early decomposition	
(2pts)	1. Pink, white appearance with skin slippage and marbling present
(3pts)	2. Gray to green discoloration: some flesh still relatively fresh
(4pts)	3. Bloating with green discoloration and purging of decompositional fluids
(5pts)	4. Postbloating following release of the abdominal gases, with discoloration changing from green to black
C. Advance decomposition	
(6pts)	1. Decomposition of tissue producing sagging of flesh; caving in of the abdominal cavity.
(7pts)	2. Moist decomposition with bone exposure less than one half that of the area being scored.
(8pts)	3. Mummification with bone exposure less than one half that of the area being scored.
D. Skeletonization	
(9pts)	1. Bones with decomposed tissue, sometimes with body fluids and grease still present.
(10pts)	2. Bones with desiccated or mummified tissue covering less than one half of the area being scored.
(11pts)	3. Bones largely dry, but retaining some grease.
(12pts)	4. Dry bone.

Table 4: Categories and stages of decomposition for the limbs (taken from Megyesi et al. 2005).

A. Fresh	
(1pt)	1. Fresh, no discoloration
B. Early decomposition	
(2pts)	1. Pink, white appearance with skin slippage of hands and/or feet
(3pts)	2. Gray to green discoloration; marbling; some flesh still relatively fresh
(4pts)	3. Discoloration and/or brownish shades particularly at edges, drying of fingers, toes, and other projecting extremities.
(5pts)	4. Brown to black discoloration, skin having a leathery appearance.
C. Advanced decomposition	
(6pts)	1. Moist decomposition with bone exposure less than one half that of the area being scored.
(7pts)	2. Mummification with bone exposure of less than one half that of the area being scored.
D. Skeletonization	
(8pts)	1. Bone exposure over one half the area being scored, some decomposed tissue and body fluids remaining.
(9pts)	3. Bones largely dry, but retaining some grease.
(10pts)	4. Dry bone.

Temperature

The temperature of each grave was recorded by a Thermocron Temperature Data Logger, also known as an iButton (Item ID: DS1921G-F5#; Embedded Data Systems) (Figure 7). Each data logger was synced to a main computer using 1-Wire Viewer Software (Maxim; SW-DBV) and was programmed to record the current temperature every three hours for the entirety of the experiment. Each data logger was sealed in a waterproof capsule (Item ID: DS9107+; Embedded Data Systems; Figure 8) and was placed directly beneath the mandible of the pig which allowed for easy recovery and assured that temperatures were being recorded in the same location of each grave. A seventh data logger and capsule was attached to a post near the graves to record ambient temperatures.

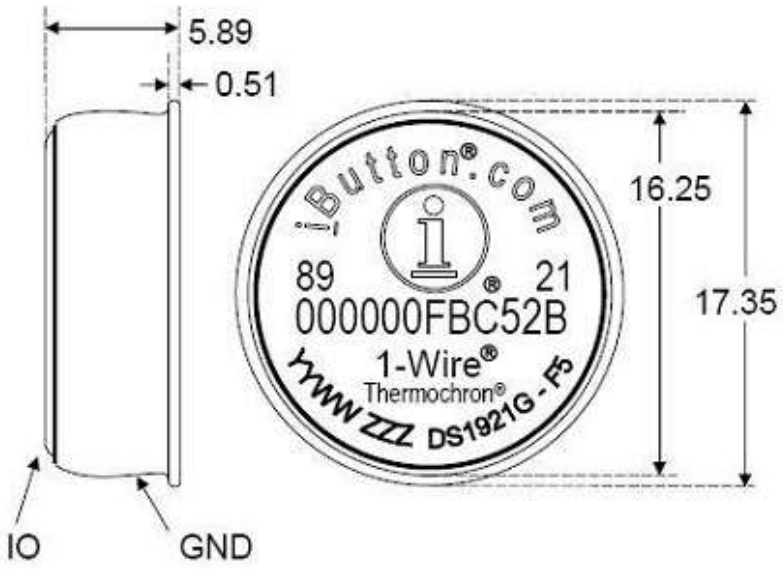


Figure 7: Diagram of Thermocron Temperature Data Logger (Item ID DS1921G-F5#; from embeddeddatasystems.com).

Each DS1921G-F5# Thermocron Data Logger has a memory of 512 bytes and is capable of recording up to 2048 temperature measurements. Each data logger can be programmed to take temperature measurements every 1 to 255 minutes.

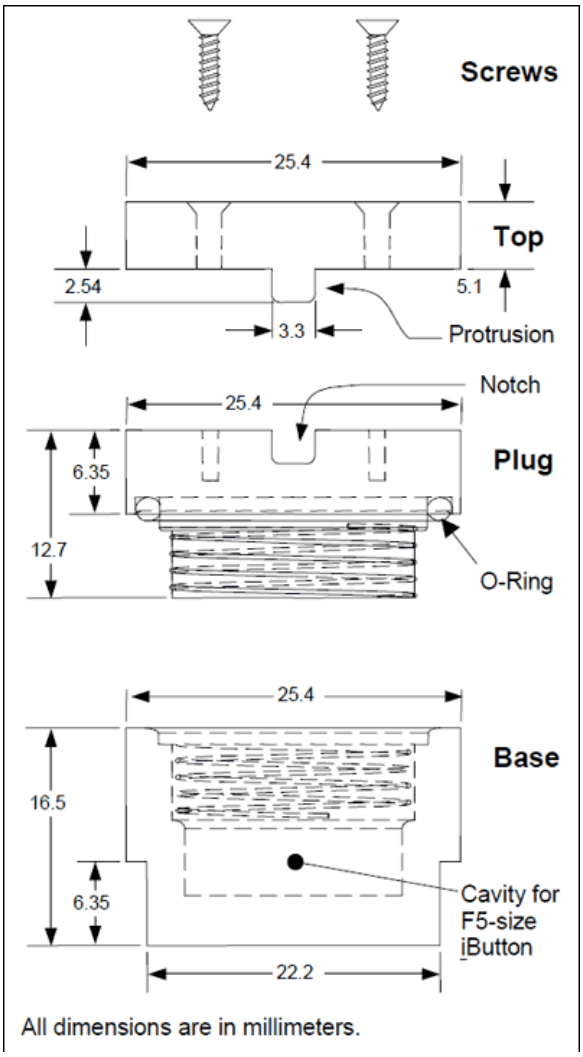


Figure 8: Diagram of waterproof capsule (Item ID DS9107+; from embeddeddatasystems.com).

The total height and maximum width of the capsules is 34.3 mm by 25.4 mm. Unfortunately, this made the data loggers too large to fit into the pigs.

The control data logger and each grave data logger recorded the temperature every three hours (180 minutes) for a total of eight temperature readings each day. From these recordings, the mean for the daily eight temperatures were calculated, and the maximum and minimum temperatures of each day were identified.

Data from a nearby weather station in Dublin, VA, was also collected during the length of the study (wunderground.com, weather station code KPSK). While located over ten miles from the site, this weather station was the closest to the site that had records of the reported daily minimum, maximum, and mean temperatures. While the temperature data available at the site itself is expected to be more reliable, the data from this weather station are reported for standardization purposes, as accumulated degree days (discussed below) may be calculated from weather station data.

Accumulated Degree Day Calculation

As both temperature and total body scores were available, accumulated degree-days (ADD) and perimortem interval estimations were calculated. For each pig that was uncovered at each data collection date, ADD were calculated twice: once using the mean temperature calculated using the minimum and maximum temperature from the control data logger, once using the mean temperature reported by the weather station, and once using the mean temperature (calculated from the minimum and maximum temperature) of the grave environment. The temperature data from the control data logger were used for ADD calculations as this information would be readily available from nearby weather stations in real cases, while the grave temperatures may not be.

While they use the temperature data available from nearby weather stations, Megyesi and colleagues (2005:8) argue that ADD should be calculated from the location's temperature, particularly when that location, such as an indoor room, has been heated or cooled. Since the grave temperatures are expected to be different than the control temperature, ADD was also calculated from the grave temperatures when available.

Chapter 4: Results

The results are split into four sections: a description of the grave conditions throughout the experiment, comparison of the decomposition between the pigs each month, comparison of decomposition of each pig between months, and an analysis of temperature throughout the experiment.

Grave Conditions through Time

While certain components of the environment in which decomposition studies take place are often analyzed, such as ambient temperature, moisture, etc., no study has reported any way to statistically analyze the overall appearance of the environment. Creating a way to do so was not the goal of this study; however, the overall appearance remained important as the changing grave conditions through time were useful for recommendations for method improvement (Table 5, Figure 9). Thus, only a report of the appearance by month follows.

Day 0

At the time of burial, all the graves and cages had been in place for about two weeks. All graves and cages had held together with no indication of sagging in the middle or corners. The screens showed no signs of tearing, and there was no evidence that any soil had fallen through the screens, as the bottoms and walls of the graves were still clean and straight. The vegetation, which had been severely affected during the grave digging had already begun to grow back, remained sparse and widespread. However, the areas beneath the grave feet were still mostly bare of any vegetation. During the placement of the first three pigs, blow flies were noted at the site but were limited. The number of flies increased during the placement of the

Table 5: Site descriptions and observations.

	Grave	Site Vegetation	Cage Vegetation	Grave Border Integrity	Cage Integrity	Cage Soil
Day 0	1	Sparse	None	Good, slight gaps at corners	Good	Settled
	2	Sparse	None	Good, slight gaps at corners	Good	Settled
	3	Sparse	None	Good, slight gaps at corners	Good	Settled
	4	Sparse	None	Good, slight gaps at corners	Good	Settled
	5	Sparse	None	Good, slight gaps at corners	Good	Settled
	6	Sparse	None	Good, slight gaps at corners	Good	Settled
Day 28	1	Sparse	None	Good, increased gaps at corners	Good	Settled
	2	Sparse	None	Good, slight gaps at corners	Good	Settled
	3	Sparse	None	Good, slight gaps at corners	Good	Settled
	4	Sparse	None	Good, slight gaps at corners	Good	Settled
	5	Sparse	None	Good, slight gaps at corners	Good	Settled
	6	Sparse	None	Good, slight gaps at corners	Good	Settled
Day 61	1	Sparse	None	Increased gaps at corners	Good	Loose
	2	Returning; sparse at foot	None	Increased gaps at corners	Good	Settled
	3	Returning; sparse at foot	None	Slight increase gaps at corners	Good	Settled
	4	Returning; sparse at foot	None	Slight increase gaps at corners	Good	Settled
	5	Returning; sparse at foot	None	Slight increase gaps at corners	Good	Settled
	6	Returning; sparse at foot	None	Slight increase gaps at corners	Good	Settled
Day 90	1	Sparse	None	Wall beginning to cave on sides	Slight bow inwards	Loose
	2	Sparse	None	Wall beginning to cave on sides	Slight bow inwards	Loose
	3	Returned; sparse at foot	Present	Increased gaps on all walls	Slight bow inwards	Settled
	4	Returned; sparse at foot	Present	Increased gaps on all walls	Slight bow inwards	Settled
	5	Returned; sparse at foot	Present	Increased gaps on all walls	Slight bow inwards	Settled
	6	Returned; sparse at foot	Present	Increased gaps on all walls	Slight bow inwards	Settled
Day 118	1	Sparse	None	Increased caving of walls	Slight bow inwards	Loose
	2	Sparse	None	Increased caving of walls	Slight bow inwards	Loose
	3	Sparse	None	Increased caving of walls	Slight bow inwards	Loose
	4	Returned; sparse at foot	Present	Increased caving of walls	Slight bow inwards	Settled
	5	Returned; sparse at foot	Present	Large gaps on all borders	Slight bow inwards	Settled
	6	Returned; sparse at foot	Present	Large gaps on all borders	Slight bow inwards	Settled

Table 5 Continued: Site descriptions and observations.

	Grave	Site Vegetation	Cage Vegetation	Grave Border Integrity	Cage Integrity	Cage Soil
Day 147	1	Sparse	None	Increased caving of walls	Increased bow inwards	Loose
	2	Sparse	None	Increased caving of walls	Increased bow inwards	Loose
	3	Returned; sparse at foot	None	Increased caving of walls	Increased bow inwards	Loose
	4	Returned; sparse at foot	None	Increased caving of walls	Increased bow inwards	Loose
	5	Returned; sparse at foot	Present	Increased caving of walls	Increased bow inwards	Settled
	6	Returned; sparse at foot	Present	Large gaps on all borders	Increased bow inwards	Settled
Day 181	1	Returned; sparse at foot	None	Increased caving of walls	Bowing, Screen tears	Loose
	2	Returned; sparse at foot	None	Increased caving of walls	Bowing	Loose
	3	Returned; sparse at foot	None	Increased caving of walls	Bowing	Loose
	4	Returned; sparse at foot	None	Increased caving of walls	Bowing	Loose
	5	Returned; sparse at foot	None	Increased caving of walls	Bowing	Loose
	6	Returned; sparse at foot	Present	Increased caving of walls	Bowing, Screen tears	Settled

rest of the pigs, though most of the interest remained in the contractor bags that had been used to transport the pigs.

Once all pigs were placed in their graves and the cages were replaced and filled, it became apparent that the movement of placing the cage so that it rested correctly in the grave had caused a small amount of soil around the corners to crumble and fall into the grave. This left gaps between the upper walls and the cage walls; however, the gaps disappeared where the PVC pipe frame met the narrowed grave walls.

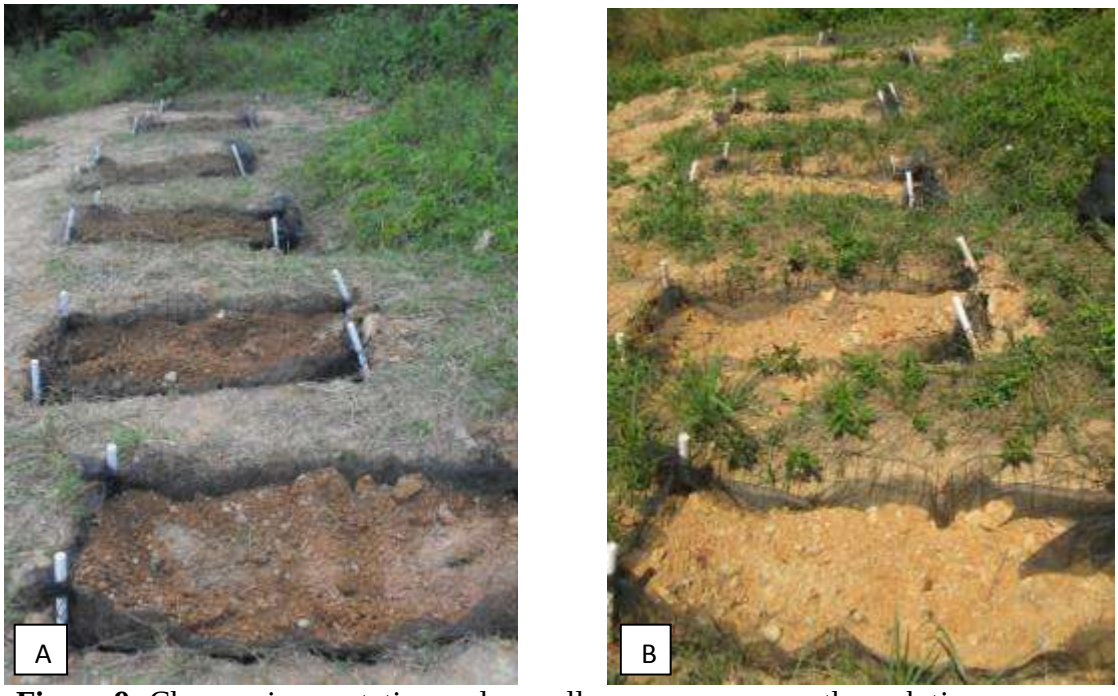


Figure 9: Changes in vegetation and overall grave appearance through time.

A) Picture was taken at day 0, once the pigs were buried. B) Picture was taken before the final date of disturbance

Day 28

Vegetation at the site had yet again started to grow back around each of the graves though it remained short and sparse. The border of the graves however remained bare, which made the soil at the borders of the graves unstable. No new growth was seen in any of the cages. Because the soil around the edges of the graves were so unstable (dry and crumbly), the gaps around the head, foot, and grave corners had increased. The soil in the cages had compacted and settled.

Day 61

Vegetation had begun to grow back around Graves 2-6, but not around the borders of Grave 1. No growth was seen in any of the cages. Further degradation was seen around the edges of each grave, and large gaps were seen around the sides in addition to the corners, head, and foot of each grave, particularly in the two graves (Grave 1 and 2) that were disturbed. The soil at the borders was dry and flaky, and the edges appeared to be slowly expanding out to where the remaining vegetation (and roots) still remained. The soil in Grave 1's cage had not resettled.

Day 90

At the site, vegetation around Graves 3-6 had returned with the exception of the area directly inferior to the foot of each grave. Vegetation around Graves 1 and 2 was present, though it was sparse, particularly at the borders. New growth was also present for the first time in the cages that had not been previously disturbed (Graves 3-6). Significant gaps between the cage and the walls of each grave were present, and gaps between the PVC pipe frame and the grave walls were present. The soil in the cages of Grave 1 and 2 did not settle, making digging comparatively

easier than in Grave 3. While the cages still appeared to fit snugly within their graves, the PVC pipe frame had begun to bow towards the middle.

Day 118

Much of the vegetation had grown back at the site, with the exception of the plants at the foot of all of the graves. This included the graves that had not been previously disturbed. Comparatively, however, the vegetation surrounding Graves 1, 2, and 3 were sparser, and the edges of the graves were bare of vegetation. Growth in the undisturbed cages had increased, and in Grave 4, the vegetation that had begun growing in the cage and on the edges of the grave had actually tangled together and had to be cut apart in order for the cage to be lifted. No growth was present in the cage for Grave 3, where there had been growth previously. The soil in the cages which had been previously disturbed had not settled and remained loose. The slight bow of each cage was still present but had not increased.

Day 147

At 5 months into the experiment, the cages began to show signs of wear, and the 1-foot posts holding the walls of the cages had all disconnected from the main PVC pipe frame. This resulted in a slight collapse in the wire fence towards the middle of the cages, meaning that the wire fencing was pulled away from the grave walls. The cages themselves were still intact. It is thought that this resulted from the extra weight of wet soil as the area experienced increased rainfall. Further, the middle of each cage appeared to have sunk down into the grave, creating an increased bowed appearance and increasing the gaps between the cage and the grave walls. Vegetation at the feet of the graves was still sparse. Vegetation in the cages that had been

previously disturbed did not grow back, while vegetation was present in cages that had not been disturbed. The soil in the disturbed cages did not settle and remained loose.

Day 181

During the final month of the experiment, two cages showed extreme wear and had torn at the bottom (Grave 1 and Grave 6). This did not result in soil falling into the graves, but indicated that the cages would probably not have held up any longer. The bowing of the cages had continued to increase, further pulling the wire fencing away from the walls of the graves and further increasing the gaps between the PVC pipe frame and the grave walls. The vegetation at the site was still present but had receded due to changes in weather. Only Cage 6 had vegetation. The soil in Cages 1-5 was loose, with the soil in Cage 6 still being compacted and settled.

Individual Grave Descriptions

Individual grave descriptions are summarized in Table 7. At Day 0, each grave and its cage had been set up for about two weeks. The walls of the graves were straight and even, with no evidence of tunneling or other animal or insect activity. There was a slight buildup on the grave walls where the PVC pipe frame sat but no soil discoloration. At the very surface of each grave, the soil was dry and flaky due to the loss of vegetation resulting from digging. Regardless, there was only a very slight cave-in of soil into the graves when the cages were moved.

Grave 1/Pig 1

Pig 1 was disturbed a total of six times (Figure 10). At day 28, the cage to Grave 1 was easily lifted with very little soil being knocked loose and falling into the grave. The cage frame

Table 6: Grave descriptions and observations.

Day	Grave	Remains Visible	Cage Line	Wall Integrity	Decomposition Fluid	Insects (grave)	Insects (cage)	Animal Activity	Other
Day 0	1	All	None	Good	Absent	Flies Present	Absent	Absent	N/A
	2	All	None	Good	Absent	Flies Present	Absent	Absent	N/A
	3	All	None	Good	Absent	Flies Present	Absent	Absent	N/A
	4	All	None	Good	Absent	Flies Present	Absent	Absent	N/A
	5	All	None	Good	Absent	Flies Present	Absent	Absent	N/A
	6	All	None	Good	Absent	Flies Present	Absent	Absent	N/A
Day 28	1	Skull, Ribs, Lower Limbs	Present; Clear	Good	Absent	Dermestids	Absent	Absent	Possible Adipocere
Day 61	1	Skull, Ribs, Lower Limbs	Present; Clear	Good	Present	Live/Unenclosed Larvae	Present	Mouse	N/A
	2	Skull, Lower Limbs	Present; Clear	Good	Absent	Dermestids	Absent	Absent	Possible Adipocere
Day 90	1	Skull, Ribs	Present	Corners Unstable	Present	Live/Unenclosed Larvae	Present	Mouse	N/A
	2	Skull, Shoulder, Ribs	Present	Corners Unstable	Present	Live/Unenclosed Larvae	Present	Absent	N/A
	3	Skull, Shoulder, Upper Limbs	Present	Corners Unstable	Absent	Dermestids Unenclosed Larvae	Absent	Garter Snake	Possible Adipocere
Day 118	1	Skull, Shoulder, Ribs, Upper Limbs	Present;	Unstable	Present	Enclosed/Unenclosed Larvae	Absent	Mouse	Moss on Walls
	2	Skull, Shoulder, Ribs, Lower Limbs	Present	Unstable	Present	Enclosed/Unenclosed Larvae	Absent	Absent	Possible Adipocere
	3	Skull, Upper Limbs	Present	Unstable	Absent (Activity Present)	Dermestids	Absent	Absent	Adipocere, Mold
	4	Skull, Shoulder, Ribs, Upper Limbs	Present	Unstable	Absent (Activity Present)	Dermestids	Absent	Absent	Possible Adipocere, Moss
Day 147	1	Skull, Shoulder, Ribs, Upper Limbs	Present	Unstable	Absent (Activity Present)	Enclosed Puperia/Larvae	Absent	Mouse	Moss
	2	Skull, Shoulder, Ribs, Upper Limbs	Present	Unstable	Present	Enclosed Puperia/Larvae	Absent	Absent	Moss Ball
	3	Skull, Upper Limbs	Present	Unstable	Absent (Activity Present)	Enclosed Puperia/Larvae	Absent	Absent	Possible Adipocere, Mold

Table 6 Continued: Grave descriptions and observations.

Day	Grave	Remains Visible	Cage Line	Wall Integrity	Decomposition Fluid	Insects (Grave)	Insects(Cage)	Animal Activity	Other
Day 147	4	Skull, Shoulder, Ribs, Upper Limbs	Present	Unstable	Present	Enclosed Puperia/Larvae	Absent	Absent	Possible Adipocere
Day 181	5	Skull, Ribs, Upper Limbs	Present	Unstable	Absent (Activity Present)	Enclosed Puperia/ Larvae	Absent	Absent	Moss
	2	Skull, Shoulder, Ribs, Limbs	Present	Unstable	Absent	Enclosed Puperia/Larvae	Absent	Mouse	N/A
	3	Skull, Limbs	Present	Unstable	Absent	Enclosed Puperia/Larvae	Absent	Mouse	Mold, Dried Grass Ball
	4	Skull, Shoulder, Ribs, Limbs	Present	Unstable	Absent	Enclosed Puperia/Larvae	Absent	Mouse	Mold, possible Adipocere
	5	Skull, Ribs, Limbs	Present	Unstable	Absent (Activity Present)	Enclosed Puperia/Larvae	Absent	Mouse	Moss
	6	Skull, Ribs, Lower Limbs	Present	Unstable	Present	Enclosed Puperia/Larvae	Absent	Absent	Moss

created distinct environments above and below the frame, with the soil beneath the frame far more wet and stable than the soil above. A buildup of soil at the frame along the sides of the grave (but not the corners) created somewhat of a seal between the two environments. The skull, ribs, and several bones of the lower limbs were visible on the surface of the bottom of the grave. A substance that resembled adipocere was present on the on the exposed portion of the skull and on the soil above the skull.



Figure 10: Pig 1 through time.

A) Day 28; B) Day 61; C) Day 90, D) Day 118, E) Day 147, F) Day 181

A small amount of enclosed and unenclosed larvae were present semi-buried around the skull, exposed ribs, and on the walls beneath the cage frame. A small number of dermestid beetles were also present along the walls.

At day 61, Grave 1 had changed considerably since its first opening. An opaque fluid located where the abdomen of the pig had been was present (Figure 11). Unenclosed larvae were present moving beneath this decomposition fluid. Burrowing was present in the walls of the grave beneath the cage frame line. Although the wall integrity was still good, the walls were less regular than in the previous month and soil had fallen into the grave around the borders, particularly at the head. Dermestids were no longer present, and the substance resembling adipocere was also no longer present. Insect activity, in the form of burrowing, was also present in the cage soil. A mouse nest also appeared in the upper right corner of the grave above the skull (Figure 12).

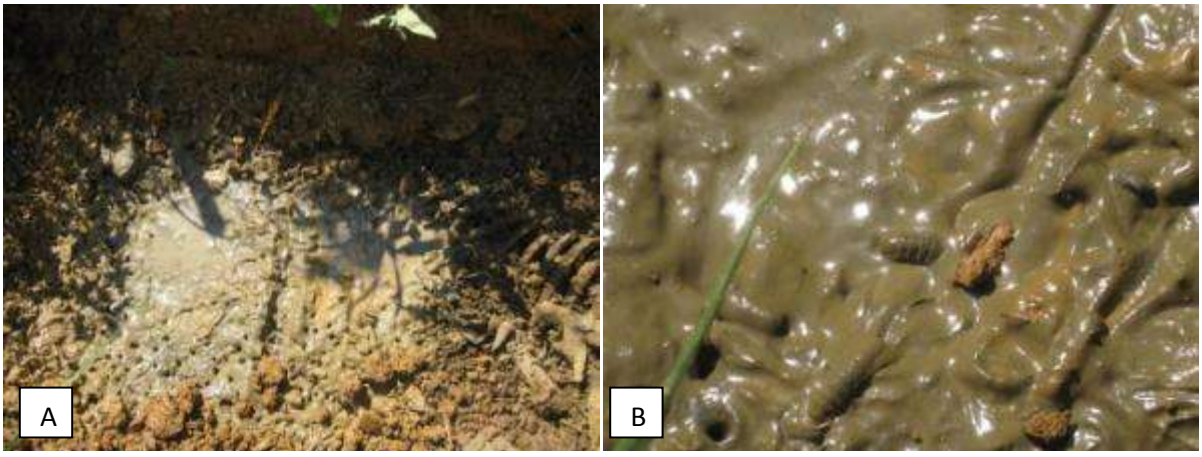


Figure 11: Decomposition fluid at the foot of Grave 1 during Day 61.

A) Decomposition fluid present at the foot of Grave 1; B) Up-close shot of the fluid, with living larvae and insect tunnels

At day 90, the decomposition fluid was still present although advanced decomposition had taken place. An area of the decomposition fluid at the base of the grave had turned black, and larvae activity had created patterns and channels through it. The corners of the grave had become incredibly unstable, even beneath the cage line. New insect activity in the form of tunneling was present in the cage soil. Mouse activity was still present, as a live mouse was present within the grave when the cage was lifted. The walls had increasing become irregular.



Figure 12: Mouse nest in Grave 1 that appeared by Day 61.

Mouse nest present at the right hand upper corner of the grave. This mouse nest was present throughout the experiment, and the inhabitant was viewed at each disturbance date.

At day 118, the decomposition fluid was still present, but had congealed considerably. Enclosed larvae were present above the decomposition fluid and around the skull. There was no

new insect activity within the cage soil. The walls of the grave had become increasingly more unstable and irregular, with the soil above the cage line widening, and the soil beneath the cage line falling away from the wall into the edges of the cage due to insect activity. The mouse nest was still present with active mouse activity.

At day 147, the decomposition fluid was no longer present; however, decomposition activity still appeared to be present via insect tunneling. Enclosed puparia and larvae were present in the middle of the grave where the trunk and abdomen of the body had been. The wall line where the cage rested in the grave was still present, but this line was much less clear than in previous months. The walls were still unstable with quite a bit of soil from the walls building up around the borders of the grave. No new insect activity in the cage soil was present. Mouse activity was still present.

At day 181, the grave had a very similar appearance to that of day 147, with the exception of the decomposition activity. The grave had dried considerably and no evidence of decomposition fluid remained. The grave still housed a mouse nest and had become home to five mice. The cage line was still present and the soil walls had become very irregular compared to the previous months. Dead leaves and other associated vegetation were present within the grave and may have either blown in or was brought in by mice.

Grave 2/Pig 2

Grave 2 was disturbed a total of five times, starting on day 61 (Figure 13). Only the skull and lower limb bones were visible. The grave was dry, with a clear cage line present. The walls of the grave were decently stable, though there was insect tunnel activity in the walls and in the cage soil. Enclosed and unenclosed larvae were present around the foot of the grave and

dermestid beetles were noted on the walls beneath the cage line. An unknown substance, similar to the adipocere-like substance in Grave1, was also present on the skull and on the soil over the vertebral column.

On day 90, a large amount of opaque decomposition fluid with living larvae was present at the foot of the grave. The ribs and shoulder bones were now visible as well. The dermestid beetles had disappeared. The grave corners were unstable with a small amount of soil fall-in, and insect tunneling activity was present in the walls beneath the cage line. The unknown substance was still present on the lower left corner of the grave.

On day 118, the grave conditions had not changed significantly with the exception that the grave walls had become more irregular with soil fall-in. Decomposition activity had increased with increased insect tunnel activity. The cage line was present but was not clear. Moss had also begun to grow on the right upper wall.

On day 147, the decomposition fluid had dried considerably, but activity was still present. A ball of moss appeared in the right hand corner of the grave near the skull (Figure 14), and leaf litter was also present. The cage line was still present, although the walls had become increasingly unstable at the corners and along the sides at the middle. The foot of the grave had also widened considerably. No insect activity was seen in the cage soil, and no animal activity was present.

On day 181, the grave had almost completely dried with very little decomposition activity still present. The cage line was still present, and the wall had lost stability, particularly below the cage line. The left upper corner of the grave had caved in completely, and the moss ball had disappeared. Enclosed larvae and puperia were present on the grave floor where the decomposition activity had been and around the exposed skeletal material. Mice were present at

the site and did access the grave when Grave 1 was disturbed. No adipocere-like substance was present.



Figure 13: Pig 2 through time.

A) Day 61, B) Day 90, C) Day 118, D) Day 147, and E) Day 181



Figure 14: Moss ball that appeared in Grave 2 by Day 147.

The moss ball appeared towards the end of the experiment. It is unknown where this came from or if it could be associated with the mice. Mice were caught actively using this grave during the date of recovery.

Grave 3/Pig 3

Grave 3 was disturbed a total of four times, starting at day 90 (Figure 15). The skull, bones of the shoulder, and upper limbs were visible on the grave floor. The grave floor was wet, but did not have decomposition fluid present. Both enclosed and non-enclosed puperia and larvae were present over the entire bottom of the grave, as well as on the walls below the cage line. The cage line was present, and the walls were still straight, with the exception of the left wall, which had collapsed beneath the cage line. A common garter snake was present in the grave upon opening, but no other animal activity was noted. No insect activity in the cage soil was noted. A large amount of an adipocere-like substance was present on the exposed portion of the skull, an area of soil inferior to the skull, and over the pelvic area of the pig.

On day 118, it appeared that decomposition activity was starting to take place in the lower portion of the grave. More insect tunneling was present beneath the cage line. The

adipocere-like substance had flourished on the soil beneath the skull. The walls at the foot of the grave, particularly the corners, were beginning to fall inward.

On day 147, grave conditions had changed very little. Some soil had fallen in from the corners, and leaf litter had appeared at the head of grave floor. It appeared that the some of the soil on the grave floor had gathered at the foot, with the result that the foot was no longer two feet deep, but was closer to one foot deep. This grave was located on a slightly steeper slope compared to the other graves, which may have aided this result.

On day 181, grave conditions had changed very little. A mouse nest appeared in the upper left corner of the grave above the skull. Much of the leaf litter had relocated to the heat of the grave. The left wall did not hold up, and a large amount of soil had caved in.



Figure 15: Pig 3 through time.

A) Day 90, B) Day 118, C) Day 147, and D) Day 181.

Grave 4/ Pig 4

Grave 4 was disturbed a total of three times, starting on day 118 (Figure 16). The skull, bones of the shoulder girdle, ribs, and upper limb bones were visible on the grave floor. Congealed decomposition activity was present at the foot of the grave, but the rest of the grave floor was dry. Insect tunneling in the decomposition fluid, around the base of the grave, and the walls under the cage line, was also present. The walls were irregular and unstable, particularly at the corners. There was no insect activity in the cage soil, and no animal activity. An adipocere-like substance was present sporadically on the soil in the upper portion of the grave and on the skull.

On day 147, condition of the grave was similar to the previous month. The decomposition activity at the grave foot was still present, and had grown slightly in surface area compared to the previous month. The dermestid beetles were absent, but enclosed puperia and larvae were present over the floor of the grave. The adipocere-like substance at the head of the grave was also present; however, the substance on the exposed right scapula and rib shafts had disappeared. The cage line was clear, but unlike the other graves, there was tunneling present above the cage line.

On day 181, the grave had dried considerably, and the decomposition activity seemed to have ceased. The cage line was present, but large portions of the wall beneath the cage line had fallen out into the grave floor. The walls at the foot and head were completely irregular. No insect activity in the cage soil was present. The adipocere-like substance that had been present in the previous month had disappeared except for a small amount on the soil near the skull. Mold had also grown in the center of the grave beneath the rib cage.

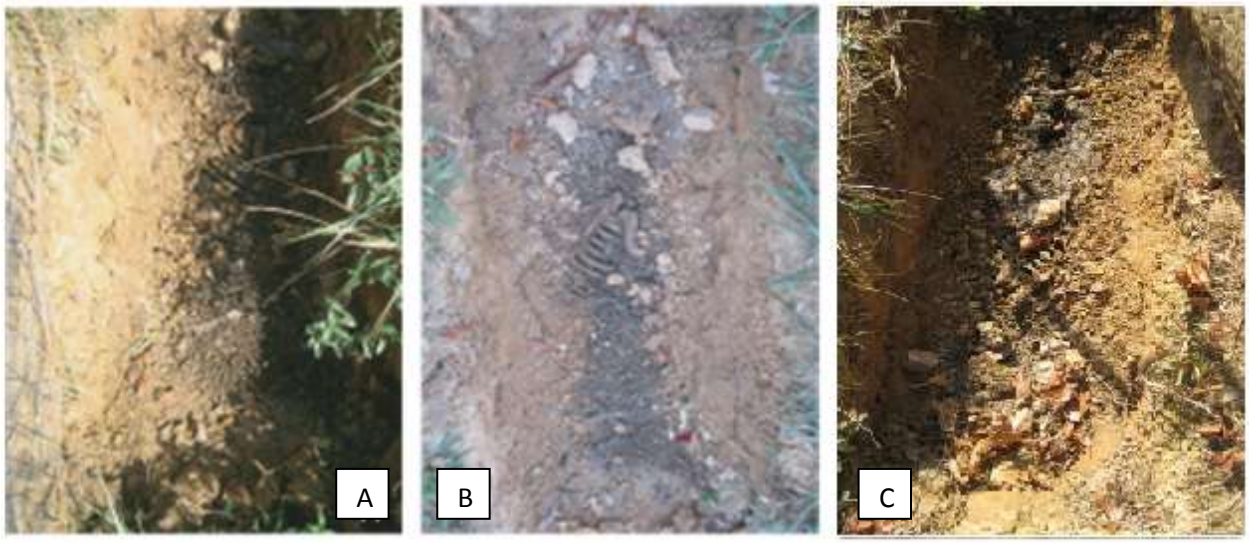


Figure 16: Pig 4 through time.

A) Day 118, B) Day 147, and C) Day 181

Grave 5/Pig 5

Day 5 was disturbed twice, starting on day 147 (Figure 17). The skull, ribs, and upper limb bones were visible on the surface of the grave bottom. The cage line was present, but no particularly clear, although the soil color was different above and below the line. The walls of the grave were irregular and unstable, with insect tunneling present below the cage line. Decomposition activity was present, although the fluid was congealed and dry compared to the activity seen in Graves 1 and 2 during previous months. Enclosed puperia and larvae were present around the borders of the grave bottom, as well as in the walls. No insect activity was present in the cage soil. Moss was identified growing on the grave walls above the cage line.

On day 181, the grave had dried considerably so that moisture was only present along the midline of the grave. The skull had been hidden by soil that had fallen into the grave during the removal of the cage, indicating severe instability of the soil from the grave walls, particularly

above the cage line. The cage line was still present on the left side of the grave, but was less clear on the right side, though the soil color still differed between above and below where the frame had sat. The left corner at the foot of the grave had caved completely. Enclosed puperia and larvae were still present, and heavy tunneling was noted around the bottom of the grave and in the walls beneath the cage line.



Figure 17: Pig 5 through time.

A) Day 147, and B) Day 181

Grave 6/Pig 6

Grave 6 was first disturbed during the final day, on day 181 (Figure 18). A large portion of the skull was visible on the surface of the grave bottom and portions of the ribs and lower limbs were also visible. Active decomposition fluid was present in the middle of the grave as opposed to the foot as in the other graves, though this may have been due to the fact that this grave had been dug on an area that had less of a slope. Enclosed puperia and larvae were present,

and no insect movement was noted. A distinct cage line was present, but the walls were unstable and irregular, with the walls beneath the cage line showing a large amount of insect tunneling. Overall, the grave had retained the most rectangular shape out of all of the graves. No insect activity was present in the cage soil. Moss was present on the grave wall above the cage line.



Figure 18: Pig 6 at Day 181.

Pig 6 during the final day of the experiment (day 181).

Pig Decomposition Comparisons

Megyesi et al.'s (2005) scoring system was used to the best of the researcher's ability due to differential exposure of skeletal elements. Further, Megyesi et al.'s (2005) system was only tested using human remains recovered from the surface and not on buried remains. Thus, the statistics are only being reported to test for significant difference between the decomposition of each pig through time, and not to represent the stages of decomposition itself. The scores for the decomposition stage of the head and neck are summarized in Table 7, the scores for the trunk are summarized in Table 8, the scores for the limbs are summarized in Table 9, and finally, the total body scores are summarized in Table 10.

On the day of placement, all six pigs showed signs of fixed lividity but no skin slippage or other discolorations, and no signs of bloating. Each anatomical area was scored as "fresh," (1 point each), resulting in a TBS of 3 per pig.

Throughout the experiment, none of the exposed skeletal material ever appeared greasy, though the bones often appeared wet due to the moisture within the grave. For all six pigs, the head/neck area was scored as 13, or "dry bone," for the entire six months. Similarly, the limbs were also scored consistently as 10, or "dry bone." The limb bones were often steeped in decomposition fluid when it was present in the graves, but it was apparent that the decomposition was not coming from this anatomical area as the fluid was always present where the abdomen had been, and no decomposition fluid was ever present near the front limb bones.

Table 7: Decomposition scores for the head and neck.

Day	Pig 1	Pig 2	Pig 3	Pig 4	Pig 5	Pig 6
0	1	1	1	1	1	1
28	13	N/A	N/A	N/A	N/A	N/A
61	13	13	N/A	N/A	N/A	N/A
90	13	13	13	N/A	N/A	N/A
118	13	13	13	13	N/A	N/A
147	13	13	13	13	13	N/A
181	13	13	13	13	13	13

Table 8: Decomposition scores for the limbs.

Day	Pig 1	Pig 2	Pig 3	Pig 4	Pig 5	Pig 6
0	1	1	1	1	1	1
28	10	N/A	N/A	N/A	N/A	N/A
61	10	10	N/A	N/A	N/A	N/A
90	10	10	10	N/A	N/A	N/A
118	10	10	10	10	N/A	N/A
147	10	10	10	10	10	N/A
181	10	10	10	10	10	10

Table 9: Decomposition scores for the trunk.

Day	Pig 1	Pig 2	Pig 3	Pig 4	Pig 5	Pig 6
0	1	1	1	1	1	1
28	12	N/A	N/A	N/A	N/A	N/A
61	9	12	N/A	N/A	N/A	N/A
90	9	9	12	N/A	N/A	N/A
118	9	9	12	9	N/A	N/A
147	12	9	12	9	9	N/A
181	12	12	12	12	9	9

Table 10: Total body scores.

Day	Pig 1	Pig 2	Pig 3	Pig 4	Pig 5	Pig 6
0	3	3	3	3	3	3
28	35	N/A	N/A	N/A	N/A	N/A
61	32	35	N/A	N/A	N/A	N/A
90	32	32	35	N/A	N/A	N/A
118	32	32	35	32	N/A	N/A
147	35	32	35	32	32	N/A
181	35	35	35	35	32	32

For the trunk, the area for each pig was scored as 12, or "dry bone," except when decomposition fluid or activity was present. When activity was present, the area was scored as 9, which was the highest score under Megyesi et al.'s (2005) system that accounted for decomposition fluid. For pig 1, the trunk was scored as 9 during day 61, 90, and 118. For pig 2, the trunk was scored as 9 for day 90, 118, and 147. Pig 3's trunk remained completely dry for the entirety of the experiment. For Pig 4, the trunk was scored as 9 for days 118 and 147. For Pig 5, the trunk was scored as 9 for days 5 and 6. Finally, Pig 6's trunk was scored as 9 for day 181. The presence of decomposition fluid in the graves resulted in the TBS dropping from 35 to 32, which was reflected in the trunk scoring.

Site Temperature Comparisons

All seven data loggers were successfully retrieved from the graves and from the control post. However, the data logger from Grave 3 had been corrupted, making the data irretrievable. It is most likely that the seal on the capsule failed, allowing moisture buildup in the grave to affect the data logger. Thus, there is no temperature data available from Grave 3.

The minimum, maximum, and mean temperatures of each day are recorded for the six data loggers in Appendix 2. The temperature data set was split into six parts, with each part

starting with a date of disturbance and ending on the day before the next disturbance date. The minimum and maximum grave temperatures rarely fluctuated beyond four degrees from each other, and thus only the daily mean is reported here. The temperature from the control data logger fluctuated wildly between the minimum and maximum temperatures recorded, thus these temperatures are reported here.

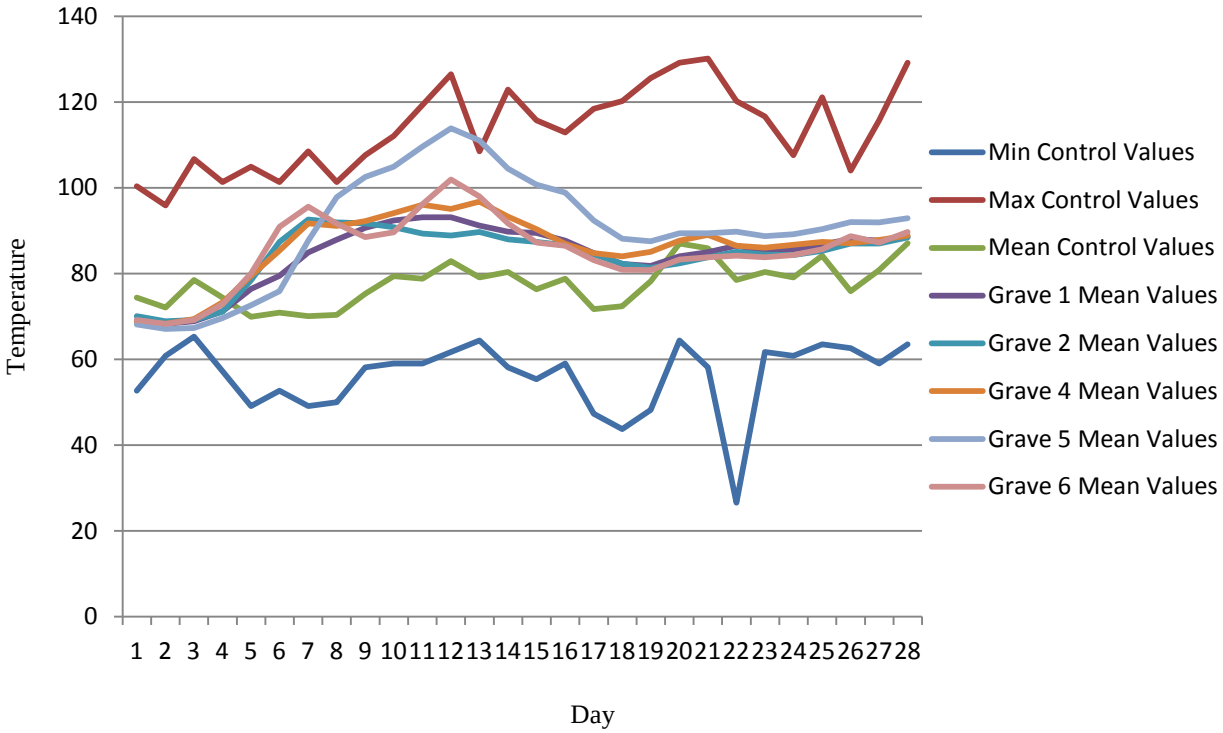


Figure 19: Temperature data from date of placement: Day 0 to Day 28.

The first temperature data set spanned 28 days, during which time no pigs were disturbed (Figure 19). The control maximum temperatures were recorded during the late afternoon (1pm to 4pm), during which the control data logger was located in direct sunlight. Most of the control

data logger's minimum temperatures were recorded at night, usually at 10 pm or 1 am. All grave data loggers recorded similar temperatures for the first 4 days. From day 7 to day 12, the data logger from Grave 5 increased sharply in comparison to the other grave data loggers. From day 18 on, all grave data loggers recorded temperatures that remained constant in the upper 80 to 90 degrees.

The second temperature data set spanned from day 29 to day 60, or 32 days in total (Figure 20). Pig 1 was disturbed on day 28. All grave data loggers recorded mean temperatures that remained constant at around 90 degrees. These temperatures slid to the mid to lower 80 degrees as the month continued. The control minimum temperatures remained constant at around 60 degrees, while the maximum temperatures jumped between 80 to 120 degrees.

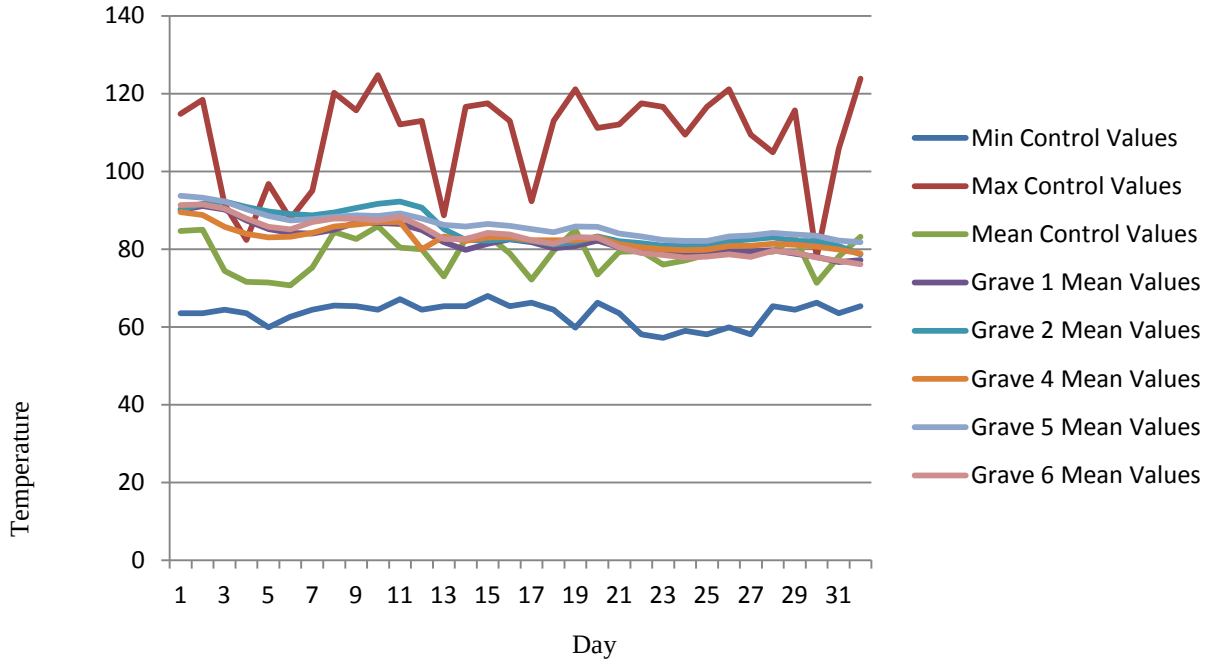


Figure 20: Temperature data from the day of disturbance of Grave 1: Day 29 to Day 60.

The third temperature data set spanned from day 61 to day 89, a total of 29 days (Figure 21). During day 61, Pig 1 and 2 were disturbed. The grave temperatures continued to remain constant, dipping down around 70 degrees during the middle of the month. The control minimum temperatures remained constant between 50 and 60 degrees, while the maximum temperatures jumped between 80 and over 120 degrees.

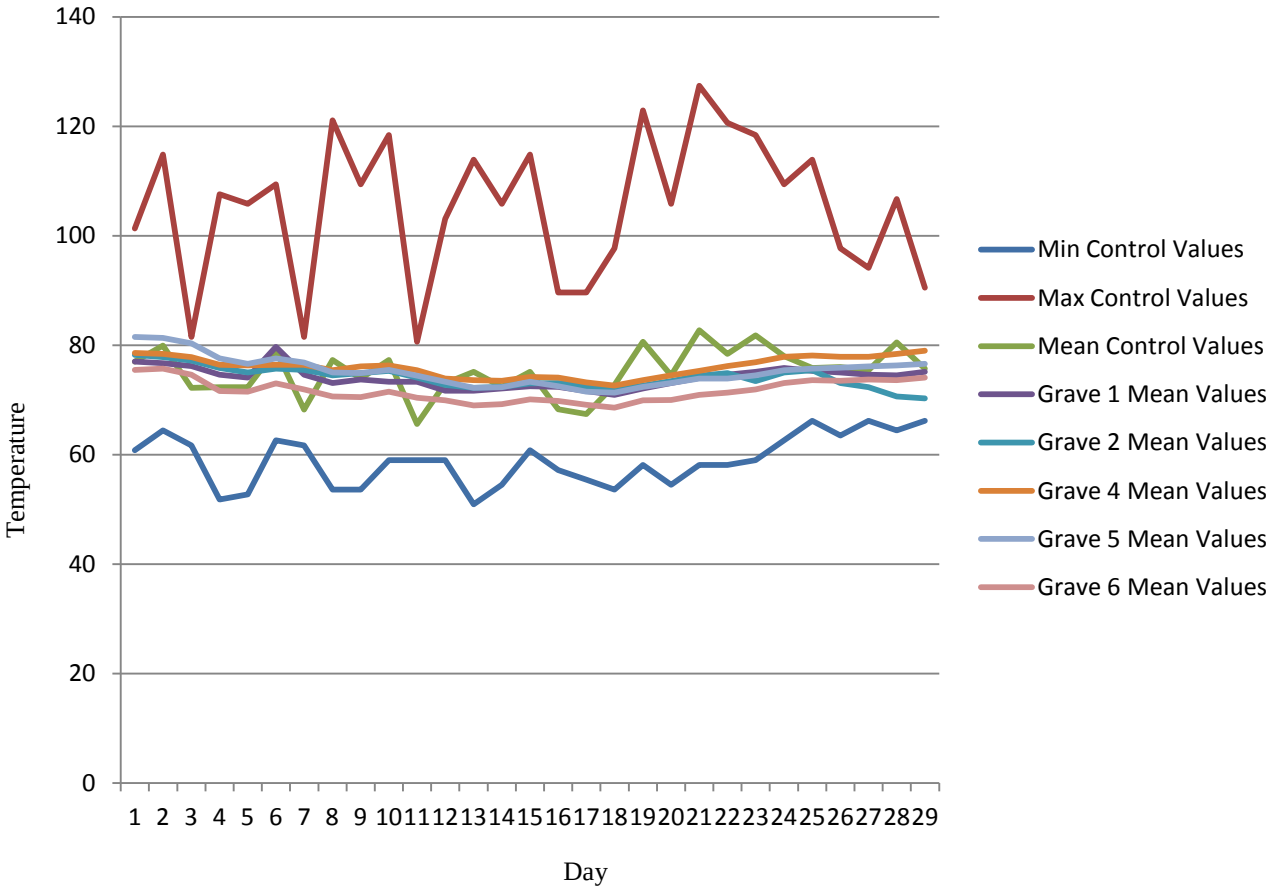


Figure 21: Temperature data from date of disturbance of Graves 1 and 2: Day 61 to Day 89.

The fourth temperature data set spanned 28 days (Figure 22). During day 90, Pigs 1, 2, and 3 were disturbed. Grave temperatures were less consistent than in previous months, but continued to generally decrease from the beginning to the end of the month. Control minimum temperatures were less consistent than in previous months, ranging anywhere from mid 60 to 30 degrees with no general trend. Control maximum temperatures ranged anywhere from 60 to 120 degrees.

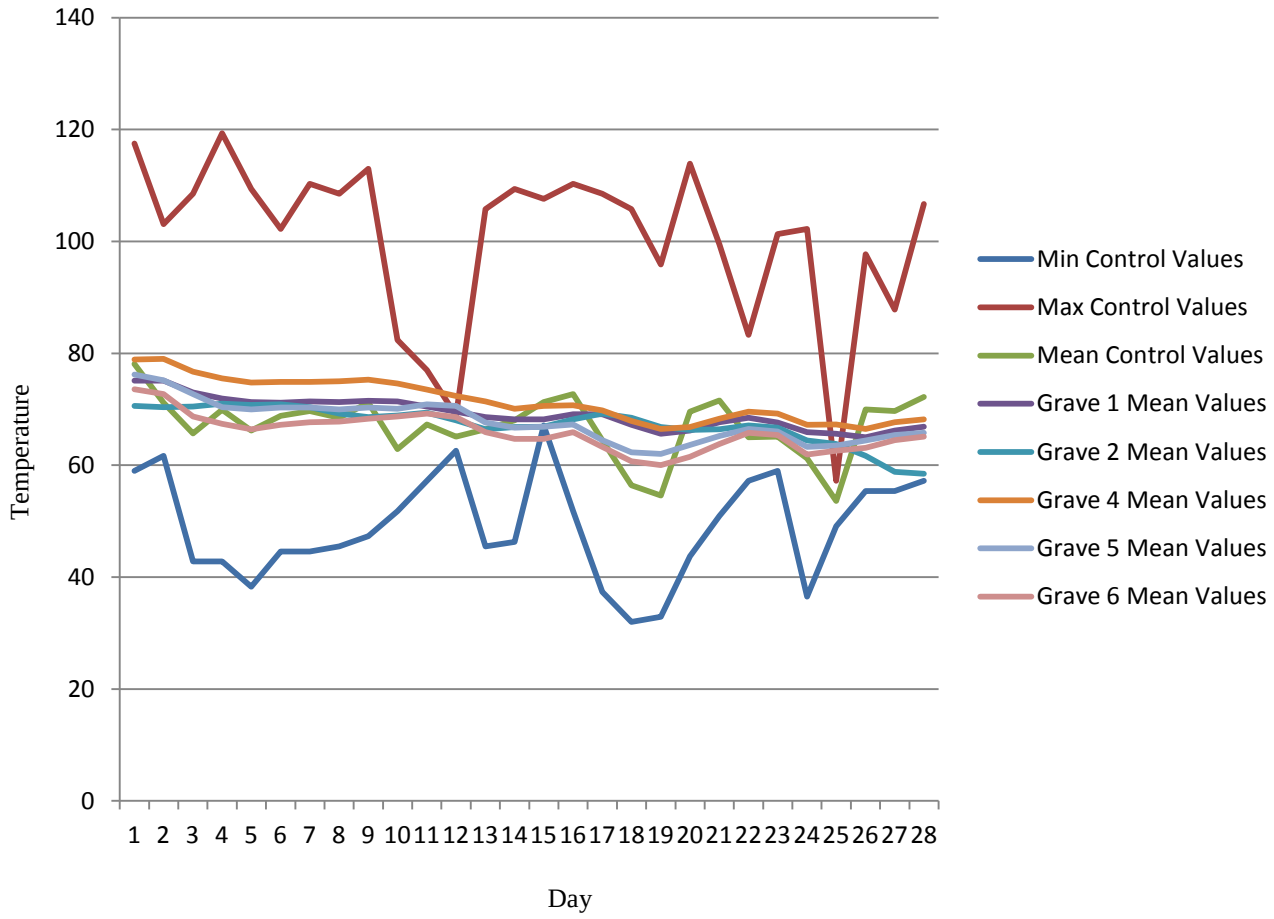


Figure 22: Temperature data from date of disturbance of Graves 1, 2, and 3: Day 90 to Day 117.

The fifth temperature data set spanned 29 days (Figure 23). During day 118, Pigs 1, 2, 3, and 4 were disturbed. Grave temperatures remained generally consistent and constant at around 60 degrees for most of the month, with the exception towards the end of the month, where Grave 2 and Grave 6's data loggers reported lower temperatures than temperatures in Graves 1, 4, ad 5. The control's minimum and maximum temperatures continued to vary greatly.

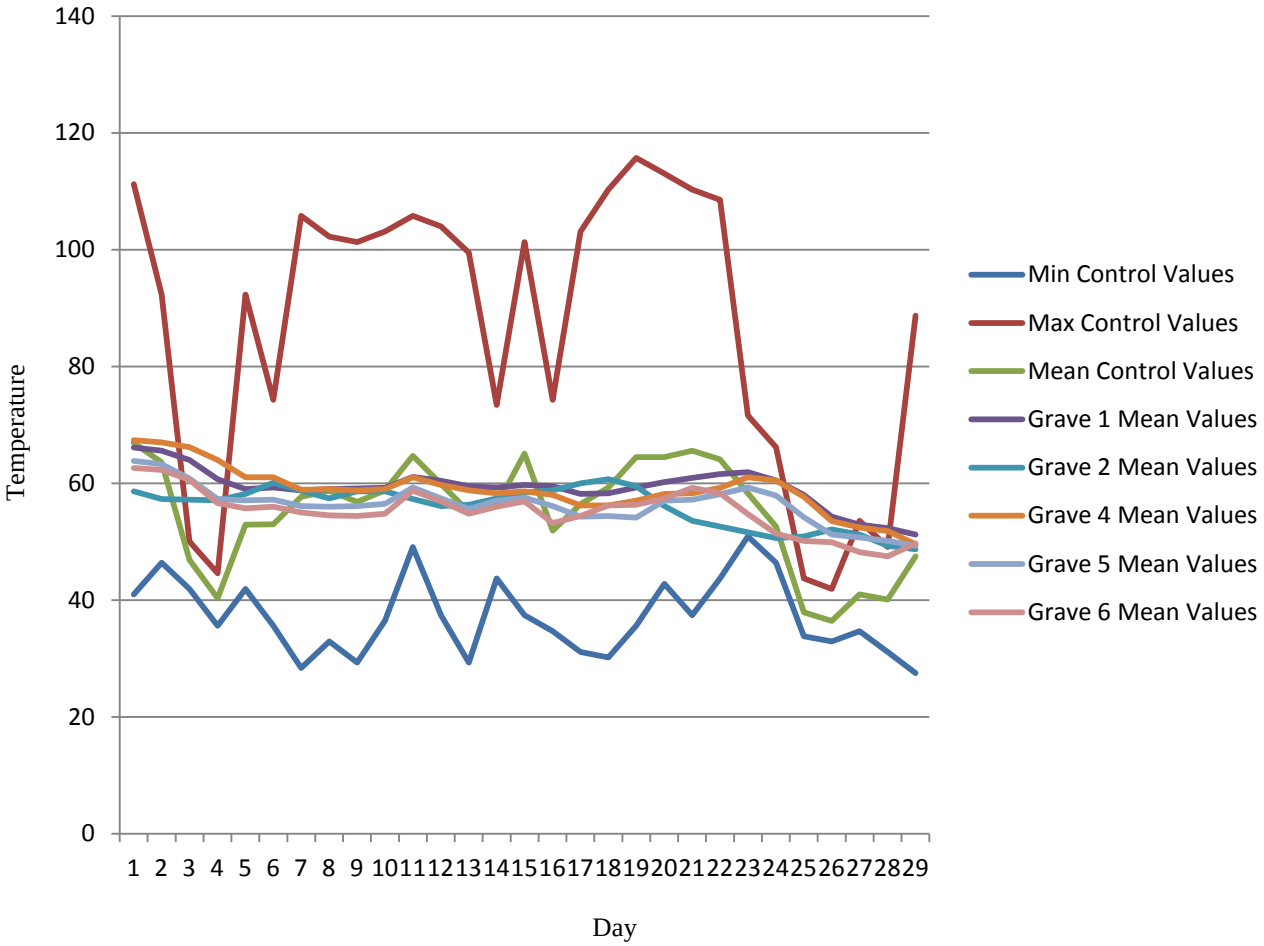


Figure 23: Temperature data from date of disturbance of Graves 1, 2, 3, and 4: Day 118 to Day 146.

The sixth and final temperature data set spanned 34 days (Figure 24). On day 147, Pigs 1, 2, 3, 4, and 5 were disturbed. Grave temperatures varied but remained between 40 and 50 degrees, with the exception of the temperature in Grave 2. The data logger for these grave recorded temperatures that increased to 65 degrees at day 26 of the data set, a 20 degree increase over the temperatures in the other graves. The control data logger's minimum and maximum temperature continued to vary greatly.

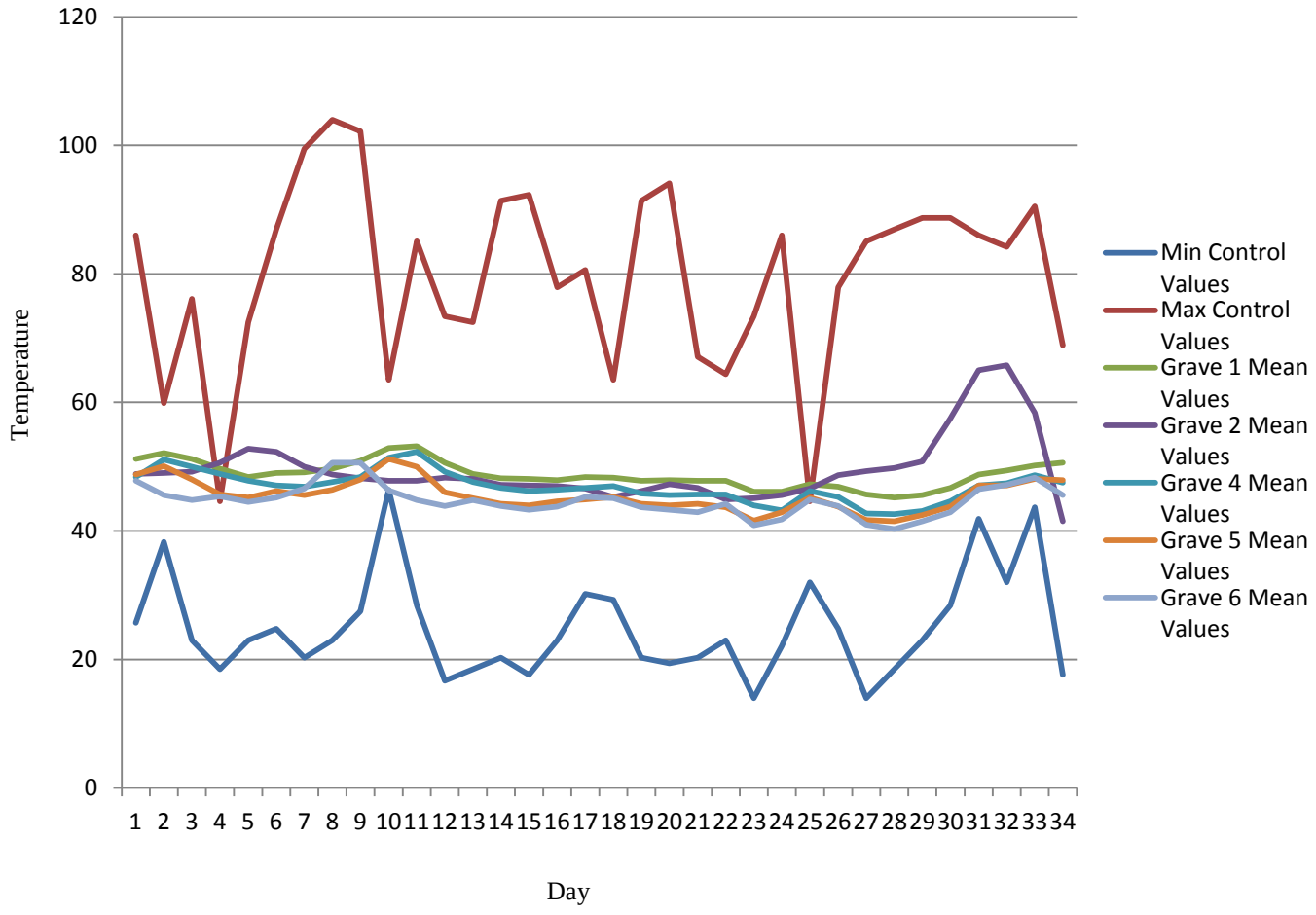


Figure 24: Temperature data from date of disturbance of Graves 1, 2, 3, 4, and 5 to Date of Recovery: Day 147 to Day 181.

Site and Weather Station Temperature Comparisons

Temperature data from the KPSK weather station located in Dublin, VA, was available for the length of the study (Appendix). When compared to the temperature from the control data logger, the mean control temperatures were consistently 10 to 15 degrees fahrenheight higher than the weather station temperatures. The daily minimum temperatures were more consistent between the two data sources, with minimum temperatures varying less than 5 degrees fahrenheight. The daily maximum temperatures, however, varied widely between the two sources, with the control temperatures consistently registering up to 30 degrees fahrenheight over the mean weather station temperatures. While the temperatures vary widely, the two sources follow the same general temperature trends.

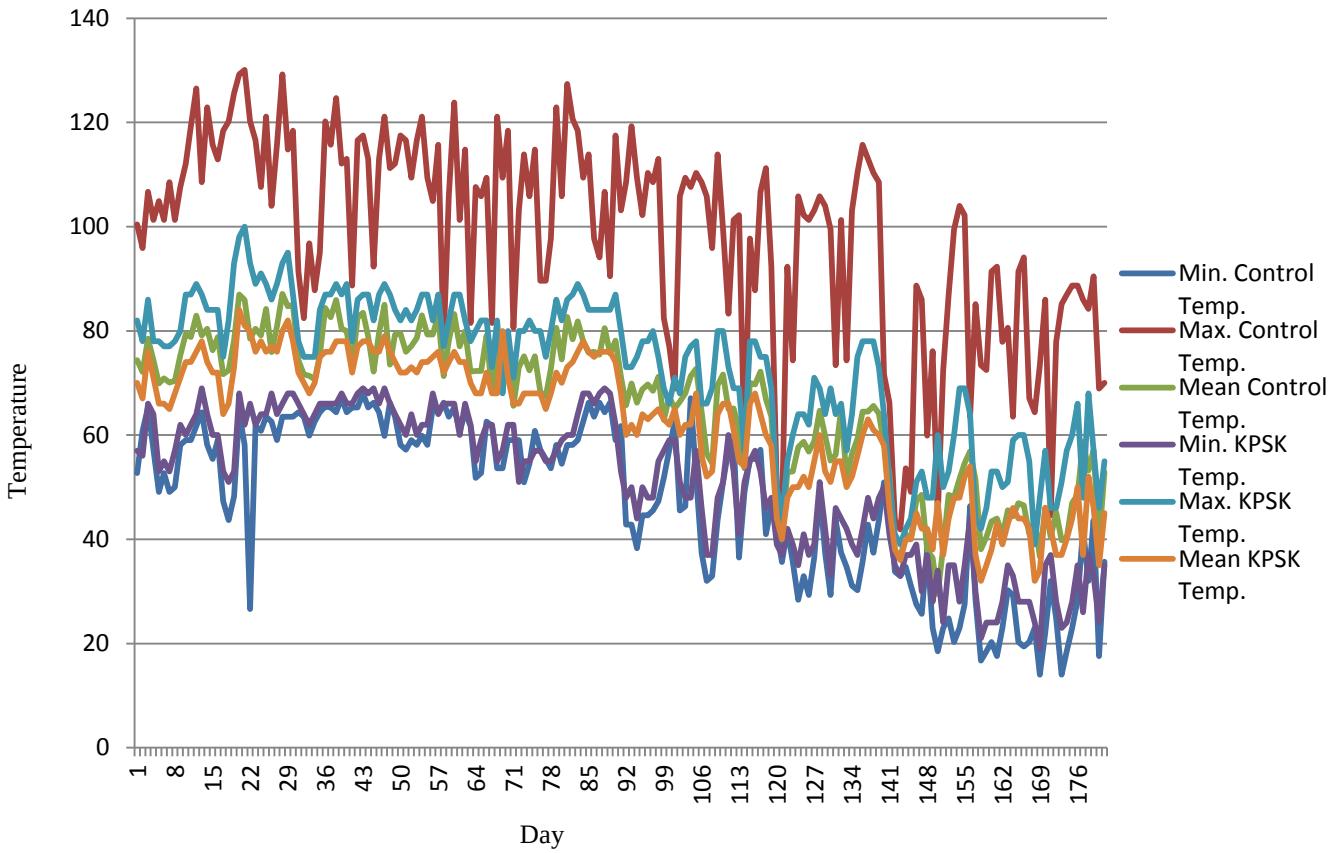


Figure 25: Site and weather station temperature comparisons.

Accumulated Degree Day Calculations and Postmortem Interval Estimations

ADD is reported for each pig that was uncovered at each data collection date (Table 11). ADD was calculated using the following simplified equation from Megyesi et al. (2005:6), where 388.16 refers to the standard error:

$$\text{ADD} = 10^{(0.002*\text{TBS}*\text{TBS}+1.81)} \pm 388.16$$

For an estimate of the 95% prediction interval, Megyesi et al. (2005:7) gave the following equation:

$$\text{ADD} \pm 776.32 \sqrt{1.02 + \frac{(\text{TBS} - 17.2)^2}{3522.42}}$$

Table 11: Accumulated degree day calculations.

Day	Date (2012)	Pig	TBS	ADD	Standard Error	Standard Error Range (ADDs)	95% CI*	95% CI* (ADDs)
0	June 10	1	3	67.29	±388.16	455.45	±871.41	938.7
0	June 10	2	3	67.29	±388.16	455.45	±871.41	938.7
0	June 10	3	3	67.29	±388.16	455.45	±871.41	938.7
0	June 10	4	3	67.29	±388.16	455.45	±871.41	938.7
0	June 10	5	3	67.29	±388.16	455.45	±871.41	938.7
0	June 10	6	3	67.29	±388.16	455.45	±871.41	938.7
28	July 8	1	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
61	Aug. 10	1	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
61	Aug. 10	2	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
90	Sept. 8	1	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
90	Sept. 8	2	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
90	Sept. 8	3	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
118	Oct. 6	1	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
118	Oct. 6	2	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
118	Oct. 6	3	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
118	Oct. 6	4	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
147	Nov. 4	1	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
147	Nov. 4	2	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
147	Nov. 4	3	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
147	Nov. 4	4	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
147	Nov. 4	5	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
181	Dec. 7	1	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
181	Dec. 7	2	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
181	Dec. 7	3	35	18197.01	±388.16	17808.85 to 18585.17	±817.89	17379.12 to 19014.9
181	Dec. 7	4	35	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
181	Dec. 7	5	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45
181	Dec. 7	6	32	7211.07	±388.16	6822.92 to 7599.23	±796.32	6414.69 to 8007.45

*Confidence Interval

The PMI estimation was calculated by starting at each data collection date for each disturbed pig and working backward, adding the degrees until the calculated ADD was reached (Table). In many instances, the PMI estimates could not be calculated using the control temperatures or grave temperatures, as these only exist for the length of the study. Thus, the weather station temperature records were used as mean temperatures were available.

The only accurate PMI estimation range, other than the burial date, was calculated for the disturbance date of September 8, 2012, and for pigs 1 and 2. Otherwise, the PMI was either estimated to be in mid to late 2011 (6 to 9 months before burial) to early January in 2012 for pigs that had a TBS of 35 at any given data collection date, and for mid June to Mid August of 2012 (after burial, but during the length of the study) for pigs that had a TBS of 32 at any given data collection date. The one exception to this was the PMI estimation for pig 1 on the August 10 data collection date, where the PMI was estimated to be mid April to mid May 2012 (before the burial date).

Table 12: Postmortem Interval Estimates.

Day	Date (20120	Pig	PMI Estimation Control Temp.		PMI Estimation KSPA Temp. Range		PMI Estimation Grave Temp. Range	
			Est. Date	Range	Est. Date	Range	Est. Date	Range
0	June 10	1	6/10/2012		6/10/2012	5/10/2012 to 6/10/2012	6/10/2012	
0	June 10	2	6/10/2012		6/10/2012	5/10/2012 to 6/10/2012	6/10/2012	
0	June 10	3	6/10/2012		6/10/2012	5/10/2012 to 6/10/2012		
0	June 10	4	6/10/2012		6/10/2012	5/10/2012 to 6/10/2012	6/10/2012	
0	June 10	5	6/10/2012		6/10/2012	5/10/2012 to 6/10/2012	6/10/2012	
0	June 10	6	6/10/2012		6/10/2012	5/10/2012 to 6/10/2012	6/10/2012	
28	July 8	1			8/17/2011	8/05/2011 to 8/28/2011		
61	Aug. 10	1			5/01/2012	4/17/2012 to 5/13/2012		
61	Aug10.	2			9/21/2011	9/07/2011 to 10/04/2011		
90	Sept. 8	1		6/18/2012*	6/01/2012	5/21/2012 to 6/13/2012		6/21/2012*
90	Sept. 8	2		6/18/2012*	6/01/2012	5/21/2012 to 6/13/2012		6/21/2012*
90	Sept. 8	3			10/26/2011	10/11/2011 to 11/10/2011		
118	Oct. 6	1	6/01/2012	6/11/2012 to 6/21/2012	6/28/2012	6/15/2012 to 7/07/2012	7/01/2012	6/24/2012 to 7/13/2012
118	Oct. 6	2	6/01/2012	6/11/2012 to 6/21/2012	6/28/2012	6/15/2012 to 7/07/2012	7/04/2012	6/24/2012 to 7/13/2012
118	Oct. 6	3			11/25/2011	11/08/2011 to 12/14/2011		
118	Oct. 6	4	6/01/2012	6/11/2012 to 6/21/2012	6/28/2012	6/15/2012 to 7/07/2012	7/05/2012	6/26/2012 to 7/14/2012
147	Nov. 4	1			1/02/2012	12/14/2011 to 1/23/2012		
147	Nov. 4	2	6/21/2012	6/11/2012 to 6/21/2012	7/16/2012	7/05/2012 to 7/26/2012	7/23/2012	7/14/2012 to 8/02/2012
147	Nov. 4	3			1/02/2012	12/14/2011 to 1/23/2012		
147	Nov. 4	4	6/21/2012	6/11/2012 to 6/31/2012	7/16/2012	7/05/2012 to 7/26/2012	7/22/2012	7-13 to 8-01
147	Nov. 4	5	6/21/2012	6/11/2012 to 6/31/2012	7/16/2012	7/05/2012 to 7/26/2012	7/23/2012	7/14/2012 to 8/02/2012
181	Dec. 7	1			2/05/2012	1/17/2012 to 2/25/2012		
181	Dec. 7	2			2/05/2012	1/17/2012 to 2/25/2012		
181	Dec. 7	3			2/05/2012	1/17/2012 to 2/25/2012		
181	Dec. 7	4	8/08/2012	7/29/2012 to 8/19/2012	8/03/2012	7/23/2012 to 8/09/2012	8/12/2012	8/03/2012 to 8/23/2012
181	Dec. 7	5	8/08/2012	7/29/2012 to 8/19/2012	8/03/2012	7/23/2012 to 8/09/2012	8/09/2012	7/31/2012 to 8/20/2012
181	Dec. 7	6	8/08/2012	7/29/2012 to 8/19/2012	8/03/2012	7/23/2012 to 8/09/2012	8/06/2012	7/27/20012 to 8/17/2012

*Only the low range estimate is reported due to data availability

Chapter 5: Discussion

This pilot study was meant to test a possible method for studying buried remains that would decrease the amount of space and number of specimens used but would also take investigator disturbance into account. The ultimate goal is to find a method that allows for the pigs to be disturbed so that the same specimen can be studied for the entirety of the experiment without influence from the investigator. However, there are no baselines for such a method when dealing with the study of buried remains, which cannot be studied (with the possible exception of temperature) without any sort of access. This study followed Adlam and Simmons' (2010) method of using the previously undisturbed set of remains as the new control each week, except that this study could not utilize a true control due to time, space, and manpower limitations. When a method that appears to work has been designed, it will need to be tested against traditional graves.

Several studies have used methods to facilitate decomposition studies of buried remains; however, the method itself that was used was not the focus (i.e. Payne and King 1968; Rodriguez and Bass 1985). It was expected that disturbing each grave would affect the decomposition of each set of remains, and visual data recording trends regarding how the decomposition and the grave itself were affected after repeated disturbance would aid in creating a sound method to test repeated disturbance against a real control. This particular method design did not hold for the duration of the experiment and appeared to fail within the first month. However, several trends in grave and environment degradation and other issues regarding general methodology for future similar studies were identified, and recommendations for future studies are offered.

Grave Methodology

It became clear very quickly that there were some major design flaws that affected the cages' overall performance. This was best represented in the gaps between the wall and the grave that appeared on the day of the pigs' placement, and these gaps continued to widen at the corners and sides throughout the experiment. These gaps were present for two main reasons: first, while the graves were dug so that walls and corners were straight, it was almost impossible to dig the corners to the exact dimensions of the cage corners so that the cage would slide in and out without damaging the grave wall but still be snug enough so that there would be no gaps. To fit the PVC cage frame snugly along the cage border, the walls above where the cage border sat also had to be wider than the PVC pipe frame in order to get it into the grave, which meant that gaps were more likely to happen. Second, the cage isolated the top soil from the grave walls, which made the border of the graves unstable. As the grave wall soil was not touching the cage above the PVC pipe frame, it dried quickly and crumbled.

While the removal of the cages appeared to be the major cause of the gaps, they also appeared in the cages that had not been previously disturbed. This indicates a problem with the overall design.

By isolating the soil in the cages, each grave effectively could not become one entity whose components all worked together. For example, isolating the soil allowed increased insect access after the date of burial due to the gaps at the corners of the cages, other animal or reptile activity, and possible sunlight, moisture, and precipitation. These components were expected to affect pig decomposition as the pigs were disturbed, but should not have affected the pigs while the cages were in place. At the junction of each PVC pipe frame and grave wall, a cage line appeared, indicating a difference in the environment within the graves (beneath the cage line)

and outside of the graves (Figure 26). This indicates that the PVC pipe frame was having some sort of effect on the grave itself, as the moisture content appeared to be much higher within the grave, and empty larvae remains were only present below the PVC pipe frame.



Figure 26: Example of the "cage line" seen on each grave wall throughout the experiment.

The cage line never disappeared, even when the walls became unstable and gaps increased in size and numbers.

The cage also had another attribute that, while not completely unexpected, facilitated increased animal and insect activity. The flat bottom of the cage did not have contact with the pig remains once they had decomposed. This created a space that was estimated to be approximately 0.5 feet from the floor of the grave to the bottom of the cage. For example, a mouse, which later became a family of mice, was actively utilizing the available grave space in at least five of the graves by the end of the experiment. While the single mouse appeared to use a hole that had been dug under the PVC pipe frame during the first few months, once the gaps were large enough, the mice were able to access the graves through the corner gaps, as was viewed on site. They also brought in materials from outside of the grave, such as grasses, nesting material, and leaf litter. In addition, they may have been responsible for the movement of skeletal material as well as any remaining hair from the pig remains, which ended up as part of the mouse nest in Grave 1.

Total Body Scores and Decomposition Comparisons

The decomposition scoring system presented by Megyesi and colleagues (2005) are based off of Galloway and colleagues' (1989) study on decomposition rates of humans in an arid environment. While several studies (e.g. Bachman and Simmons 2010, Simmons et al. 2010a, 2010b) successfully used ADDs to estimate the length of time to skeletonization for their studies for both surface and buried rabbit remains, it needs to be noted that TBS is meant for human remains and has not been tested for experimental buried remains.

Since pigs are considered to be an adequate human analog for decomposition studies (Dabbs 2010), using the scoring system should work. The problem in this case lies with the fact that these remains were buried. The abdomen and pelvis of each pig were never visible, resulting in the TBS being recorded with the information available from a noninvasive visual assessment,

which was the same technique used by Megyesi and colleagues (2005). For example, when pig 1 was uncovered during the first data collection date, the remains appeared completely skeletonized. However, the pelvic region, where the decomposition fluid was reported at the next data collection date, was not visible on the surface. There certainly may have been activity present at the first data collection date, but since it was not visible, it could not be recorded.

Rodriguez (1997) states that buried remains can take up to eight times longer to decompose than remains on the surface. However, this does not discuss the actual time frame of each decomposition stage. Does each stage take up to eight times longer to decompose, or is it only certain stages that take longer than others? If so, does this need to be represented in the scoring system?

It appears that, for this particular case, the categories in the decomposition scoring system may not be sensitive enough. For pig 1, for example, the amount of decomposition fluid in the grave decreased and changed over time, while the general area itself (that was visible) was skeletonized. Regardless of this progression, the TBS for the pig remained at 32 at each data collection date that the pig had any decomposition fluid present. Similarly, pigs 5 and 6 both had decomposition fluid present, but nowhere near the amount that pig 1 and pig 2 had had. However, because the trunk otherwise appeared skeletonized, they were also scored with a TBS of 32, even though it was clear that these pigs were either at a different stage of decomposition or had decomposed differently.

Finally, the visual aspect of the scoring system is problematic for buried remains in general. Because the top soil was isolated from the remains, there was no removal of any decomposition matter from the remains, and thus the system was applicable to this study. However, if traditional graves are being investigated, the removal of any material to reach the

remains so that they can be studied may affect how the remains may look visually, and whether the appearance of remains that are buried in traditional graves differ from remains that are interred in modified graves. This is something that needs to be the focus of its own investigation.

Grave Temperature and Decomposition Stage

It was expected that the data loggers would report temperature changes of some kind shortly after graves were disturbed, particularly as decomposition activity did take place after disturbance. Strangely, no unusual changes were recorded, and all of the grave temperature data loggers recorded temperatures that were consistent with each other during the main months of the experiment. This may be due to the fact that the data loggers were relatively far from where the actual decomposition activity was taking place. Grave 2's data logger recorded a significant increase in temperature during the last 10 days of the experiment, but it is not known why. When uncovered for the final time, it looked similar to Grave 1. All data loggers were recovered buried under 1 inch of soil at the base of the skull, so this temperature spike was not due to other factors such as external sunlight or animal activity. The addition of more temperature recording devices placed throughout the grave during the length of the study may aid in the understanding of the decomposition taking place during the time that the remains are not visible to the investigator.

Temperature, Accumulated Degree Days, and Postmortem Interval Estimates

Temperatures within the graves also did not fluctuate with the exception of the first and last 10 days of the experiment. The grave data loggers also did not record any temperatures consistent with the daily minimum temperature; strangely, the daily maximum grave temperatures were actually recorded at the same time of day that the minimum control

temperatures were recorded. For example, the maximum grave temperature was recorded either at 11 p.m. or 2 a.m., at which time the control data logger recorded the minimum ambient temperature.

While the data loggers worked well, with the exception of the data logger for Grave 3, the onsite documentation of temperature for buried remains is problematic. Since the estimation of the PMI for each set of remains requires an ambient temperature, that documentation was not available for this study. For the investigation of surface remains, this is an easy fix, as temperature data collection can begin long before any remains are placed. For buried remains, however, grave temperature data will simply not be available before the grave has been dug. Even if a temperature recording device is placed in a grave to record grave temperatures for estimates long before the remains are interred, the graves are enclosed spaces, which may affect the temperatures recorded as the devices may be recording heat given off by decomposition. It may be useful to investigate a way to calculate the ground temperature at different depths in a given location for more accurate PMI estimations. Once again, this is a separate study in itself.

Dabbs (2010) argued in her study that weather station temperature records may not be accurate depending up the location of the station versus the location of the site. For this study, it is difficult to determine whether or not the PMI estimates using the weather station temperatures were more accurate or not than the estimates using the data logger temperatures, as a large amount of the data was missing. For some data collection dates, the weather station estimates were more accurate (on September 7 and December 7), but on the rest, they were less accurate. Because so much of the data logger estimates are missing, and due to the problems with the data logger temperatures as described above, the results for the PMI estimations remain inconclusive and require further investigation.

5.2 Future Studies

There are a large number of components that need to be taken into account when investigating buried remains, particularly when the focus involves investigator disturbance. When a grave is dug and remains are introduced, the burial essentially becomes three separate entities: the grave itself, including the walls and floor; the remains and any associated material; and the top soil used to cover the remains. Over time, a traditional burial ultimately moves to become a single entity again as the three different components begin to interact at the commencement of decomposition. This does not necessarily happen completely, as the borders of graves and skeletal material can be recovered and documented after a significant amount of time has passed, but the interaction between the three components is still going to be crucial when studying buried remains.

This method design essentially added an extra entity in comparison to the traditional grave. The space between the remains and the top soil allowed for unintentional interaction between the remains and variables that are more often seen on the surface, such as the interaction from mice. While the instability of the grave walls is a major problem with this design, this can be remedied (as discussed below), but this empty space and the isolation of the soil in the cage is an issue that may not be so easily solvable.

In attempting to study buried remains in this way, there is no way to remedy the isolated top soil so that the soil does not need to be dug up to be removed; any device or method that separates the pig from the top soil, even if this top soil is still interacting with the pig, will ultimately affect decomposition due to the ceiling effect that was reported in this study. It is unknown what the actual affect of this isolation actually is as there were some major design flaws as discussed above; however, since there was a difference between the environments above

the cage line (with the soil being unstable, dry, and crumbly) and below the cage line (with the soil being wet and more stable), there did appear to be some sort of effect. In terms of investigator disturbance, the removal of the soil covering the remains is key, as the constant disturbance of the soil should, in theory, continuously introduce components that were not part of the grave environment previously. Again, the actual effect of continuously disturbed soil on decomposition is unknown, as it has never been the focus of a published study and thus needs to be investigated.

There are a number of improvements that can be made to this design that will not only make the graves more stable but decrease any unintentional influence from external variables. This may also decrease investigator disturbance by decreasing soil fall-in from the grave walls. For this pilot study, the cages were built prior to the graves being dug. This means that the graves had to be dug to the dimensions of the cage, which is not only incredibly difficult to do, but if the walls fall or are dug too wide, there is nothing that can be done to fix the mistakes except dig a new grave. Thus, the graves should be dug first and cages built to fit the graves directly. This still creates a problem as the lifting of the cage may still rub against the sides of the grave and cause fall-in.

To remedy this, it may be possible to fix plates into the sides of the grave with a rung along the bottom to hold the cage (Figure 27), much like Payne and King (1968) did for their study. This not only evens the wall, but increases the wall stability and gives a surface that will not degrade over time and repeated disturbance, thus resulting in a decrease of fall-in. If the same plates are used to construct the cage walls, the fit should be snug and not create any gaps along the border. Rolling tracks can easily be added to facilitate easy removal of the cage, and a rubber seal along the cage and grave wall border can assure that no gaps will be created. The bottom of

the cage is still problematic, as wire and screen was used in this pilot study to facilitate interaction between the cage soil and grave; however, is does not appear that this actually happened, as the soil simply solidified. Whatever material is used for the cage bottom will have some sort of effect on the decomposition of the remains. This is something that should be tested before going full-scale.

The problem of the empty space created by the cage is a little harder to fix. There are two ways in which the bottom of the cage can be designed. The first is the way in which the cage bottom was created for this study: as a flat bottom that did not have contact with the pig. The second is to create an inversely rounded bottom that stretches over the remains but has contact with the pig. If the bottom is flexible enough, it may be able to shift as the remains decompose. However, the cage bottom may create a greater amount of pressure on the remains than traditional top soil would. Further, the cage frame would need to extent to, or close to, the bottom of the grave, increasing the amount of soil that would need to be lifted. Finally, if the cage bottom is flexible, the soil within the cage may shift when the cage is removed from the grave, which arguably could be similar to just digging up the soil.

The pigs themselves also add another issue to the cage bottom. When the pigs for this study were placed, it became apparent that the abdomen took up a large amount of the available grave space, and even replacing soil around the empty spaces near the head and limbs still left a large amount of open space. The head, neck, and limbs are expected to have differential decomposition based on Megyesi et al. (2005), so these portions of the body need to be visible. This means that using a flat-bottomed cage and building up the soil around the extremities to create a flat surface for the cage bottom to interact with is not possible, particularly when larger pigs or other specimens are used. If smaller human remains are used, this issue may be re solved,

as human remains can be placed in the grave is such as way that the abdomen won't extend well beyond the head and limbs.

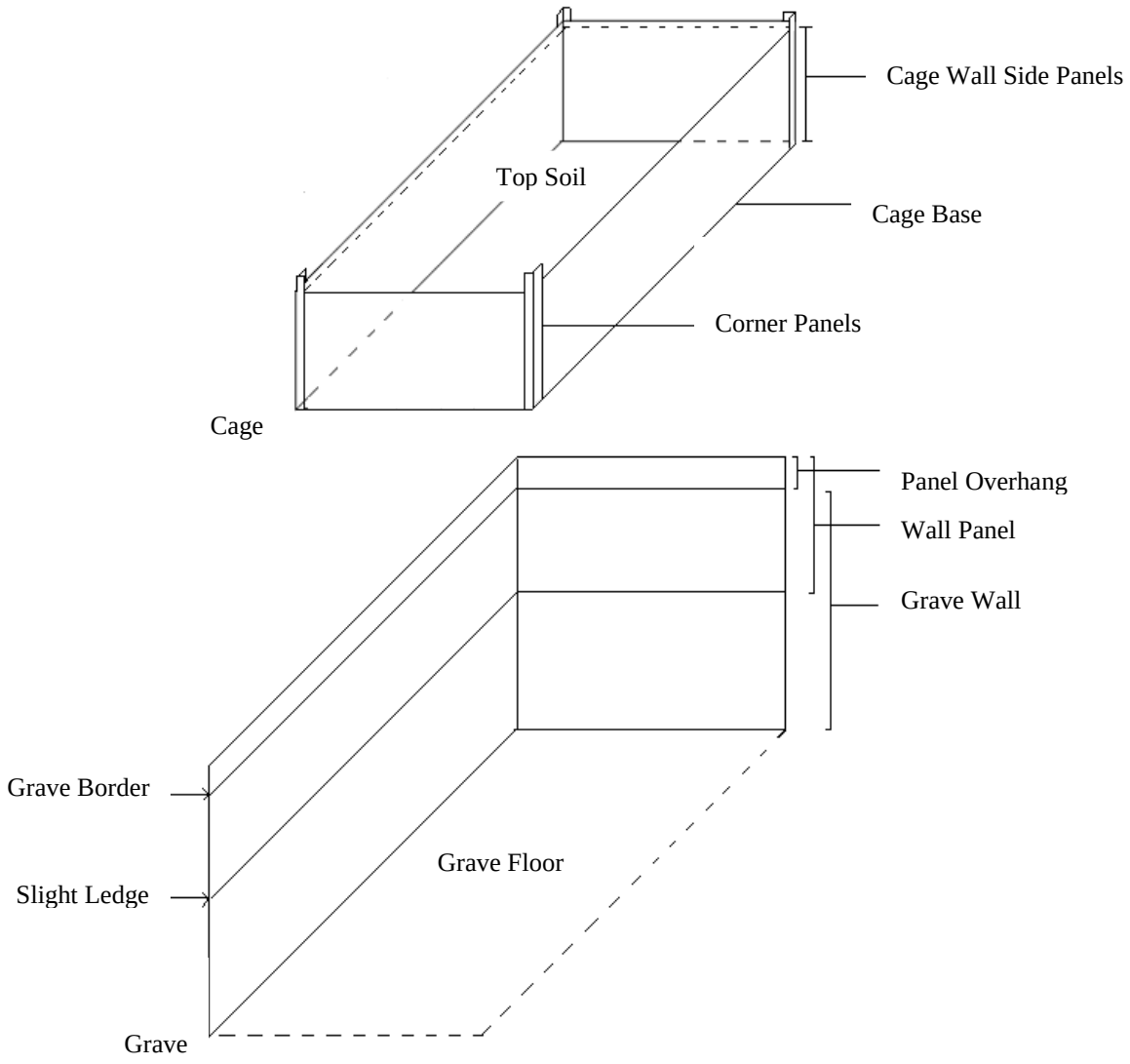


Figure 26: Method improvement suggestions.

Adding panels to the grave walls so that they go beyond the borders of the grave should improve the grave wall integrity. If the cage walls are also made of the same material, and the fit between the cage and the grave is tight enough, there should also be a reduction of impact from external variables. The corner panels on the cage should also help to improve the integrity of the corners of the grave, which are the weakest points.

Even with a new cage design, the environment in which the grave is set also needs to be discussed. Removing the soil in any way is going to allow access for external components (such as insects and small animals) to the remains which normally would not have access. The vegetation is also going to be affected, as the soil becomes unstable when the top soil is not replaced once a grave is dug. One way to combat this may be in a lab setting where the temperature can be controlled and insects and other external variables are absent, but this is still problematic in that the grave walls would have to be created, and thus would not represent a traditional burial.

There are definitely improvements that can be made on this cage-in-grave design; however, the question becomes whether or not to continue along this line of inquiry. Isolating the top soil in cages did have a differential effect on decomposition, though the exact effect is not known based off of this pilot experiment. It may be worth improving upon the design and retesting this improved method using a set of traditional graves for comparison. This would require a large amount of space accomplish. Pig size for retesting can probably decrease, though if promise is shown, more improvements are going to need to be tested in order to use larger nonhuman or even human specimens. As the specimen size grows, the graves become larger and more unstable, and the amount of soil (and its weight, which will need to be lifted by the investigators) increases significantly.

TBS, ADDs, and PMI estimations have become standard in recent decomposition studies. However, as described above, these will need to be investigated within the context of buried remains. The decomposition scoring system may not be accurate as the system was not meant for buried remains, but still has been used for other published (e.g. Bachman and Simmons 2010, Simmons et al. 2010). The ADDs calculations and PMI estimations will reflect any issues with

the TBS. Thus, TBS, ADDs, and the resulting PMI estimations should be studied within the context of traditional burials and modified burials before they be used as standards for comparisons.

As the standard methods for studying decomposition have not been standardized in the context of buried remains, it is highly recommended that studies of these methods, such as TBS, ADDs, and PMI estimations, be done in the context of traditional burials before continuing with this line of inquiry. For comparison purposes, it may also be useful to have an understanding how a traditional burial actually functions, particularly in how the top soil interacts with the remains. Without this understanding, it is not known if studying buried remains by isolating the soil for easy visual access for decomposition scoring and PMI estimations is worth continuing to investigate. If the top soil plays a role in the process of decomposition, isolation of this soil will not result in accurate decomposition scoring and PMI estimations in real cases. If there seems to be no effect on soil isolation, this method of study for buried remains will be worth the further inquiry.

Conclusion

Buried remains of any kind are often difficult to study due to several factors. First, these types of studies need a large amount space with virgin soil. There are few places that have the space needed. Second, investigator disturbance is completely unavoidable for studies dealing with buried remains, as the top soil has to be removed in order for the decomposition to be assessed. This study attempted to test a method that could possibly allow for the study of buried remains without disturbing the remains by simply trying lifting the soil; however, this brings into focus several other factors, such as the importance of the interaction between the remains and the surrounding soil (including the top soil).

This particular methodology did not work. The graves were built for the cages, which became problematic as the graves had to be wide enough to get the frame down to the desired depth. This meant that there were small gaps present from the beginning of the study, and with nothing to support the grave walls, the gaps only widened and allowed outside soil to fall in. There are some other fundamental components that need to be analyzed as well, such as the real importance of the top soil on remains within a grave. Such a method will isolate the top soil from the remains in one way or another, and this may result in the remains in these modified graves acting differently from those in traditional graves, particularly for decomposition scoring, temperature data, and for the calculation of ADDs and the resulting PMI estimations.

This method can be improved upon. The stability of the grave walls and limiting any gaps, particularly in the corners, should be the main goal if this study is redesigned. Fixing plates directly to the grave walls will stop any fall-in from happening and will give a sturdy material for the cage walls to rub against as the cage is lifted. This also allows the components to all fit together smoothly, with no gaps.

Even with the design's flaws, it is highly doubtful that investigating buried remains without disturbing the graves and having some sort of affect on the decomposition process is possible. Isolating the top soil may affect decomposition, even if it is not removed during the study. If this line of inquiry continues, this is the main component that needs to be tested. However, it is recommended that the standard methods used for comparisons, such as TBS, ADDs, and PMI estimations be investigated for use within the burial context before continuing this line of inquiry.

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Appendices

Appendix A

Site Documentation



Figure A-1: Site at Day 28.

Site was visited at 10 a.m., 28 days into the experiment, and Pig 1 was uncovered from 10:10 to 10:15 a.m. Weather was sunny, with no clouds present.

The vegetation appears to have returned slightly, mostly in between the graves and directly around the graves, but not on the borders and on the lower portion beneath the feet of the graves, where the top soil was placed when the graves were being dug.

The grave and cages appear to be holding up well, though a couple of the cages do not fit very well within their graves, particularly graves 3 and 5. There are slight gaps at all grave corners.

The soil in each of the graves looks like it has settled.



Figure A-2: Grave 1 at Day 28.

Pig 1 shows advanced (general) decomposition. The skull, ribs, and shoulder visible on the grave floor. The bones do not look greasy. It appears that the lower portion of the pig sunk as it decomposed. A small amount of insect larvae are present, but difficult to see. Dermestids are present on the left-hand side (viewing from the head of the grave) on the grave walls just below the cage line. The portion of the grave beneath the cage line is much wetter than the portions above, which are dry and crumbly.

There is some adipocere present on the skull and on the soil above the skull.

Some vegetation has begun to grow back but it is very sparse and does not hold the edges of the grave together very well.



Figure A-3: Site at Day 61.

Site was visited at 10 a.m., 61 days into the experiment. Pig 1 was uncovered from 10:15 to 10:20 a.m., and Pig 2 was uncovered from 10:35 to 10:40 a.m. Weather was sunny and partly cloudy.

The vegetation is still returning, mostly in between the graves and directly around the graves, but not on the borders and on the lower portion beneath the feet of the graves. The vegetation still remains short and relatively sparse.

In graves 1 and 2, there is no vegetation in the cage soil and the walls of the graves are beginning to cave. For the remaining graves, there are increased gaps around the grave edges. All of the cages are starting to bow slightly towards the center.



Figure A-4: Grave 1 at Day 61.

The adipocere from the grave has completely disappeared. Decomposition fluid has appeared in the lower portion of the grave below the ribs. The bones are muddy, but do not look greasy.

The cage line is still present and clear. The walls still seem even, though there appears to be "gouges" out of the wall on the right-hand side beneath the cage line. Large amounts of living larva are moving within the decomposition fluid, and are also present along the borders and walls of the grave beneath the cage line. There is some insect tunneling taking place in the walls throughout the grave. A mouse nest has appeared at the left upper corner, and a live mouse was seen leaving the grave as the cage was lifted.

The vegetation that was present last month has continued to grow, but much of the border is still bare and unstable.

Insect tunneling was visible in the cage soil, and several insects were found buried in the soil. The cage soil did not appear to settle.



Figure A-5: Grave 2 at Day 61.

In comparison to Grave 1, Grave 2 is considerably dry. Only the skull and several of the lower limb bones are visible on the grave floor. There is some insect activity on the right-hand upper corner of the grave, with tunneling visible. Dermestids are present near the skull and around the grave walls. There is adipocere on the skull and on the soil over the vertebrae.

The cage line is present and clear, but there is not as great of a difference in the appearance and color of the soil below and above the cage line. There is vegetation on the right border of the grave, but the rest is bare with little growth. The grave wall is still holding up, but the border is soft and crumbly.



Figure A-6: Site at Day 90.

Site was visited at 10:05 a.m., 90 days into the experiment, and Pig 1 was uncovered from 10:20 to 10:25 a.m., Pig 2 was uncovered from 10:40 to 10:45 a.m., and Pig 3 was uncovered from 11:00 to 11:05 a.m. Weather was partly cloudy.

The vegetation is continuing to return, with the exception of the area around Grave 1 and Grave 2. The area beneath each grave is still bare, and the vegetation that has returned remains short compared to the surrounding area.

Vegetation is beginning to grow in the cages that had not been disturbed previously.

The walls of the graves are beginning to cave, and the PVC pipe frames are bowing inwards towards the center.



Figure A-7: Grave 1 at Day 90.

The concentrated decomposition fluid is still present at the foot of the grave. The overall appearance of the grave floor seems much wetter than it did in the previous month, particularly near the skull. Black material appeared at the foot of the grave and appears to be patterned (this was later determined to be more decomposition material with insect tunneling). The skull and ribs are more visible than in previous months. A large amount of live larvae are present throughout the grave. The mouse nest is also still present.

The head of the grave appears to be deeper than in previous months, with the foot appearing to be much shallower. It may be that some of the soil traveled from the head to the foot. Each corner of the grave has become unstable and there is fall-in present, though this may be a result of moving the cage. The cage line is still present.

The cage soil still appears disturbed, even a month later, but there is no evidence of any new insect tunneling.



Figure A-8: Grave 2 at Day 90.

Decomposition fluid is now present in Grave 2. The fluid takes up almost half of the grave and excess moisture and activity was present in the rest of the grave. The ribs, lower limb bones and shoulder are not in anatomical position, though what disturbed the grave is unknown. A large number of live larvae are present throughout the grave.

The corners of the grave are still unstable, and there is a large amount of fall-in at the head of the grave. More vegetation is present, but the borders are still unstable. The walls of the grave are becoming less regular, resulting in large gaps between the cage and the grave. The cage line is still present, but is not as clear.

The cage soil appeared disturbed, and there is insect activity present in the form of tunneling.



Figure A-10: Grave 3 at Day 90.

There is no decomposition fluid present, but the bottom of the grave is wet in comparison to the sides of the grave. Adipocere is present on the skull and on the soil over the shoulder bones.

When the cage was lifted, a large amount of soil fell into the grave from the wall above the cage line. Dermestids and live larvae are present throughout the grave.

The cage line is still present, but it is not very clear. The vegetation is still sparse immediately around the grave, and the borders are unstable, which resulted in the fall-in at the sides.



Figure A-11: Site at Day 118.

Site was visited at 10 a.m. on day 118 of the experiment. Pig 1 was uncovered from 10:10 to 10:15 a.m.; Pig 2 was uncovered from 10:30 to 10:35; Pig 3 was uncovered from 10:50 to 10:55; and Pig 4 was uncovered from 11:10 to 11:15. The weather was sunny with clouds present.

The vegetation has continued to grow back, mostly in between the graves and directly around the graves, but not on the borders and on the lower portion beneath the feet of the graves, where the top soil was placed when the graves were being dug. The graves that have been previously disturbed have less vegetation around them.

The soil in the cages from Graves 4, 5, and 6 still looks settled and have vegetation growing, while the soil in the cages from the graves that have been previously disturbed still look as if they've been disturbed.

Each grave appears to have a slight bow in the frame towards the center.



Figure A-12: Grave 1 at Day 118.

The grave has dried considerably from the previous month, and the amount of decomposition fluid has decreased. The blackened material has disappeared, and there is no evidence of any new insect tunneling. There are both enclosed and unenclosed larvae present throughout the grave. The unenclosed larvae are mostly present in the decomposition fluid while the enclosed larvae are scattered along the borders.

The cage line is still present, but is not clear. The walls are becoming more unstable and irregular.

The border of the grave is still bare, although the vegetation has continued to return around the grave itself.



Figure A-13: Grave 2 at Day 118.

The grave has dried considerably from the previous month. The blackened decomposition material seen in Grave 1 during day 90 is now present with a large amount of insect tunneling activity also present. There are both enclosed and unenclosed larvae present throughout the grave. The unenclosed larvae are mostly present in the decomposition fluid while the enclosed larvae are more scattered along the borders.

The cage line is still present, but is almost indistinct. The walls are becoming more unstable and irregular.

The border of the grave is still bare, although the vegetation has continued to return.



Figure A-14: Grave 3 at Day 118.

No decomposition fluid is present in this grave, though there is insect activity present throughout the grave. Dermestids are present, along with enclosed and unenclosed larvae. Adipocere and what appears to be mold are also present around the skull.

The cage line is still present, though it is not clear. The walls are unstable, resulting in more fall-in. The vegetation around the immediate border of the grave is still sparse.

The cage soil still appeared disturbed, and there is no new insect activity present.



Figure A-14: Grave 4 at Day 118.

No decomposition fluid is present in Grave 4. The skull, shoulder, ribs, and lower limb bones are visible on the grave floor. Adipocere is present on the skull and shoulder girdle. Both unenclosed and enclosed larvae are present throughout the grave, and dermestids are present on the walls.

The grave walls and corners are unstable, and there is fall-in in the corners. The walls are not regular. A cage line is present, but is not clear. The cage soil, before disturbance, looks settled. There is no insect activity, including tunneling, present.

The vegetation is returning, but still sparse, particularly around the borders.

The cage shows a slight bowing from the corners to the center, and there are large gaps around the edges.



Figure A-16: Site at Day 147.

Site was visited at 10:30 a.m., 147 days into the experiment. Pig 1 was uncovered from 10:45 to 10:50 a.m., Pig 2 was uncovered from 11:05 to 11:10 a.m., Pig 3 was uncovered from 11:25 to 11:30 a.m., Pig 4 was uncovered from 11:45 to 11:50 a.m., and Pig 5 was uncovered from 12:05 to 12:10 a.m. Weather was mostly cloudy and slightly rainy.

The vegetation is still present in between the graves and above the heads, but the area beneath each grave is bare.

In graves 1, 2, 3, and 4, there is no vegetation in the cage soil. There is an increased bowing in the cages towards the center, which is causing the corners to become raised. This is increasing the gaps between the cages and the grave walls, although the cages are still being held in their original position.



Figure A-17: Grave 1 at Day 147.

The decomposition fluid that was present in previous months has disappeared. However, there still seems to be an increased amount of moisture still present, particularly in the lower half (foot) of the grave. The foot of the grave appears to have lost its depth, and the lower wall appears to have collapsed. The mouse nest is still present, and a large amount of leaf litter has appeared.

The walls are still unstable and irregular, and the vegetation is still sparse around the borders of the grave resulting in soft, crumbly soil. The cage line is still present.

The cage soil had a disturbed appearance, and there is no new insect tunneling or other activity present.



Figure A-18: Grave 2 at Day 147.

For the most part, decomposition fluid has dried but there still seems to be activity in the lower half (foot) of the grave. Black decomposition material is still present. A ball of moss appeared in the upper corner of the grave, near the skull. There is a large amount of leaf litter around the ball.

The walls are still unstable and irregular. There is still a large amount of insect activity, though most of what remains is empty larvae. The cage line is still present but is not clear.

The cage soil appears disturbed, and there is no new insect activity present.



Figure A-19: Grave 3 at Day 147.

No decomposition fluid has formed in this grave. The grave floor is covered in empty larva or pupa casings. The grave walls are very irregular, and there appears to have been some major fall-in from the portion of the walls above the cage line. The cage line is present, but the fall-in makes it difficult to see.

There is still adipocere and what looks to be mold present beneath the skull. A large amount of leaf litter is also present in the grave.

The cage soil looks disturbed, and there are no indications of insect activity.

The cage is beginning to bow and dip in the center.



Figure A-20: Grave 4 at Day 147.

There is a slight amount of decomposition fluid present at the foot of the grave, and moisture and other activity present on the grave floor. There is a large amount of empty larva and pupa casings throughout the grave. There has also been a large amount of fall-in, particularly around the sides.

The grave walls are unstable and irregular. The cage line is still present, but is not clear, and removing the cage is beginning to affect the borders of the grave. This time around, lifting the cage has caused a number of rocks to fall into the grave.

The cage soil still looks disturbed, but there is no evidence of any new insect activity.

The cage is beginning to bow at the center.



Figure A-21: Grave 5 at Day 147.

Decomposition activity is present throughout the grave. A large amount of empty larvae and pupae casings are present in the areas that are showing activity. The head of the grave suffered a large amount of fall-in, though soil that fell from the top of the walls appears to be same color as the soil beneath the cage line, which is present and but is not clear.

The grave walls are irregular and unstable, particularly at the head of the grave. The cage soil does not look disturbed. The cage has become increasingly bowed towards the center, which is increasing the gaps between the cage and the grave walls.

Moss has begun to grow around the corners of the grave where the borders are bare of vegetation.



Figure A-22: Site at Day 181.

Site was visited at 11:00 a.m., 181 days into the experiment. Pig 1 was uncovered at 11:45 a.m., Pig 2 was uncovered at 12:05 p.m., Pig 3 was uncovered at 12:20 p.m., Pig 4 was uncovered at 12:35 p.m., Pig 5 was uncovered at 12:50 p.m., and Pig 6 was uncovered at 1:05 p.m. The pigs were not reburied as this was the last day of the experiment. Weather was mostly cloudy and slightly rainy.

The vegetation has significantly decreased from the previous month, but this is most likely due to the change in the weather. The areas that have been bare of vegetation in the past are still bare.

In graves 1, 2, 3, 4, and 5 there is no vegetation in the cage soil. There is an increased bowing in the cages towards the center, which is causing the corners to become raised. This is increasing the gaps between the cages and the grave walls, although the cages are still being held in their original position.



Figure A-23: Grave 1 at Day 181.

The grave is still dry and the floor is unified in color. The walls of the grave are still unstable, but there seems to be no new fall-in from the previous month. There is a cage line present, and is a bit clearer than in the previous month. Leaf litter is still present, and the mouse nest is still present. Four mice (one adult and three young) were in the grave when the cage was lifted, but promptly disappeared into Grave 2.

The cage soil still appears disturbed, and there is no new insect activity in the soil. The cage is bowing severely, and the screen is torn in the center. The screen appears very wet.

The borders of the grave are still bare and unstable, with very little vegetation. The cage is severely bowing at the center.



Figure A-23: Grave 2 at Day 181.

The grave is dry and the floor is unified in color. The walls of the grave are still unstable, and there is some new fall-in present. There is a cage line present, nut it is not clear. There appears to be a lot of extra loose soil on the grave floor. Leaf litter is still present, and the mouse nest is still present. Four mice (one adult and three young) were in the grave when the cage was lifted, but promptly disappeared into Grave 3.

The cage soil still appears disturbed, and there is no new insect activity in the soil. The cage is bowing severely, and the screen is torn in the center. The screen appears very wet.

The borders of the grave are still bare and unstable, with very little vegetation. The cage is severely bowing at the center.



Figure A-24: Grave 3 at Day 181.

The grave has dried considerably compared to the previous month, but the grave walls have not held up well at all. There has been a large amount of fall-in. The cage line is still present; however, it is not clear.

The walls of the grave are incredibly unstable and irregular, and do not resemble the original walls at all. The edges of the grave are still bare of vegetation, and mouse activity is present. A ball of dried grasses is present. This may be the moss ball that was in Grave 2 previously.

The cage soil still looks disturbed, and there is no new insect activity or tunneling. The cage has bowed considerably.



Figure A-25: Grave 4 at Day 181.

There is no decomposition activity present and the grave is considerably dry. There is a large amount of hair scattered throughout the grave, and it appears that there was mouse activity in the grave. There is a large amount of leaf litter present in the grave, particularly at the head. There is a cage line present, but it is not clear.

The walls of the grave are irregular and unstable, particularly at the head and foot of the grave. There is a small amount of vegetation around the borders of the grave, but the area is still relatively bare.

The cage soil appears disturbed, and there is no new insect activity. The cage is severely bowing in the middle.



Figure A-26: Grave 5 at Day 181.

There is still a slight amount of activity taking place in the midline of the grave, from the ribs to the border at the foot. Compared to the other graves, the walls actually held up decently, although there is still fall-in present. A large portion of soil has fallen into the grave from the right hand corner at the foot, which left a large gap.

The cage line is present, and is clear along the sides but not at the head or foot. The borders of the grave are unstable, and there is very little vegetation.

The cage soil appears disturbed, and there is no new insect activity or tunneling.



Figure A-27: Grave 6 at Day 181.

Decomposition fluid is present in the middle of the grave floor. Enclosed and unenclosed larvae and pupae are present. Compared to the other graves, the walls appear to have held up particularly well. The walls are still unstable and irregular, but are in the best condition out of each of the graves. There is still some fall-in present.

The borders of the grave are still bare, with very little vegetation.

The cage soil appeared settled prior to being dug. There is no evidence of insect activity or tunneling.

Appendix B

Daily Minimum, Maximum, and Mean Temperature Values

Table B-1: Daily minimum, maximum and mean temperatures.

	Control			Grave1			Grave2			Grave4			Grave 5			Grave 6		
Day	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
10-Jun	52.7	100.4	74.4	68	71.6	69.1	68.9	71.6	70.1	68	69.8	68.7	67.1	69.8	68.1	68	71.6	69.2
11-Jun	60.8	95.9	72.1	68	68.9	68.3	68.9	68.9	68.9	68	69.8	68.3	67.1	67.1	67.1	68	68.9	68.3
12-Jun	65.3	106.7	78.5	68	69.8	68.9	68.9	69.8	69.2	68.9	70.7	69.4	67.1	68	67.3	68.9	70.7	69.2
13-Jun	57.2	101.3	74.4	69.8	72.5	71.2	69.8	72.5	71.1	70.7	76.1	73.3	68	71.6	69.6	71.6	76.1	72.8
14-Jun	49.1	104.9	69.9	73.4	78.8	76.4	73.4	83.3	78.4	77	83.3	79.5	71.6	74.3	72.6	76.1	85.1	80
15-Jun	52.7	101.3	70.9	77.9	83.3	79.5	84.2	89.6	87.4	84.2	87.8	85.4	74.3	80.6	75.9	85	95.9	90.9
16-Jun	49.1	108.5	70.1	84.2	86.9	84.9	90.5	94.1	92.6	87.8	91.4	91.7	82.4	93.2	87.7	94.1	97.7	95.6
17-Jun	50	101.3	70.4	86.9	90.5	87.9	90.5	93.2	91.9	91.4	92.3	91.1	95	101.3	97.8	89.5	95	91.6
18-Jun	58.1	107.6	75.3	90.5	93.2	90.7	90.5	92.3	91.7	89.6	93.2	92.2	100.4	104.9	102.5	86.9	89.6	88.5
19-Jun	59	112.1	79.4	90.5	95	92.4	91.5	90.5	90.8	90.5	94.1	94.1	100.4	108.5	104.9	85.1	92.3	89.6
20-Jun	59	119.3	78.8	91.4	95.9	93.1	88.7	90.5	89.3	92.3	96.8	96	106.7	113	109.6	90.5	103.1	96.2
21-Jun	61.7	126.5	82.9	91.4	95	93.1	88.7	91.4	88.9	95	96.8	95.1	111.2	117.5	113.9	99.5	104.9	101.9
22-Jun	64.4	108.5	79.1	89.6	93.2	91.2	88.7	90.5	89.7	93.2	96.8	96.8	109.4	113.9	111	95.9	101.3	98
23-Jun	58.1	122.9	80.4	88.7	92.3	89.8	87.8	88.7	88	95	99.5	93.3	102.2	107.6	104.5	89.6	94.1	91.7
24-Jun	55.4	115.7	76.3	87.8	92.3	89.5	86.9	87.8	87.4	91.4	93.2	90.4	98.6	102.2	100.7	85.1	88.7	87.2
25-Jun	59	112.9	78.8	86	89.6	87.7	86	87.8	86.6	89.6	93.2	86.9	97.7	100.4	98.9	85.1	88.7	86.5
26-Jun	47.3	118.4	71.7	83.3	87.8	84.8	83.3	86.9	84.5	86	88.7	84.8	90.4	95.9	92.4	80.6	85.1	83.1
27-Jun	43.7	120.2	72.4	80.6	84.2	82.2	81.5	84.2	82.3	83.3	86	84	86	89.6	88.1	78.8	83.3	80.9
28-Jun	48.2	125.6	78.2	80.6	84.2	81.8	80.5	82.4	81.3	83.3	85.1	85.1	86	89.6	87.5	78.8	83.3	80.8
29-Jun	64.4	129.2	87	83.3	86	84	81.5	83.3	82.4	84.2	86.9	87.7	87.8	91.4	89.4	81.5	86	83.3
30-Jun	58.1	130.1	85.9	83.3	86.9	85	83.3	84.2	83.8	86.9	89.6	89	87.8	91.4	89.4	81.5	86.9	83.8
1-Jul	26.6	120.2	78.5	86	87.8	86.5	85.1	85.1	85.1	88.7	89.6	86.5	88.7	90.5	89.8	83.3	85.1	84.2
2-Jul	61.7	116.6	80.4	83.3	86.9	85.2	83.3	86	84.4	85.1	86.9	86	87.8	89.6	88.7	81.5	86	83.8
3-Jul	60.8	107.6	79.1	60.8	87.8	85.7	84.2	84.2	84.3	85.1	86.9	86.7	87.5	90.5	89.2	82.4	86.9	84.3
4-Jul	63.5	121.1	84.2	85.1	88.7	86.7	85.1	86	85.3	86	87.8	87.4	88.7	93.2	90.4	83.3	88.7	85.7
5-Jul	62.6	104	75.9	86.9	89.6	88.1	86.9	87.8	87	86.9	87.8	87.1	90.5	93.2	92	85.1	88.7	88.7
6-Jul	59	115.7	80.8	86.9	89.6	87.7	86	87.8	87	86	88.7	87.8	90.5	93.2	91.9	85.1	90.5	87.2

Table B-1 Continued: Daily minimum, maximum and mean temperatures.

	Control			Grave1			Grave2			Grave4			Grave5			Grave6		
Day	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
7-Jul	63.5	129.2	87.1	86.9	95.5	88.6	87.8	89.6	88.4	86.9	89.6	88.9	91.4	95	92.9	86.9	94.1	89.7
8-Jul	63.5	114.8	84.7	88.7	91.4	90	89.9	91.4	90.3	87.8	90.5	89.5	92.3	95	93.7	88.7	94.1	91.3
9-Jul	63.5	118.4	85	88.7	97.4	91.1	91.4	92.3	91.7	88.7	90.5	88.8	92.3	94.1	93.2	89.6	94.1	91.5
10-Jul	64.4	91.4	74.4	89.6	91.4	90.2	91.4	93.2	92.2	87.8	90.5	85.7	91.4	94.1	92.2	89.6	92.3	90.4
11-Jul	63.5	82.4	71.6	86.9	88.7	87.4	90.5	91.4	90.8	85.1	86.9	83.9	89.6	90.5	90.3	86.9	88.7	87.9
12-Jul	59.9	96.8	71.4	84.2	86.9	85.2	88.7	90.5	89.7	83.3	85.1	83	87.8	89.6	88.5	84.2	86.9	85.7
13-Jul	62.6	87.8	70.7	83.3	85.1	84.2	88.7	89.6	89	82.4	83.3	83.2	86.9	87.8	87.4	84.2	86	85.1
14-Jul	64.4	95	75.3	83.3	85.1	84	88.7	88.7	88.7	82.4	84.2	84.2	86.9	88.7	87.7	85.1	89.6	87
15-Jul	65.5	120.2	84.4	83.3	87.8	85	88.7	90.5	89.4	83.3	86	85.8	86.9	89.6	88.3	86	90.5	87.9
16-Jul	65.3	115.7	82.6	85.1	88.7	86.8	90.5	91.4	90.6	85.1	86.9	86.3	87.8	89.6	88.7	86	90.5	87.8
17-Jul	64.4	124.7	85.9	85.1	88.7	86.7	91.4	92.3	91.7	85.1	87.8	87	87.8	89.6	88.5	85.1	90.5	87.4
18-Jul	67.1	112.1	80.4	85.1	87.8	86.5	91.4	92.3	92.2	86	87.8	87	88.7	89.6	89.2	86.9	89.6	88.3
19-Jul	64.4	113	80	83.3	86.9	84.9	88.7	92.3	90.7	86	86.9	80	86.9	88.7	87.9	84.2	87.8	85.8
20-Jul	65.3	88.7	73	80.6	84.2	81.8	83.3	88.7	85.2	85.1	86.9	83.3	86	86.9	86.2	81.5	83.3	82.6
21-Jul	65.3	116.6	82.6	78.8	80.6	79.8	81.5	83.3	82.4	81.5	83.3	82.1	85.1	86.9	85.8	80.6	86	82.6
22-Jul	68	117.5	83.5	80.6	82.4	81.4	81.5	82.4	82.2	82.4	84.2	83	86	86.9	86.5	82.4	86.9	84.2
23-Jul	65.3	113	78.9	81.5	83.3	82.5	82.4	83.3	82.6	82.4	84.2	83.1	85.1	86.9	86	81.5	86	83.8
24-Jul	66.2	92.3	72.2	80.6	83.3	81.8	81.5	82.4	82.1	81.5	83.3	82.3	85.1	86	85.2	81.5	83.3	82.3
25-Jul	64.4	113	79.6	78.8	81.5	80.2	80.6	81.5	81.2	80.6	82.4	82.3	83.3	86	84.3	79.9	84.2	81.4
26-Jul	59.8	121.1	85	79.7	82.4	80.8	81.5	83.3	81.8	81.5	83.3	82.3	85.1	86.9	85.8	80.6	86.9	83.1
27-Jul	66.2	111.2	73.5	80.6	83.3	82.2	83.3	83.3	83.3	82.4	83.3	83.1	85.1	86	85.7	81.5	84.2	82.9
28-Jul	63.5	112.1	79.3	78.8	82.4	80.5	81.5	83.3	82	80.6	82.4	81.3	83.3	85.1	84	78.8	83.3	80.5
29-Jul	58.1	117.5	79.5	78.8	81.5	79.9	80.6	82.4	81.5	79.7	81.5	80.5	82.4	84.2	83.3	77	81.5	79
30-Jul	57.2	116.6	76	77.9	81.5	79.1	80.6	81.5	80.9	79.7	81.5	80	81.5	83.3	82.4	77	80.6	78.5
31-Jul	59	109.4	77.1	77	79.7	78.4	80.6	81.5	80.8	78.8	80.6	79.7	80.6	83.3	82.1	76.1	79.7	77.8
1-Aug	58.1	116.6	78.6	77	79.7	78.5	80.6	81.5	81.1	78.8	81.5	79.9	80.6	84.2	82.1	76.1	80.6	78.1
2-Aug	59.9	121.1	83	77	80.6	79.5	81.5	82.4	82	79.7	82.4	80.8	82.4	85.1	83.3	77	81.5	78.7

Table B-1 Continued: Daily minimum, maximum and mean temperatures.

	Control			Grave1			Grave2			Grave4			Grave5			Grave6		
Day	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
3-Aug	58.1	109.4	79.3	77.9	81.5	79.5	81.5	83.3	82.5	79.7	81.5	80.9	82.4	85.1	83.5	76.1	80.6	78
4-Aug	65.3	104.9	79.3	78.8	80.6	79.7	82.4	83.3	83	80.6	81.5	81.4	83.3	85.1	84.2	78.8	80.6	79.6
5-Aug	64.4	115.7	83	78.8	79.7	78.8	82.4	83.3	82.1	80.6	81.5	81.1	83.3	84.2	83.8	77.9	80.6	79.1
6-Aug	66.2	77.9	71.3	77	79.7	78	81.5	82.4	82	80.6	80.6	80.6	83.3	84.2	83.4	77	78.8	77.8
7-Aug	63.5	105.8	78.1	76.1	77	76.7	79.7	81.5	80.8	79.7	80.6	79.9	81.5	83.3	82.2	76.1	78.8	77
8-Aug	65.3	123.8	83.2	76.1	78.8	77.2	77.9	79.7	78.7	77.9	79.7	78.9	81.5	82.4	81.8	75.2	77.9	76.1
9-Aug	60.8	101.3	77	76.1	78.8	77	77.9	78.8	78.2	77.9	79.7	78.6	80.6	82.4	81.5	74.3	77	75.5
10-Aug	64.4	114.8	79.9	76.1	77.9	76.7	77	78.8	77.8	77.9	78.8	78.4	80.6	82.4	81.3	74.3	77	75.7
11-Aug	61.7	81.5	72.2	75.2	77.9	76.2	77	77.9	77.2	77	78.8	77.8	79.7	81.5	80.3	73.4	76.1	74.6
12-Aug	51.8	107.6	72.3	73.4	76.1	74.6	75.2	77	75.8	75.2	77.9	76.4	76.1	78.8	77.6	69.8	73.4	71.6
13-Aug	52.7	105.8	72.3	72.5	75.2	74.1	74.3	76.1	75	75.2	77	76.3	75.2	77.9	76.6	68.9	73.4	71.5
14-Aug	62.6	109.4	79.1	73.4	76.1	79.7	75.2	76.1	75.7	76.1	77	76.4	76.1	78.8	77.6	71.6	74.3	73
15-Aug	61.7	81.5	68.2	73.4	76.1	74.6	75.2	76.1	75.5	76.1	77.9	76.4	76.1	77.9	76.8	71.6	72.5	71.9
16-Aug	53.6	121.1	77.3	71.6	75.2	73.1	73.4	75.2	74.5	74.3	77	75.4	73.4	76.1	75	68.9	72.5	70.6
17-Aug	53.6	109.4	73.9	72.5	75.2	73.7	74.3	75.2	74.9	75.2	77	76.1	73.4	76.1	74.9	68.9	72.5	70.5
18-Aug	59	118.4	77.3	72.5	74.3	73.3	75.2	76.1	75.3	76.1	77	76.3	74.3	77	75.5	69.8	73.4	71.5
19-Aug	59	80.6	65.6	72.5	75.2	73.3	73.4	76.1	74.1	74.3	77	75.4	73.4	75.2	74.4	68	71.6	70.4
20-Aug	59	103.1	73	70.7	72.5	71.7	72.5	73.4	72.7	73.4	74.3	73.9	72.5	74.3	73.3	68.9	70.7	69.9
21-Aug	50.9	113.9	75.1	70.7	73.4	71.7	71.6	72.5	72.2	72.5	74.3	73.6	70.7	73.4	72.2	68	70.7	69
22-Aug	54.5	105.8	72.4	70.7	73.4	72.1	71.6	72.5	72.4	72.5	74.3	73.5	70.7	73.4	72.3	68	70.7	69.2
23-Aug	60.8	114.8	75.1	71.6	73.4	72.5	72.5	73.4	73	73.4	75.2	74.2	72.5	74.3	73.3	68.9	71.6	70.1
24-Aug	57.2	89.6	68.3	71.6	73.4	72.4	72.5	73.4	73.1	72.5	74.3	74.1	71.6	73.4	72.5	68.9	70.7	69.8
25-Aug	55.4	89.6	67.4	70.7	72.5	71.6	72.5	73.4	72.5	71.6	73.4	73.2	70.7	72.5	71.5	68	69.8	69.1
26-Aug	53.6	97.7	72.7	69.8	72.5	70.9	71.6	72.5	71.9	72.5	75.2	72.6	69.8	72.5	71.3	67.1	70.7	68.6
27-Aug	58.1	122.9	80.6	70.7	74.3	72.1	71.6	73.4	72.6	73.4	76.1	73.6	70.7	74.3	72.4	68.9	71.6	69.9
28-Aug	54.5	105.8	74.5	71.6	74.3	73.1	72.5	74.3	73.4	74.3	77	74.5	71.6	74.3	73.1	68	72.5	70
29-Aug	58.1	127.4	82.7	72.5	76.1	74	74.3	75.2	74.4	75.2	77	75.3	72.5	75.2	73.9	69.8	72.5	70.9

Table B-1 Continued: Daily minimum, maximum and mean temperatures.

	Control			Grave1			Grave2			Grave4			Grave5			Grave6		
Day	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1-Sep	62.6	109.4	78	74.3	77	75.8	71.6	77	75	77	78.8	77.9	73.4	76.1	75.4	72.5	74.3	73.1
2-Sep	66.2	113.9	75.8	74.3	76.1	75.3	71.6	77	75.4	77	78.8	78.1	75.5	76.1	75.7	72.5	75.2	73.6
3-Sep	63.5	97.7	76	74.3	76.1	75	71.6	75.2	73.1	77	77.9	77.9	75.5	76.1	75.9	72.5	74.3	73.5
4-Sep	66.2	94.1	75.4	74.3	75.2	74.6	70.7	73.4	72.3	77.9	77.9	77.9	75.5	77	76.1	73.4	74.3	73.7
5-Sep	64.4	106.7	80.5	73.4	76.1	74.5	68.9	71.6	70.6	77.9	79.7	78.4	75.5	77	76.3	72.5	75.2	73.6
6-Sep	66.2	90.5	75.7	74.3	76.1	75.1	68.9	71.6	70.3	78.8	79.7	79	76.1	77	76.6	73.4	75.2	74.1
7-Sep	59	117.5	78.1	74.3	76.1	75.1	68.9	71.6	70.6	77.9	79.7	78.9	75.2	77.9	76.2	72.5	75.2	73.6
8-Sep	61.7	103.1	71.2	74.3	76.1	75.1	68.9	71.6	70.4	78.8	79.7	79	72.5	76.1	75.2	71.6	74.3	72.7
9-Sep	42.8	108.5	65.7	71.6	75.2	73	68.9	71.6	70.5	77.9	75.2	76.7	69.8	76.1	72.7	67.1	70.7	68.7
10-Sep	42.8	119.3	69.9	70.7	73.4	71.9	69.8	71.6	71	74.3	77	75.5	68.9	72.5	70.4	65.3	69.8	67.4
11-Sep	38.3	109.4	66.2	69.8	72.5	71.3	70.7	71.6	70.8	73.4	76.1	74.8	67.1	71.6	70	64.4	69.8	66.4
12-Sep	44.6	102.2	68.8	69.8	72.5	71.2	70.7	71.6	70.9	73.4	76.1	74.9	68	72.5	70.3	65.3	70.7	67.2
13-Sep	44.6	110.3	69.7	69.8	72.5	71.4	69.8	70.7	70.4	73.4	76.1	74.9	68.9	72.5	70.3	66.2	70.7	67.7
14-Sep	45.5	108.5	68.5	69.8	72.5	71.3	68.9	69.8	69.2	73.4	76.1	75	68	71.6	70	66.2	70.7	67.8
15-Sep	47.3	113	71.2	70.7	72.5	71.5	68	68.9	68.6	74.3	76.1	75.3	68.9	71.6	70.3	66.2	70.7	68.3
16-Sep	51.8	82.4	62.9	70.7	72.5	71.4	68	69.8	68.9	74.3	76.1	74.6	69.8	70.7	70.1	68	69.8	68.7
17-Sep	57.2	77	67.3	69.8	70.7	70.5	68	69.8	69.4	73.4	74.3	73.5	68.9	71.6	70.9	68.9	69.8	69.2
18-Sep	62.6	68.9	65.1	68.9	70.7	69.6	66.2	68.9	68	71.6	73.4	72.4	68.9	71.6	70.6	68	69.8	68.6
19-Sep	45.5	105.8	66.4	67.1	69.8	68.6	65.3	67.1	66.4	70.7	72.5	71.4	66.2	68.9	67.6	64.4	67.1	65.9
20-Sep	46.3	109.4	68	67.1	69.8	68.2	65.3	66.2	66.8	69.8	70.7	70.1	65.3	68	66.7	63.3	66.2	64.7
21-Sep	67.1	107.6	71.3	67.1	69.8	68.2	65.3	68	66.9	69.8	71.6	70.6	65.3	68	66.9	63.3	67.1	64.7
22-Sep	51.8	110.3	72.7	68	70.7	69.1	67.1	68.9	68.2	69.8	71.6	70.7	66.2	68.9	67.3	64.4	68	65.9
23-Sep	37.4	108.5	64.5	67.1	70.7	69.1	68.9	69.8	69.2	68.9	71.6	69.8	62.6	66.2	64.5	61.7	65.3	63.3
24-Sep	32	105.8	56.4	65.3	69.8	67.2	67.1	68.9	68.5	67.1	69.8	67.9	60.8	64.4	62.3	59	62.6	60.7
25-Sep	32.9	95.9	54.6	64.4	66.2	65.6	66.2	67.1	66.8	65.3	68	66.5	59.9	63.5	62	58.1	67.1	60
26-Sep	43.7	113.9	69.6	64.4	68	66.2	66.2	67.1	66.3	65.3	68	66.8	61.7	65.3	63.6	59	64.4	61.5
27-Sep	50.9	99.5	71.6	66.2	69.8	67.7	65.3	67.1	66.4	68	69.8	68.3	63.5	67.1	65.2	62.6	66.2	63.8

Table B-1 Continued: Daily minimum, maximum and mean temperatures.

	Control			Grave1			Grave2			Grave4			Grave5			Grave6		
Day	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
30-Sep	36.5	102.2	61.2	64.4	67.1	65.9	63.5	65.3	64.4	66.2	68.9	67.2	61.7	64.4	63.3	59.9	64.4	61.9
1-Oct	49.1	57.2	53.6	64.4	67.1	65.6	63.5	64.4	63.8	68	67.1	67.3	63.5	63.5	63.5	62.6	62.6	62.6
2-Oct	55.4	97.7	70	64.4	66.2	65	59.9	62.6	61.7	66.2	68	66.5	63.3	65.3	64.4	62.6	64.4	63.1
3-Oct	55.4	87.8	69.7	66.2	67.1	66.2	58.1	59	58.8	67.1	68.9	67.7	64.4	66.2	65.4	63.5	65.3	64.5
4-Oct	57.2	106.7	72.2	66.2	68	66.9	58.1	59	58.5	68	68.9	68.2	65.3	66.2	65.8	64.4	66.2	65.1
5-Oct	41	111.2	66.9	65.3	67.1	66.1	58.1	59	58.6	67.1	68	67.4	62.6	65.3	63.8	60.8	64.4	62.6
6-Oct	46.4	92.3	63.6	65.3	67.1	65.6	57.2	58.1	57.3	66.2	67.1	67	62.6	64.4	63.3	60.8	63.5	62.3
7-Oct	41.9	50	46.9	62.6	65.3	64	56.3	58.1	57.2	65.3	67.1	66.2	59	61.7	60.8	59	62.6	60.6
8-Oct	35.6	44.6	40.3	59.9	62.6	60.7	56.3	58.1	57.1	61.7	66.2	64	57.2	58.1	57.3	56.3	58.1	56.6
9-Oct	41.9	92.3	52.9	58.1	59.9	59	56.3	59.9	58.2	59.9	61.7	61	56.3	58.1	57.1	55.4	57.2	55.7
10-Oct	35.6	74.3	53	58.1	59.9	59.3	59	60.8	60.1	59.9	61.7	61	56.3	58.1	57.2	54.5	57.2	56
11-Oct	28.4	105.8	57.7	57.2	59.9	58.8	57.2	59.9	58.7	59.9	61.7	58.9	54.5	57.2	56.1	52.7	57.2	55
12-Oct	32.9	102.2	58.7	58.1	59.9	59	56.3	58.1	57.4	58.1	59.9	59	54.5	57.2	56	52.7	56.3	54.5
13-Oct	29.3	101.3	56.8	58.1	59.9	59.1	58.1	59	58.6	59	59	58.8	54.5	57.2	56.1	52.7	56.3	54.4
14-Oct	36.5	103.1	58.8	58.1	60.8	59.2	58.1	59	58.6	58.1	59	59	54.5	59	56.5	53.6	57.2	54.8
15-Oct	49.1	105.8	64.7	60.8	61.7	61.1	56.3	58.1	57.3	59.9	61.7	61	59	59.9	59.3	58.1	59.9	58.7
16-Oct	37.4	104	59.9	59	61.7	60.4	55.4	56.3	56.1	59	60.8	59.7	56.3	58.1	57.4	55.4	59	56.9
17-Oct	29.3	99.5	55.1	58.1	60.8	59.5	54.5	57.2	56.3	58.1	59	58.8	53.6	57.2	55.6	53.6	56.3	54.8
18-Oct	43.7	73.4	56.2	59	60.8	59.3	58.1	59	57.4	57.2	59	58.3	56.3	58.1	57	55.4	57.2	56
19-Oct	37.4	101.3	65.1	59	60.8	59.7	57.2	59.9	58.4	57.2	59	58.6	56.3	58.1	57.5	55.4	58.1	56.9
20-Oct	34.7	74.3	51.9	57.2	59	59.5	57.2	59.9	58.8	57.2	59	58	55.4	57.2	56.1	51.8	55.4	53.2
21-Oct	31.1	103.1	56.4	57.2	59.9	58.2	59	60.8	60	54.4	57.2	56.2	52.7	55.4	54.3	52.7	56.3	54.4
22-Oct	30.2	110.3	59.3	58.1	60.8	58.3	59.9	60.8	60.7	55.4	58.1	56.2	52.7	56.3	54.4	54.4	58.1	56.2
23-Oct	35.6	115.7	64.5	59	61.7	59.3	58.1	59.9	59.5	55.4	59	57	52.7	55.4	54.1	54.5	58.1	56.3
24-Oct	42.8	113	64.5	59	62.6	60.2	55.4	57.2	56.1	57.2	59.9	58.2	55.4	58.1	57	56.3	59.9	57.4
25-Oct	37.4	110.3	65.6	59.9	62.6	60.9	52.7	54.5	53.6	57.2	59.9	58.3	55.4	59	57.2	59	59.9	59.2
26-Oct	43.7	108.5	64.1	60.8	62.6	61.6	51.8	52.7	52.6	58.1	60.8	59.2	57.2	59	58.1	57.2	59.9	58.3

Table B-1 Continued: Daily minimum, maximum and mean temperatures.

	Control			Grave1			Grave2			Grave4			Grave5			Grave6		
Day	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
27-Oct	50.9	71.6	58.3	61.6	62.6	61.9	50.9	51.8	51.6	60.8	61.7	61	59	59.9	59.3	52.7	57.2	54.7
28-Oct	46.4	66.2	52.6	59.9	61.7	60.5	50	50.9	50.6	59.9	61.7	60.5	56.3	59	57.9	50.9	52.7	51.4
29-Oct	33.8	43.7	37.9	56.3	59.9	58	50	51.8	50.9	56.3	59.9	57.7	52.7	56.3	54.2	50	50.9	50.1
30-Oct	32.9	41.9	36.4	53.6	55.4	54.3	51.8	52.7	52.1	52.7	55.4	53.5	50.9	51.8	51.2	49.1	50	49.9
31-Oct	34.7	53.6	41	52.7	53.6	52.9	50.9	51.8	51.2	51.8	52.7	52.4	50	50.9	50.7	47.3	49.1	48.2
1-Nov	31.1	49.1	40.1	51.8	52.7	52.3	49.1	50	49.3	50.9	52.7	51.8	49.1	50.9	50.1	46.4	50	47.5
2-Nov	27.5	88.7	47.5	50.9	51.8	51.2	48.2	49.1	48.7	49.1	50	49.6	49.1	50	49.3	49.1	50.9	49.7
3-Nov	25.7	86	48.5	50	51.8	51.2	48.2	49.1	48.9	47.3	50	48.4	47.3	50	48.8	46.4	50	47.8
4-Nov	38.3	59.9	37.9	51.8	52.7	52.1	48.2	50	49	50.9	51.8	51.1	49.1	50.9	50.1	44.6	47.3	45.6
5-Nov	23	76.1	36.4	50	51.8	51.2	48.2	50	49.2	49.1	50.9	50	46.4	49.1	48	43.7	46.4	44.8
6-Nov	18.5	44.6	29.5	49.1	50.9	49.7	49.1	51.8	50.6	48.2	50	48.9	44.6	46.4	45.7	43.7	46.6	45.4
7-Nov	23	72.5	38.5	47.3	49.1	48.4	51.8	53.6	52.8	47.3	48.2	47.8	43.7	46.4	45.2	42.8	46.4	44.5
8-Nov	24.8	86.9	48.5	48.2	50	49	51.8	52.7	52.3	46.4	48.2	47.1	44.6	47.3	46.2	43.7	47.3	45.2
9-Nov	20.3	99.5	48.1	48.2	50.9	49.1	50	50.9	50	46.4	48.2	46.9	43.7	47.3	45.6	45.5	49.1	46.6
10-Nov	23	104	51.6	48.2	50.9	49.7	48.2	49.1	48.8	46.4	48.2	47.6	44.6	48.2	46.4	49.1	51.8	50.6
11-Nov	27.5	102.2	54.6	50	52.7	50.9	47.3	49.1	48.2	47.3	49.1	48.4	45.5	50	48	50	51.8	50.6
12-Nov	46.4	63.5	56.9	52.7	53.6	52.9	47.3	48.2	47.8	47.3	50	51.4	50	51.8	51.2	44.6	48.2	46.3
13-Nov	28.4	85.1	51.4	52.7	53.6	53.2	47.3	48.2	47.8	51.8	52.7	52.3	47.3	51.8	50	43.7	45.5	44.8
14-Nov	16.7	73.4	38.1	49.1	52.7	50.6	48.2	49.1	48.3	48.2	50.9	49.2	44.6	47.3	46	42.8	45.5	43.9
15-Nov	18.5	72.5	40.4	48.2	50	48.9	47.3	48.2	48.1	47.6	48.2	47.6	43.7	46.4	45.1	43.7	45.5	44.8
16-Nov	20.3	91.4	43.4	47.3	49.1	48.2	46.4	48.2	47.2	46.4	47.3	46.7	42.8	45.5	44.2	42.8	45.5	43.9
17-Nov	17.6	92.3	44	47.3	49.1	48.1	46.4	48.2	47.1	45.5	46.4	46.2	41.9	45.5	44	41.9	44.6	43.3
18-Nov	23	77.9	40.7	47.3	48.2	47.9	46.4	48.2	47	46.4	46.4	46.4	43.7	45.5	44.6	42.8	45.5	43.8
19-Nov	30.2	80.6	45.6	48.2	49.1	48.4	45.5	47.3	46.6	46.4	47.3	46.7	44.6	45.5	44.9	44.6	46.4	45.3
20-Nov	29.3	63.5	44.4	47.3	49.1	48.3	44.6	46.4	45.3	46.4	47.3	47	44.6	46.6	45.3	44.6	46.4	45.1
21-Nov	20.3	91.4	46.9	46.4	49.1	47.8	45.5	47.3	46.2	45.5	46.4	45.8	42.8	45.5	44.2	41.9	45.5	43.7
22-Nov	19.4	94.1	46.5	46.4	49.1	47.9	47.3	47.3	47.3	45.5	46.5	45.6	41.9	45.5	44	41.9	44.6	43.3

Table B-1 Continued: Daily minimum, maximum and mean temperatures.

	Control			Grave1			Grave2			Grave4			Grave5			Grave6		
Day	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
25-Nov	14	73.4	36.7	44.6	47.3	46.1	44.6	45.5	45.1	43.7	45.5	44	40.1	42.8	41.6	39.2	42.8	40.9
26-Nov	22.1	86	46.1	44.6	47.3	46.1	44.6	46.4	45.6	41.9	44.6	43.2	41	44.6	42.9	40.1	43.7	41.8
27-Nov	32	44.6	40.4	47.3	47.3	47.3	45.5	47.3	46.6	45.5	46.4	46.2	44.6	45.5	45.2	44.6	45.5	44.9
28-Nov	24.8	77.9	45.2	46.4	47.3	46.9	48.2	49.1	48.7	44.6	45.5	45.3	42.8	44.6	43.8	42.8	44.6	43.9
29-Nov	14	85.1	39.8	44.6	47.3	45.7	48.2	50	49.3	41.9	43.7	42.7	40.1	42.8	41.7	39.2	42.8	41
30-Nov	18.5	86.9	40.3	44.6	46.4	45.2	48.2	50	49.8	41.9	43.7	42.6	40.1	42.8	41.5	39.2	41.9	40.3
1-Dec	23	88.7	47	44.6	47.3	45.6	48.2	53.6	50.8	42.8	44.6	43.1	41	43.7	42.5	40.1	43.7	41.5
2-Dec	28.4	88.7	48.5	45.5	48.2	46.7	48.2	65.3	57.5	43.7	46.4	44.6	41.9	45.5	43.8	41.9	44.6	42.9
3-Dec	41.9	86	58.7	48.2	50	48.8	64.4	72.5	65	46.4	48.2	47.1	46.4	48.2	47.1	45.5	48.2	46.5
4-Dec	32	84.2	53.2	48.2	50	49.4	61.7	70.7	65.8	46.4	48.8	47.4	45.5	48.2	47.1	45.5	48.2	47.2
5-Dec	43.7	90.5	57.1	50	50.9	50.2	49.1	62.6	58.4	48.8	49.1	48.7	46.4	49.1	48.1	48.2	49.1	48.3
6-Dec	17.6	68.9	39.4	48.2	52.7	50.6	36.5	43.7	41.5	45.5	52.7	47.5	42.8	56.3	47.9	42.8	50.9	45.6
25-Nov	14	73.4	36.7	44.6	47.3	46.1	44.6	45.5	45.1	43.7	45.5	44	40.1	42.8	41.6	39.2	42.8	40.9
26-Nov	22.1	86	46.1	44.6	47.3	46.1	44.6	46.4	45.6	41.9	44.6	43.2	41	44.6	42.9	40.1	43.7	41.8
27-Nov	32	44.6	40.4	47.3	47.3	47.3	45.5	47.3	46.6	45.5	46.4	46.2	44.6	45.5	45.2	44.6	45.5	44.9
28-Nov	24.8	77.9	45.2	46.4	47.3	46.9	48.2	49.1	48.7	44.6	45.5	45.3	42.8	44.6	43.8	42.8	44.6	43.9
29-Nov	14	85.1	39.8	44.6	47.3	45.7	48.2	50	49.3	41.9	43.7	42.7	40.1	42.8	41.7	39.2	42.8	41
30-Nov	18.5	86.9	40.3	44.6	46.4	45.2	48.2	50	49.8	41.9	43.7	42.6	40.1	42.8	41.5	39.2	41.9	40.3
1-Dec	23	88.7	47	44.6	47.3	45.6	48.2	53.6	50.8	42.8	44.6	43.1	41	43.7	42.5	40.1	43.7	41.5
2-Dec	28.4	88.7	48.5	45.5	48.2	46.7	48.2	65.3	57.5	43.7	46.4	44.6	41.9	45.5	43.8	41.9	44.6	42.9
3-Dec	41.9	86	58.7	48.2	50	48.8	64.4	72.5	65	46.4	48.2	47.1	46.4	48.2	47.1	45.5	48.2	46.5
4-Dec	32	84.2	53.2	48.2	50	49.4	61.7	70.7	65.8	46.4	48.8	47.4	45.5	48.2	47.1	45.5	48.2	47.2
5-Dec	43.7	90.5	57.1	50	50.9	50.2	49.1	62.6	58.4	48.8	49.1	48.7	46.4	49.1	48.1	48.2	49.1	48.3
6-Dec	17.6	68.9	39.4	48.2	52.7	50.6	36.5	43.7	41.5	45.5	52.7	47.5	42.8	56.3	47.9	42.8	50.9	45.6

Appendix C

Weather Station Temperature And Weather Data

Table C-1: Daily weather station minimum, maximum, and mean temperatures.

Date	Min	Max	Mean	Precipitation	Humidity	Weather Conditions
10-Jun	57	82	70	0.00	71	Clear
11-Jun	56	78	67	0.17	87	Rain
12-Jun	66	86	76	0.00	78	Overcast, Clear
13-Jun	64	78	71	0.00	66	Clear
14-Jun	53	78	66	0.00	71	Clear
15-Jun	55	77	66	0.00	76	Clear
16-Jun	53	77	65	0.00	74	Clear
17-Jun	57	78	68	0.02	83	Mostly Cloudy
18-Jun	62	80	71	0.02	86	Light Rain, Clear
19-Jun	60	87	74	0.00	74	Clear
20-Jun	62	87	74	0.37	80	Clear, Rain
21-Jun	64	89	76	0.00	78	Clear
22-Jun	69	87	78	0.02	76	Clear, Light Rain
23-Jun	64	84	74	0.00	67	Clear
24-Jun	60	84	72	0.00	77	Clear, Drizzle
25-Jun	60	84	72	0.00	69	Clear
26-Jun	53	75	64	0.00	50	Clear
27-Jun	51	82	66	0.00	56	Clear
28-Jun	53	93	73	0.00	54	Clear
29-Jun	68	98	84	0.00	44	Clear, Drizzle
30-Jun	62	100	81	0.00	59	Clear
1-Jul	66	93	80	0.00	61	Clear
2-Jul	62	89	76	0.11	71	Heavy Rain, Clear
3-Jul	64	91	78	0.06	74	Clear, Rain
4-Jul	64	89	76	0.00	73	Clear
5-Jul	68	86	77	0.01	77	Clear, Light Rain
6-Jul	64	89	76	0.00	78	Clear, Drizzle
7-Jul	66	93	80	0.00	71	Clear
8-Jul	68	95	82	0.00	67	Clear
9-Jul	68	87	78	0.00	72	Clear
10-Jul	66	78	72	0.31	88	Rain, Clear
11-Jul	64	75	70	0.01	88	Clear, Light Rain
12-Jul	62	75	68	0.01	83	Clear, Light Rain
13-Jul	64	75	70	0.10	96	Overcast, Light Rain
14-Jul	66	84	75	0.01	91	Overcast, Light Rain
15-Jul	66	87	76	0.09	87	Light Rain, Clear
16-Jul	66	87	76	0.02	82	Clear, Light Rain
17-Jul	66	89	78	0.00	75	Clear
18-Jul	68	87	78	0.01	87	Clear, Light Rain
19-Jul	66	89	78	0.47	84	Clear, Heavy Rain
20-Jul	66	78	72	0.07	90	Clear, Light Rain
21-Jul	68	86	77	0.00	77	Clear, Cloudy

Table C-1 Cont.: Daily weather station minimum, maximum, and mean temperatures.

Date	Min	Max	Mean	Precipitation	Humidity	Weather Conditions
22-Jul	69	87	78	0.03	83	Light Rain, Clear
23-Jul	68	87	78	0.00	84	Clear
24-Jul	69	82	76	0.00	83	Clear, Drizzle
25-Jul	66	87	76	0.00	77	Clear
26-Jul	69	89	79	0.00	77	Clear
27-Jul	66	87	76	0.08	83	Clear, Light Rain
28-Jul	64	84	74	0.00	75	Clear, Slightly Cloudy
29-Jul	62	82	72	0.00	69	Clear
30-Jul	60	84	72	0.00	77	Clear
31-Jul	64	82	73	0.02	84	Clear, Light Rain
1-Aug	60	84	72	0.05	80	Clear, Light Rain
2-Aug	62	87	74	0.00	74	Clear
3-Aug	62	87	74	0.00	82	Clear
4-Aug	68	82	75	0.00	82	Clear
5-Aug	64	87	76	0.23	85	Clear, Light Rain
6-Aug	66	77	72	0.00	94	Clear, Drizzle
7-Aug	66	82	74	0.00	86	Overcast, Clear
8-Aug	66	87	76	0.00	74	Clear
9-Aug	60	87	74	0.01	82	Clear, Light Rain
10-Aug	66	82	74	0.00	83	Mostly Cloudy
11-Aug	62	78	70	0.07	78	Light Rain, Overcast
12-Aug	55	80	68	0.00	70	Clear
13-Aug	59	82	68	0.00	77	Clear
14-Aug	62	82	72	0.01	81	Clear, Light Rain
15-Aug	62	73	68	0.00	89	Clear, Drizzle
16-Aug	55	82	68	0.00	74	Clear
17-Aug	57	68	80	0.00	81	Clear, Drizzle
18-Aug	62	80	71	0.00	69	Clear
19-Aug	62	71	66	0.00	93	Mostly Cloudy, Drizzle
20-Aug	51	80	66	0.00	69	Clear
21-Aug	55	80	68	0.00	82	Clear, Mostly Cloudy
22-Aug	55	82	68	0.00	82	Overcast, Clear
23-Aug	57	80	68	0.00	90	Clear, Drizzle
24-Aug	57	80	68	0.00	90	Clear, Overcast
25-Aug	55	75	65	0.00	84	Overcast
26-Aug	55	80	68	0.00	79	Mostly Cloudy
27-Aug	57	86	72	0.00	77	Overcast, Clear
28-Aug	59	82	70	0.00	78	Clear
29-Aug	60	86	73	0.00	66	Clear
30-Aug	60	87	74	0.00	75	Clear
31-Aug	64	89	76	0.00	73	Clear
1-Sept	68	87	78	0.10	85	Clear, Light Rain

Table C-1 Cont.: Daily weather station minimum, maximum, and mean temperatures.

Date	Min	Max	Mean	Precipitation	Humidity	Weather Conditions
2-Sep	68	84	76	0.00	94	Clear
3-Sep	66	84	75	0.00	89	Overcast, Drizzle
4-Sep	68	84	76	0.49	94	Overcast, Heavy Rain
5-Sep	69	84	76	0.01	89	Overcast, Drizzle
6-Sep	68	84	76	0.00	82	Mostly Cloudy, Clear
7-Sep	62	87	74	0.00	78	Clear
8-Sep	53	80	68	0.00	88	Clear
9-Sep	48	73	60	0.00	75	Clear
10-Sep	50	73	62	0.00	66	Clear
11-Sep	44	75	60	0.00	74	Clear
12-Sep	50	78	64	0.00	79	Clear, Overcast
13-Sep	48	78	63	0.00	75	Clear
14-Sep	48	80	64	0.00	75	Clear
15-Sep	55	75	65	0.00	77	Clear
16-Sep	57	69	63	0.00	92	Overcast, Drizzle
17-Sep	59	66	62	0.30	99	Overcast, Light Rain
18-Sep	59	71	65	0.38	96	Overcast, Rain
19-Sep	51	68	60	0.00	73	Clear
20-Sep	48	75	62	0.00	82	Overcast, Clear
21-Sep	48	77	62	0.00	80	Clear
22-Sep	57	78	68	0.00	72	Clear
23-Sep	46	66	56	0.00	51	Clear
24-Sep	37	66	52	0.00	65	Clear
25-Sep	37	69	53	0.01	84	Clear, Light Rain
26-Sep	48	80	64	0.00	81	Clear
27-Sep	51	80	66	0.00	79	Clear
28-Sep	60	73	66	0.01	90	Mostly Cloudy
29-Sep	53	69	61	0.01	84	Cloudy, Light Rain
30-Sep	41	69	55	0.00	74	Clear
1-Oct	51	57	54	0.05	100	Overcast, Light Rain
2-Oct	55	78	66	0.05	95	Overcast, Light Rain
3-Oct	57	78	68	0.00	84	Clear
4-Oct	53	75	64	0.00	77	Clear
5-Oct	46	75	60	0.00	77	Clear
6-Oct	48	69	58	0.00	83	Mostly Cloudy
7-Oct	39	50	44	0.12	93	Overcast, Light Rain
8-Oct	37	44	40	0.02	99	Overcast, Light Rain
9-Oct	42	55	48	0.00	89	Overcast
10-Oct	39	60	50	0.00	81	Clear, Mostly Cloudy
11-Oct	35	64	50	0.00	62	Clear
12-Oct	41	64	52	0.00	60	Clear
13-Oct	37	62	50	0.00	74	Clear

Table C-1 Cont.: Daily weather station minimum, maximum, and mean temperatures.

Date	Min	Max	Mean	Precipitation	Humidity	Weather Conditions
14-Oct	39	71	55	0.00	83	Clear
15-Oct	51	69	60	0.01	72	Overcast, Clear
16-Oct	42	64	53	0.00	59	Clear
17-Oct	33	69	51	0.00	75	Clear
18-Oct	46	64	55	0.00	82	Clear
19-Oct	44	66	55	0.00	61	Clear
20-Oct	42	57	50	0.00	61	Clear
21-Oct	39	64	52	0.00	63	Clear
22-Oct	37	75	56	0.00	71	Clear
23-Oct	42	78	60	0.00	72	Clear
24-Oct	48	78	63	0.00	69	Clear
25-Oct	44	78	61	0.00	69	Clear
26-Oct	48	73	60	0.00	83	Overcast
27-Oct	50	64	58	0.04	93	Light Rain
28-Oct	41	51	46	0.00	84	Overcast
29-Oct	35	41	38	0.01	86	Light Snow
30-Oct	33	39	36	0.00	73	Overcast, Light Snow
31-Oct	37	42	40	0.00	76	Overcast
1-Nov	37	44	40	0.00	69	Overcast
2-Nov	39	51	45	0.00	44	Overcast
3-Nov	30	53	42	0.05	59	Clear
4-Nov	37	48	42	0.03	88	Overcast
5-Nov	28	48	38	0.00	65	Clear
6-Nov	34	60	47	0.00	87	Clear
7-Nov	24	50	37	0.00	72	Clear, Mostly Cloudy
8-Nov	35	53	44	0.00	42	Clear
9-Nov	35	60	48	0.00	50	Clear
10-Nov	28	69	48	0.00	54	Clear
11-Nov	35	69	52	0.00	61	Clear
12-Nov	44	64	54	0.20	87	Overcast, Light Rain
13-Nov	30	44	37	0.04	70	Clear, Light Rain
14-Nov	21	42	32	0.00	78	Clear
15-Nov	24	46	35	0.00	79	Clear
16-Nov	24	53	38	0.00	67	Clear
17-Nov	24	53	43	0.00	65	Clear
18-Nov	28	50	39	0.00	75	Clear, Overcast
19-Nov	35	51	43	0.00	86	Overcast, Clear
20-Nov	33	59	46	0.00	69	Clear
21-Nov	28	60	44	0.00	53	Clear
22-Nov	28	60	44	0.00	58	Clear
23-Nov	28	55	42	0.00	69	Clear
24-Nov	24	39	32	0.00	59	Overcast, Clear

Table C-1 Cont.: Daily weather station minimum, maximum, and mean temperatures.

Date	Min	Max	Mean	Precipitation	Humidity	Weather Conditions
25-Nov	19	48	34	0.00	51	Clear
26-Nov	35	57	46	0.00	44	Clear
27-Nov	37	46	42	0.04	89	Overcast, Light Rain
28-Nov	28	46	37	0.00	58	Overcast, Clear
29-Nov	23	51	37	0.00	64	Clear
30-Nov	24	57	40	0.00	65	Clear
1-Dec	28	60	44	0.00	77	Clear
2-Dec	35	66	50	0.00	78	Clear
3-Dec	26	48	37	0.00	79	Clear
4-Dec	37	68	52	0.00	81	Clear, Mostly Cloudy
5-Dec	33	57	46	0.00	60	Overcast, Drizzle
6-Dec	24	46	35	0.02	86	Clear, Light Rain
7-Dec	35	55	45	0.00	95	Overcast, Clear

Vita

Lindsay Sliwa was born in Arlington Heights, Illinois on 14 February 1988. She grew up in Vernon Hills, IL and attended Adlai E. Stevenson High School. She received her Bachelor of Science degree with honors in Anthropology from Radford University in the spring of 2010. She currently has no plans to continue in Anthropology at this time.