DIFFERENTIAL DECOMPOSITION IN TERRESTRIAL, FRESHWATER, AND SALTWATER ENVIRONMENTS: A PILOT STUDY

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ABSTRACT

DIFFERENTIAL DECOMPOSITION IN TERRESTRIAL, FRESHWATER, AND SALTWATER ENVIRONMENTS: A PILOT STUDY

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The study of decomposition is essential for any forensic anthropologist for estimating postmortem interval. While surface rates of decomposition have been studied, especially in certain areas (Mann et al. 1990), the decomposition rate of bodies submerged in water has rarely been studied using controlled experiments (Haglund & Sorg 2002; Sorg et al. 1997). Most forensic anthropologists simply rely on generalizations, such as a body decomposing one week on the surface of the ground is equivalent to a body two weeks in the water (after Mann et al. 1990). In addition, there has not been much investigation into whether a

saltwater environment affects decomposition differently than a freshwater environment. This differential decomposition in diverse environments, whether open-air terrestrial or in fresh or saltwater, is important to consider in Texas because there because of an abundance of freshwater lakes and rivers and the proximity of the Gulf of Mexico. This study aimed to address two questions: 1) Does submersion in water affect decomposition in a way that supports the longstanding generalization that a body decomposing one week on the surface of the ground is equivalent to two weeks in the water (after Mann et al. 1990), and 2) Does the type of water (salt or fresh) differentially affect the rate of decomposition of a body submerged in water? Following anecdotal evidence, it was hypothesized that the surface specimens would decompose the fastest, the specimens in freshwater would decompose slower, and specimens in saltwater would decompose the slowest of all. This study took place outdoors at the Forensic Anthropology Research Facility at Texas State University-San Marcos, Texas. Though human remains and pig carcasses do float differently in water (Haglund & Sorg 2002), pig carcasses were used in this experiment in lieu of human remains due to their similarity to human tissue, as well as due to practical constraints. Six pigs (*Sus scrofa)* with weights from 20-30 lbs (9-13.6 kg) were humanely euthanized following Institutional Animal Care and Use Committee guidelines. Carcasses were placed on the surface of the ground (N=2), in saltwater tanks with water created by mixing freshwater with a purchased saltwater mix (N=2), and in freshwater tanks with water from the local Edwards Aquifer (N=2). Salinity in the saltwater tanks was the same as the Gulf of Mexico (34-36 ppts; Boatman 2006). Air and water temperatures were recorded daily. The surface carcasses and tanks were penned to prevent animal scavenging. The study was completed when all specimens were fully skeletonized. While placement in water affected the rate of decomposition, placement in freshwater

made the specimens decompose much faster than those on the surface of the ground or placed in saltwater, at least in the summer environment of central Texas. This is hypothesized to be a result of the high temperatures killing the maggot masses present on the surface carcasses only one day after hatching, while the maggot masses on the freshwater carcasses lived and thrived, possibly because the water was on average 4.45° Celsius (8° Fahrenheit) cooler than ambient temperature. Thus, the effect of water on decomposition did not support the longstanding generalization in the field, as the carcasses in freshwater decomposed much more quickly than the surface carcasses. In addition, the type of water differentially affected the rate of decomposition, as the carcasses in saltwater decomposed much more slowly than the carcasses placed in freshwater. The reason for this slower rate is likely related to the fact that the carcasses in saltwater did not have the burst abdomens with abdominal protrusion present in the carcasses in freshwater, which were most likely the result of osmosis. The abdominal protrusion on the freshwater specimens attracted blowflies, while the carcasses in saltwater did not, and thus with no insect activity the decomposition rate slowed considerably.

I. INTRODUCTION

Forensic investigations involving human remains occur in a variety of climates and environments. Forensic anthropologists are often called upon to estimate the time since death, or postmortem interval (PMI), when human remains are found. They may lack, however, the necessary knowledge base for making an accurate estimate of the PMI in all the situations they may encounter (Love and Marks 2003). One situation that is particularly lacking in research is decomposition in aqueous environments. The estimation of the PMI of bodies submerged in water is complex, and currently there is a scarcity of experimental research in the field to provide insight (see Haglund & Sorg 2002, Sorg et al. 1997). There are several possible reasons for this. Practical restrictions and accessibility concerns, such as the environmental impact of the contaminating water sources with human cadavers for research purposes, is one major obstacle. There are also various independent environmental factors, like scavenger activity and temperature (Haglund & Sorg 2002, Sorg et al. 1997); as well as bodily factors, including trauma, disease, or weight (Teather 1994), that are thought to potentially increase or retard decomposition, depending on the situation. These

factors need to be controlled in an experimental environment, which makes research design difficult. The dearth of experimental research and knowledge about aquatic decomposition has led many forensic anthropologists to rely on untested generalizations when estimating the PMI of a body found in water (Byers 2008, Dix and Graham 2000, Maples and Browning 1994, Rodriguez 1997). This research attempts to test one such generalization, that a body decomposing one week on the surface of the ground is equivalent to a body decomposing two weeks in the water (Mann et al. 1990). This means that a body decomposing in water is expected to take twice as long as body decomposing on the surface of the ground. This generalization makes no differentiation, however, between a saltwater and a freshwater environment. These two aqueous environments differ in many ways, such as scavenger activity, salinity, and bacteria content, all of which are thought to affect the decomposition rate (Rodriguez 1997).

This research attempts to make a comparison between the decomposition rates of an open-air terrestrial environment with that of a freshwater and a saltwater environment. This differential decomposition in diverse environments is important to consider in Texas, as there is not only access to several freshwater lakes and rivers, but also the saltwater Gulf of Mexico. Improvements in the ability to estimate the PMI in aqueous environments could provide a more accurate estimate of time since death, which will not only aid in identification of

the deceased individual, but will also help to establish an accurate timeline of the events surrounding the death event. The results of this research will provide a baseline data set for more extensive research in differing climates, seasons, and environments, in order to make more accurate generalizations about estimating the PMI in aqueous environments.

This thesis will attempt to explicate the following questions:

1) Does submersion in water affect decomposition in a way that supports the longstanding generalization that a body decomposing one week on the surface of the ground is equivalent to two weeks in the water (after Mann et al. 1990)?

2) Does the type of water (salt or fresh) differentially affect the rate of decomposition of a body submerged in water?

II. LITERATURE REVIEW

Research in aquatic decomposition is a rather recent development in the field of forensic taphonomy, with the first critical investigations starting in the early 1990s (Haglund 1993), and continuing into the present (Alley 2007, Haskell et al. 1993, Haglund & Sorg 2002, O'Brien 2007, Sorg et al. 1997). In contrast, surface decomposition in forensic anthropological contexts has been studied in differing areas and environments since the inception of The University of Tennessee's Anthropological Research Facility (e.g. Bass 1997, Galloway 1997, Gill-King 1997, Mann 1990, Maples and Browning 1994, Rodriguez 1997, Rodriguez and Bass 1983). Because the majority of aquatic decomposition rates are compared to surface decomposition rates, it is important to review past research not only in the field of aquatic decomposition, but in comparison to research on surface decomposition as well.

As previously stated, the most frequently stated generalization regarding aquatic decomposition is that a body decomposing one week on the surface of the ground is equivalent to a body decomposing for two weeks in the water (Byers 2008, Dix and Graham 2000, Mann et al. 1990, Maples and Browning 1994,

Rodriguez 1997), which means that a body decomposing in water is expected to take twice as long to decompose as a body on the surface of the ground. One of the earliest publications of this generalization is found in Mann et al. (1990). This study also states that bodies floating in water will exhibit the typical indicators of decomposition that are seen on the surface of the ground, such as bloating, discoloration and insect infestation. These generalizations were based on broad observations seen at The University of Tennessee's Anthropological Research Facility. This generalization is often repeated; however, no evidence of empirical testing of it exists in publication.

Anecdotal Information on Aquatic Decomposition

Due to a lack of experimental studies, the majority of information obtained in the area of aquatic decomposition is based on anecdotal experiences. Dix and Graham (2000), Rodriguez (1997), Di Maio and Di Maio (1993), and Teather (1994) have all published observations about determining postmortem interval (PMI) of a body submerged in water. All observations are based solely on their experiences, which come from a variety of fields. Di Maio and Di Maio (1993) write about forensic pathology from their experiences working in the New York Office of the Medical Examiner, while Teather (1994) is a member of the Canadian Public Safety Divers. Both are examples of separate fields overlapping

with interests in forensic anthropology, and all repeat the generalization.

Di Maio and Di Maio (1993) focus on the decompositional differences in antemortem trauma appearance when bodies are submerged in water. As an example, they mention that water can cause a "bloodlessness" appearance which can mislead investigators by disguising trauma, or result in overestimation of the PMI. Teather (1994) observes the common absence of lividity in bodies submerged in water, leading to an underestimation of the PMI as well as a lack of evidence regarding the body position at death. Rodriguez (1997) attributes the differentiation between surface and aquatic decomposition because of the reduced temperatures and reduction in insect activity that is present in water. He also discusses factors that he thinks could affect decomposition in water, such as bacterial content and salinity, as well as aquatic animal activity. Teather (1994) likewise discusses common aqueous scavengers in both saltwater and freshwater, such as crustaceans, fish, sticklebacks, sea lice, alligators, and maggots. Differences in bacterial content and salinity may quicken or retard decomposition, and the fact that aquatic scavengers are not present in experimental studies must be taken into account, as their absence might slow decomposition.

A differentiation between saltwater and freshwater is typically not made in the literature, which commonly leads to a false assumption that all aquatic

decomposition is the same. Because all of the factors affecting aquatic decomposition (bacterial content, temperature, salinity, and scavengers) differ between saltwater and freshwater, it stands to reason that the rates of decomposition would greatly differ between them. Rodriguez (1997) is the only one to differentiate between saltwater and freshwater decomposition rates, stating that a body in a saltwater environment will decompose slower than a body in a freshwater environment due to the reduction in bacterial action because of the salt concentration. This observation is stated as a fact, without any reference to research or experimental evidence. Teather (1994) states that the factors affecting the speed of decomposition in aquatic environments are water temperature, water environment, body weight, and overall health of the individual. He also states that colder temperature will slow decomposition compared more tepid water, and stagnant water quickens decomposition over a stream or flowing water environments. Teather additionally creates a decomposition clock or sequence, explaining and describing the typical findings for the first two weeks after submersion. In comparison with anecdotal observations, published case studies similarly hold little experimental value; however, they are a popular subject in the literature (Cotton et al. 1987, Dix 1987, Giertsen et al. 1989, O'Brien 1997).

Information from Forensic Case Studies

The conclusions drawn from forensic case studies demonstrate how forensic anthropologists and pathologists judge and determine the decomposition rates of bodies retrieved from water, and other ideas currently held in the field regarding aquatic decomposition. Boyle et al. (1997) conducted a study that consisted of a review of records for water-related deaths from 1980 to 1992 in Santa Cruz, California. Utilizing remains found in freshwater (N=29), which includes bathtubs and hot tubs, as well as remains found in saltwater (N=64), they conducted assessments. They based these on written descriptions of the remains, in order to estimate and classify the stage of decomposition and the PMI for the remains. The sample of freshwater remains was too small and too varied to provide a pattern or sequence of decomposition. The saltwater remains were found to have reached advanced decomposition between one week and one month. The authors attribute this range due to differences in scavenger predation, abrasion, water temperature and movement.

O'Brien (1997) describes the water action of a lake, and how it typically passes through four phases seasonally. These phases are the spring overturn, summer stratification, fall overturn, and winter stratification. Depending on the phase of the water action, bodies may become submerged or float at different intervals.

In Cotton et al.'s (1987) case study from Duluth, Minnesota, two bodies were recovered with no decomposition or odor observed, even though they were pulled from a freshwater environment after submersion for five years. Analogously, Dix (1987) discusses four cases of homicide victims found in Missouri's lakes, all deposited between November and December of the same year, who also had no advanced decomposition observed. Adipocere formation, or the preservation of soft tissues due to saponification, was varied among the bodies, and is stated as a reason for the slowed decomposition in both case studies.

Adipocere is also the main focus of O'Brien's (1997) observations on the "Goldilocks phenomenon" of its formation, with relation to a case study of a body recovered from Lake Ontario. He states that water that is too warm will cause tissues to liquefy easily and macerate, resulting in rapid soft tissue decomposition. If the water is too cold, decomposition will slow in freezing waters and will result in crystallization as the bodily fluids freeze. It is only in exactly moderate temperatures that adipocere tends to form due to chemical reactions.

Giertsen et al. (1989) discuss the state of two bodies found at sea. This was one of the only case studies to discuss saltwater decomposition. One individual was missing both hands and eyes, and the other had multiple defects, which was

attributed to marine scavenging. This demonstrates how the actions of marine scavengers can quicken the decomposition of bodies submerged in water. In contrast, in Dix's freshwater case study, the victim with head wounds was the only individual to skeletonize, and that was restricted to the area surrounding the trauma. No other body in his case study showed signs of skeletonization, even after having been submerged in water for ten months.

When comparing these case studies, the temperature of water stands out as a source of possible variation, as bodies recovered from cold water show no signs of advanced decomposition. Although the observations seen in these case studies cannot be replicated, they pose areas of future research for experimental studies, which should attempt to quantify the sources of variation in aquatic decomposition.

Experimental Studies

The majority of experimental studies also focus on differing facets of aquatic decomposition, such as insect succession (Haskell et al. 1989, Hobischak and Anderson 2002, Payne and King 1972), the effect of running versus stagnant water (Reh et al. 1977), adipocere formation (O'Brien 1994), body buoyancy (Donoghue and Minnigerode 1977), chlorinated water versus freshwater (Alley 2007), estimation of the PMI in freshwater (Seet 2005), or the disarticulation

sequence (Haglund 1993), instead of the aquatic decomposition process overall.

One such experimental study on aquatic decomposition was O'Brien's research on adipocere formation (1994). His research focused on the transformation into adipocere on three human bodies at The University of Tennessee's Anthropological Research Facility in a freshwater environment over 12 weeks. O'Brien proposed a sequence of postmortem actions of a human body during underwater decomposition. This sequence consists of: (1) float, (2) initial sinking, (3) gas formation resulting in refloatation, which is differential depending on temperature; (4) differential decomposition, and lastly (5) secondary sinking, either free (5a) or snagged (5b). He concluded that adipocere formation can occur rapidly, but does need certain basic conditions such as a moist environment, warm temperatures, intrinsic bacterial action, and adipose tissue (O' Brien 2007). He also discusses the amount of variation in decomposition in submerged bodies, including the type of water (freshwater, saltwater, or chlorinated) as a possible source of this variation (O' Brien 1994). Alley (2007) tested two of these types of differential decomposition by comparing freshwater (N=2) and chlorinated water environments (N=2), using pigs submerged in tanks in San Marcos, Texas. She found that a chlorinated environment most likely delays decomposition in comparison to a freshwater environment, which is probably due to the chemicals of chlorination.

O'Brien (1994) also proposed stages of aquatic decomposition, which include: float, bloat, first insect activity, hatching, mummification/maceration, fungal growth, color loss, cutis anserina (goose-fleshing), and adipocere. Although he was unable to give estimated time intervals for each stage due to his small sample size, these proposed stages are still an objective and easily replicated progression.

Alley's (2007) work was also essential from a methodological standpoint, providing successful methods to replicate, such as use of pigs, tanks, and a retrieval mechanism for retrieving the carcasses after complete submersion in water. Her study also highlighted pitfalls to avoid, such as unequal sun exposure between tanks and allowing fire ant access to the carcasses. O'Brien's (1994) study suggests methodological concerns that are important to take into consideration in all experimental studies related to aquatic decomposition. One such concern is the need to add water to combat natural evaporation, which could possibly affect the results of his study by disrupting bacterial or microbial growth on the water.

Summary

Even though the estimation of the PMI has been investigated in cases of bodies submerged in water, there remains a serious lack in the forensic literature

on how to make such estimations. Aquatic decomposition is affected by a number of independent environmental factors (water type, movement, temperature, bacterial content, salinity, scavengers), as well as human bodily factors (trauma present, weight, and health of the individual) that make it difficult to conduct experimental studies to test and quantify decomposition rate variations. Thus, most of the information on aquatic decomposition is gleaned from anecdotal information and forensic case studies, which is difficult to apply and compare. This has resulted in the use of untested generalizations, such as a body decomposing one week on the surface of the ground is equal to two weeks in the water with no differentiation made between saltwater and freshwater, as first stated by Mann et al. (1990).

The present study, therefore, aims to address two important issues regarding aquatic decomposition. The first issue is comparing surface decomposition to aquatic decomposition, in order to test the longstanding generalization that a body decomposing one week on the surface of the ground is equal to one decomposing two weeks in the water. The second is to compare two different types of aquatic contexts, saltwater and freshwater, to observe the differences in the rate of decomposition. This will provide new information to help determine the PMI of bodies found submerged in water.

III. MATERIALS AND METHODS

Materials

In order to study the differential decomposition between open-air terrestrial, freshwater, and saltwater environments, two specimens were placed in each of the three environments at the same time and allowed to decompose. All specimens were observed throughout the process. Pig carcasses were used in this experiment in lieu of human remains due to their similarity to human tissue (Love and Marks 2003, Tucker et al. 2001, Wheatley 2008), as well as practical constrictions. Although it has been stated that human remains and pig carcasses float differently in water, with humans tending to float on the ventral surface, and pigs floating on the dorsal surface (Haglund and Sorg 2002), they have still been used in the past as an acceptable proxy (Alley 2007, Haskell et al. 1997, Payne and King 1972).

Six pigs (*Sus scrofa),* each weighing between 20 and 30 pounds (9-13.6 kg), were obtained from a local pig farmer after having been humanely euthanized under strict Institutional Animal Care and Use Committee (IACUC) protocols

(Approval Code: 0920_0601_17).

Following euthanization, the pigs were transported to the Texas State University-San Marcos Forensic Anthropology Research Facility at Freeman Ranch. They were transported in a Rubbermaid ® agricultural 100 gallon tank. The pigs submerged in water were each placed in individual tanks, which consisted of 4 Rubbermaid ® agricultural 100 gallon tanks, measured as follows: Length: 52" (1.32 m), Width: 31" (0.79 m), Height: 25" (0.64 m). The tanks were obtained from Dr. Grady Early, and had been previously used by Olivia Alley in her thesis research (Alley 2007). Each tank was filled with approximately 75 gallons of water, about three-quarters full, before the pig was placed in the tank.

In total, four pigs were placed in water, with two in saltwater and two in freshwater. The freshwater was obtained from the water source at the Forensic Anthropology Research Facility, which originates from the Edwards Aquifer. The saltwater was created by mixing the freshwater with a CoralLife® saltwater mix from a local pet store. The salt concentration was measured at each check using a salinity meter, and was kept between 34-36 parts per thousand (ppt) at all times. This level of salt concentration was chosen for the present study because it accurately reflects the salinity for the Gulf of Mexico (Boatman 2006).

Plastic baskets were placed in the bottom of each tank underneath each pig in order to catch the majority of the bones, as well as allow recovery to the

surface in the event of submersion. Each plastic basket had two hooks installed on one side to allow the basket to be hooked onto the top of the tank for photographs or observation. Due to the basket's natural buoyancy, they were each weighted down with a five pound weight, to prevent them from causing the carcass to float unnaturally.

The tanks were left outdoors at the Texas State University Forensic Anthropology Research Facility to allow the natural weather patterns to remain in effect, but were surrounded by a chicken-wire pen to deter animal scavenging. Additionally, each tank was placed inside of a six foot diameter plastic wading pool filled with water (Figure 1). The purpose of this pool was not only to deter fire ants, which would not be present in a true water environment and could distort results (Alley 2007), but to also serve as a reservoir to refill the tanks as water evaporated. Each tank had a float switch installed at the water line. This float switch was connected to a pump in the pool, which had black rubber hosing that connected the pool to the tank. Whenever evaporation caused the water level in the tank to fall below the water line (so that the float switch was no longer floating), the pump would activate and pump water up the hosing from the pool to the tank until the water level was once more at its original level. All of the pumps and switches were run through relays and attached to a lawn-mower battery. The battery was taken out occasionally to recharge, and then reinstalled .

Figure 1: The tanks were placed in a wading pool and inside a pen to deter animal scavenging.

The pen was placed in an area with no trees or other obstructions that would provide additional shade to any area of the pen. The pen measurements were as follows: Length: 21' (6.4 m), Width: 18' (5.49 m), Height: 63" (1.6 m). The pen was constructed using fence posts drilled into the ground on the borders. The bottom half of the pen was made of chicken-wire wrapped around the posts and secured with wire ties. The top half was made of poultry netting wrapped around the posts and secured with zip-ties. The top of each section between posts was secured with metal drywall trim to hold up the poultry netting. The roof was constructed with braided fishing line. Due to the thinness of the fishing line, sections of two-inch wide red ribbon were braided in the roof, to ensure that

vultures or other scavengers were able to see there was a roof in place. The west side of the pen had the upper section secured with zip-ties on all sides. These zip-ties were cut to allow access into the pen, and secured again with new zip-ties upon leaving.

Each tank had a floating marine thermometer placed in it, while another thermometer was zip-tied to the west side of the pen at eye-level. The temperature, both ambient and within each individual tank, were checked twice daily for the first 7 days, once daily for the next 8 days (minus 1 due to bee infestation), thrice weekly for the following 21 days, and then once a week for the remainder of the study. The study lasted a total of 65 days.

The salinity of the saltwater tanks was also measured at each visit to ensure it stayed within the specified range. The only instance in which the salinity was outside the specified range was immediately following a rainstorm, when the concentration of salt decreased as the water level rose. More salt was not added, as it would not evaporate and would cause the water to be over-salinated when the levels were properly restored due to natural evaporation of the excess water (two days later).

The pH levels were measured using a standard Rainbow© brand pH testing kit. They were measured on the initial day of the study, on the second day of the study, at the day 31 benchmark, and on the day the specimen was removed

from the tank.

After arriving at the research site on Day 1, the pigs were laid on the ground in size order (Figure 2). There were 3 pigs that were larger and closer to 30 pounds (13.61 kg), and 3 pigs that were smaller and closer to 20 pounds (9.07 kg). One larger and one smaller pig were put into each environment, and named according to environment. Thus, Saltwater 1 and Saltwater 2 were placed into the saltwater tanks, Freshwater 1 and Freshwater 2 were placed into the freshwater tanks, and Ground 1 and Ground 2 were placed on the surface of the ground. The size order of the pigs from largest to smallest was: Ground 2, Saltwater 2, Freshwater 2, Ground 1, Freshwater 1, and Saltwater 1.

The pigs were euthanized approximately three hours prior to placement. All pigs were initially placed in their environments on their right side.

Methods

The decompositional categories and stages of Galloway (1997) were used as the majority were found to be applicable to all specimens in all of the environments, even though they were developed for the Arizona-Sonoran Desert. The categories are: fresh, early decomposition, advanced decomposition, skeletonization, and extreme skeletonization, with each of these categories

Figure 2: Pigs in size order, largest to smallest. (Left to Right) Ground 2, Saltwater 2, Freshwater 2, Ground 1, Freshwater 1, and Saltwater 1.

parsed further in to discrete stages. The stages were modified, as not all would apply to the submerged pigs (Table 1). In addition to these stages, the following decomposition factors were observed on a presence or absence basis in all specimens, as utilized by Galloway (1997): lividity, marbling, skin slippage, and mold. At each check, each pig was observed to determine which category and stage they were currently in and what (if any) other decomposition factors were present. It was noted how many days, both chronological and accumulated degree, it took each pig to reach each of these categories and stages.

Accumulated Degree Days

Accumulated Degree Days (ADD) is a quantifiable measure used to chart decomposition and provide a comparison across climates and seasons (Meygesi 2005). Temperature and other weather data were collected in thirty minute intervals and retrieved for the entirety of the study from the weather station located on Freeman Ranch closest to the facility (Heilman 2009). ADD is calculated by averaging the high and low temperature of each day, and then subtracting the lower threshold, at which decomposition will no longer advance (Meygesi 2005). There is some disagreement about the proper lower threshold to utilize, as forensic entomologists use 10 to 6°C as the temperature at which fly species cease to grow and develop (Megyesi 2005). On the other hand, Micozzi

Table 1: Categories and Stages of Decomposition

Category	**Stages**
A. Fresh	1. No discoloration or insect activity
B. Early	1. Pink-white appearance with skin slippage and some hair loss 2. Gray to green discoloration, some flesh relatively fresh 3. Bloating with green discoloration 4. Post bloating following rupture of the abdominal gases with discoloration going from green to dark
C. Advanced	1. Decomposition of tissues producing sagging of the flesh, caving in of the abdominal cavity, often accompanied by extensive maggot activity 2. Moist decomposition in which there is bone exposure 3. Mummification with bone exposure of less than one half the skeleton*
D. Skeletonization	1. Bones with desiccated tissue or mummified tissue covering less than one half of the skeleton

(Based on Galloway 1997)

*Only applies to terrestrial specimens

(1991) states no advancement in decomposition occurs at temperatures lower than 4°C, and Vass (1992) states 0°C is when decomposition no longer advances, due to high salt concentration in the body.

For this study, 0°C was used as the lower threshold, as freezing temperatures greatly inhibit decompositional processes. After the average was calculated for each day, the averages were summed to determine the total ADD at any given point. For example, the data for the first two days of the study are seen in Table 2. ADD for July 23 is the sum of the average for day 1 (30.68), plus the average for Day 2 (30.765), for a total ADD of 61.445. The ADD data for the entirety of the study can be found in Appendix A.

ADD were calculated in order to better quantify the results of the study. For example, while it only took two days to reach an ADD of 61.445 in the present study, a study in a colder climate or season would have lower daily temperature averages, and thus might take a much longer time interval to reach the same ADD.

The ADD was calculated using the ambient temperature for all specimens, including those submerged in water. ADD was not calculated using the individual tank's water temperatures because resources were not available to allow the water temperature to be constantly recorded throughout the day, as necessary to obtain the daily high and low in order to calculate ADD.

Table 2: Example ADD Calculation

Date	Low (°C)	High(°C)	Average	ADD
22-Jul	22.95	38.41	30.68	30.68
23-Jul	23.11	38.42	30.765	61.445

In a typical forensic setting when remains are found in water, however, it is assumed the investigator would have to calculate ADD using ambient temperature, and not the water temperature, due to similar limitations in data. Thus, it was not considered inaccurate or inappropriate to calculate the ADD for all specimens from the ambient temperature. For reference, a complete table of the water temperatures for each tank at each check can be found in Appendix B.

Data Collection

The study began on July 22, 2009, and ended on September 24, 2009. The specimens were checked twice daily for the first 7 days, once daily for the following 8 days (minus one due to bee infestation), thrice weekly for the following 21 days, and then once a week for the remainder of the study (29 days).

The study lasted a total of 65 days. At each check, it was noted at which category and stage each specimen was categorized into, and each specimen was photographed from all available sides (facing North, South, East, and West; respectively), as well as any additional pictures (i.e. close-ups). Due to placement of the tanks, Saltwater 1 and Saltwater 2 could not be photographed facing South; while Freshwater 1 and Freshwater 2 could not be photographed facing North. A photograph log was kept, and can be found in Appendix C.

After each specimen was determined to be fully skeletonized, the bones were removed. A metal colander was attached to a plastic mop handle with packing tape and zip-ties. This device was used for retrieving the bones from the bottom of the tank that were not inside the plastic baskets.

After retrieval, the bones of each specimen were taken back to the Grady Early Forensic Anthropology Research Lab for processing so they could be curated, and added to a zooarchealogical collection. They were soaked in water with an enzyme solution for five to seven days, then cleaned and rinsed. If bones were determined to be missing at processing, they were later retrieved when the water had fully evaporated from the tank and could be more easily found, then processed and sorted with the rest of the specimen. After drying for seven days, the bones were cataloged for each individual specimen. The study was completed when all six specimens were fully skeletonized, which took 65 days.

V. RESULTS

First, the results of the study with regard to the decompositional stages and categories will be discussed. Next, the observations of decomposition factors, lividity, marbling, skin slippage, and mold, will be discussed on a presence or absence basis. A summary table of these results can be seen in Table 3, as well as summary tables of each category in Tables 4, 5, and 6.

The day in which the pigs were euthanized and placed in their environments is designated as Day 1, the following day is Day 2, and so on, through the entirety of the study, which ended on Day 65.

Categories and Stages of Decomposition

Fresh

The fresh category is defined as no discoloration or insect activity present. Lividity was present on all specimens at pickup, which was approximately three hours prior to placement on Day 1 (ADD 30.68). Thus, the Fresh category, in which no discoloration or insect activity was present, was never observed.

Table 3: Summary of Results

	Pigs		
Category	**Freshwater**	**Saltwater**	**Surface**
Fresh	N/A	N/A	N/A
Early: Pink-white appearance Bloating with green discoloration Gray/Green discoloration Post-bloating with dark discoloration	Freshwater 1: Ended on Day 3 (ADD 91.95) Freshwater 2: Ended on Day 5/6 (ADD 151.51/ 183.02)	Saltwater 1: Ended on Day 6/15(ADD 183.02/481.66) Saltwater 2: Ended on Day 6 (ADD 183.02)	Ground 1/Ground 2- Ended on Day 4/5 (ADD 120.87/151.51)
Advanced Decomposition of tissues Moist decomposition in which there is bone exposure Mummification with bone exposure of less than one half the skeleton* *Only applies to terrestrial specimens	Freshwater 1: Ended on Day 9 (ADD 273.34) Freshwater 2: Ended on Day 20 (ADD 602.93)	Saltwater 1: No stages in this category were ever observed Saltwater 2: A single bone was spotted floating on the surface on Day 11 (ADD 333.59)	Ground 1/Ground 2: Ended on Day 57 (ADD 1590.65)
Skeletonization Bones with desiccated tissue or mummified tissue covering less than one half of the skeleton	Freshwater 1: Study completed on Day 11 (ADD 333.59) Freshwater 2: Study completed on Day 22 (ADD 663.12)	Saltwater 1/Saltwater 2: Study completed on Day 38 (ADD 1128.14)	Ground 1/Ground 2: Study completed on Day 65 (ADD 1764.25)

Table 4: Summary of Early Decomposition Results

	Pigs		
Stage	**Freshwater**	**Saltwater**	**Surface**
Pink-white appearance	Present by Day 1 (ADD 30.68)	Present by Day 1 (ADD 30.68)	Present by Day 1 (ADD 30.68)
Bloating with green discoloration	Present by Day 2 (ADD 61.36)	Present by Day 2 (ADD 61.36)	Present by Day 2 (ADD 61.36)
Gray to Green Discoloration/ Some Flesh Relatively Fresh	Present by Day 2 (ADD 61.36)	Present by Day 3 (ADD 91.95)	Present by Day 2 (ADD 61.36)
Post-bloating with dark discoloration	Freshwater 1: Present by Day 3 (ADD 91.95) Freshwater 2: Present by Day 5/6 (ADD 151.51/ 183.02)	Saltwater 1: Present by Day 6/15 (ADD 183.02/481.66) Saltwater 2: Present by Day 6 (ADD 183.02)	Present by Day 4/5 (ADD 120.87/151.51)

Early

The first stage of early decomposition is defined by a pink-white skin appearance with skin slippage and hair loss. Lividity was observed approximately two hour post-euthanization (Figure 3). Flies were first spotted around Saltwater 2's tub at 5:45 pm, which was approximately 3 hours post-euthanization, and one hour since removed from the vehicle. Flies were spotted in the air and around the pen, but not observed to land on any specimen on Day 1 (ADD 30.68), even though observations continued for more than two hours

Figure 3: Pictures of all pigs upon initial placement, with lividity already present. (Left to right) Top Row: Saltwater 1, Saltwater 2, Freshwater 1. Bottom Row: Freshwater 2, Ground 1, Ground 2.

after placement.

The second stage of early decomposition is defined as bloating with green discoloration. Galloway's (1997) stages has bloating following initial green discoloration, but she notes that the stages are not necessarily chronological. In this study, bloating was seen on the morning of Day 2 (ADD 61.36) for all specimens, preceding discoloration in five of the six specimens. Only Freshwater 1 had green discoloration on the abdomen that coincided with the onset of bloating on the morning of Day 2 (Figure 4). Three of the other specimens (Freshwater 2, Ground 1, and Ground 2) had green discoloration present by the

Figure 4: Close-up of the abdomen of Freshwater 1 on the morning of Day 2.

end of the same day.

The third stage of early decomposition is defined by green to gray discoloration, while some skin is relatively fresh. Green discoloration was first observed on the freshwater specimens on the second day. The discoloration was located on the chin, chest, and abdomen of both specimens. By the second check on Day 2 (ADD 61.36), Freshwater 1's intestines had protruded through the skin. This also happened to Freshwater 2, but not until Day 3 (ADD 91.95). These abdominal protrusions were on the right, or exposed, side of both specimens (Figure 5). Blowflies were seen swarming these abdominal protrusions within 24

Figure 5: Abdominal protrusion on the abdomens of Freshwater 1 (left) and Freshwater 2 (right).

hours of each rupture. The intestines were seemingly the attractant for the flies to the specimens, as they were not spotted on or near the freshwater pigs prior to rupture.

Blue-green discoloration was also present by Day 2 (ADD 61.36) on the heads and abdomens of the surface specimens (Figure 6). Blowflies and ants were observed swarming the surface specimens by the second check on this day.

Green discoloration was present on the saltwater specimens by Day 3 (ADD 91.95). Discoloration was concentrated around the heads of both specimens (Figure 7). Blowflies were never observed landing on either of the saltwater specimens.

Figure 6: Ground 1 (left) and Ground 2 (right) on Day 2.

Figure 7: Saltwater 1 (left) and Saltwater 2 (right) on Day 3.

The fourth stage of early decomposition is defined by post-bloating deflation, with discoloration changing from green to dark. Darkened discoloration was again first noted in Freshwater 1. This change was present by the morning of Day 3 (ADD 91.95), and was accompanied by a darkening of the intestinal tissues, which had ruptured the day before. Darkened discoloration was first noted on the chest and abdomen (Figure 8). Ground 1 and Ground 2 had post-bloating deflation by the second check on Day 4 (ADD 120.87). This coincided with the maggots hatching for these specimens. Darkened discoloration, however, was not present until Day 5 (ADD 151.51) for both specimens. This was initially only observed on the head and limbs, with the torsos of both specimens retaining a relatively fresh appearance with no discoloration. Post-bloating deflation occurred by the evening of Day 5 (ADD 151.51) for Freshwater 2. Darkened discoloration, however, was not present until Day 6 (ADD 183.02), and was concentrated on the head and abdomen.

Post-bloating deflation occurred by Day 6 (ADD 183.02) for the saltwater specimens. Darkened discoloration coincided with this deflation in Saltwater 2, and was observed on all surfaces that touched the water. It was not observed in Saltwater 1, however, until Day 15 (ADD 451.18). This darkened discoloration was concentrated on the lower torso, with the remainder of the skin still retaining a relatively fresh appearance (Figure 9).

Figure 8: Freshwater 1 on the afternoon of Day 3.

Figure 9: Saltwater 1 (left) and Saltwater 2 (right) on Day 6. Post-bloating deflation is observed on both specimens, but only Saltwater 2 had coinciding darkened discoloration.

Table 5: Summary of Advanced Decomposition Results

	Pigs		
Stages	**Freshwater**	**Saltwater**	**Surface**
Decomposition of tissues	Freshwater 1: Started on Day 3 (ADD 91.95)/5 Freshwater 2: Started on Day 5 (ADD 151.51)	N/A	Ended on Day 6 (ADD 183.02)
Moist decomposition in which there is bone exposure	Freshwater 1: Ended on Day 9 (ADD 273.34) Freshwater 2: Ended on Day 20 (ADD 602.93)	Saltwater 1: N/A Saltwater 2: Single bone spotted on Day 11 (ADD 333.59)	Ended on Day 6 (ADD 183.02)
Mummification with bone exposure of less than one half the skeleton* *Only applies to terrestrial specimens	N/A	N/A	Started on Day 9 (ADD 273.34) Ended on Day 51 (ADD 1461.38)

Advanced

The first stage of advanced decomposition is defined by decomposition of tissues producing sagging of the flesh, caving in of the abdominal cavity, and is often accompanied by extensive maggot activity. Decomposition of the tissues and maggot activity started on Day 4 (ADD 120.87) for Ground 1 and Ground 2. The maggot activity for both surface specimens was over by the termination of Day 6 (ADD 183.02).

In Freshwater 1 caving in of the abdominal cavity was present by Day 3 (ADD 91.95), but maggot activity and decomposition of the soft tissue was not observed until Day 5 (ADD 151.51). Freshwater 2 was also observed to have decomposition of the tissues and maggot activity starting on Day 5 (ADD 151.51), with the concentration of decomposing tissue initially on the left front leg and head.

The tissues were never observed to be sagging or decomposing on either saltwater specimen, though the limbs and head did drop beneath the surface of the water.

The second stage of advanced decomposition is defined by moist decomposition with bone exposure. Bone exposure was present in both surface specimens by Day 5 (ADD 151.51), and was concentrated on the hind legs. Moist decomposition was over by the termination of Day 6 (ADD 183.02) for both surface specimens.

Both freshwater specimens had bone exposure by Day 5 (ADD 151.51). It was first noted on the mandible on Freshwater 1 and the left front leg of Freshwater 2. Moist decomposition continued until Day 9 (ADD 274.34) for Freshwater 1, and until Day 20 (ADD 602.93) for Freshwater 2. At the end of this stage, each specimen was almost fully skeletonized.

No bone exposure was ever observed in Saltwater 1. A large portion of the

skin was visible floating on the surface until Day 22 (ADD 663.12), with the majority still retaining a relatively fresh appearance. After Day 22, only a small portion remained above the surface, and was present for the duration of the study.

For Saltwater 2, a single vertebrae was observed floating on the surface of the water on Day 11 (ADD 333.59). No other bone exposure was ever visible on the surface. A large portion of the skin was visible floating on the surface until Day 17 (ADD 511.09). After Day 17, only a small portion remained above the surface, and was present for the duration of the study.

The third stage of advanced decomposition is defined by mummification, with bone exposure of less than one half the skeleton. This is the only stage that applies solely to the surface specimens, as the specimens submerged in water did not mummify. The skin of the surface specimens began to mummify on Day 9 (ADD 274.34), with visible loss of the internal organs, and bone exposure still limited to the hind legs. This stage continued through the majority of the remainder of the study, until heavy rainfall on Day 52 (ADD 1480.43) rehydrated the specimens. This restored a fresh appearance and was an attractant to scavengers, though blowflies never returned.

Table 6: Summary of Skeletonization Results

	Pigs		
Stage	**Freshwater**	**Saltwater**	**Surface**
Bones with desiccated tissue or mummified tissue covering less than one half of the skeleton	Freshwater 1: Study completed on Day 11 (ADD 333.59) Freshwater 2: Study completed on Day 22 (ADD 663.12)	Saltwater 1/Saltwater 2: Study completed on Day 38 (ADD 1128.14)	Ground 1/Ground 2: Study completed on Day 65 (ADD 1764.25)

Skeletonization

The first stage of skeletonization is defined by bones with desiccated tissue or mummified tissue covering less than one half of the skeleton. Skeletonization was present first on Freshwater 1 on Day 9 (ADD 274.34). This stage was considered complete, and thus the study ended, on Day 11 (ADD 333.59) for this specimen.

Freshwater 2 was the next specimen that was skeletonized over the majority of the surface. This occurred on Day 20 (ADD 602.93). This stage was considered complete, and thus the study ended, on Day 22 (ADD 663.12) for this specimen.

No skeletonization was ever observed on either of the saltwater specimens, and some skin remained floating on the surface the entirety of the

study. A strainer was used on both tanks on Day 36 (ADD 1073.88), to see if skeletonization had progressed beneath the surface. Bones were found in both tanks. The baskets were then pulled on Day 38 (ADD 1128.14), revealing that both specimens had fully skeletonized. Thus, the study ended for both saltwater specimens at this point.

Skeletonization was present on the majority of both surface specimens on Day 58 (ADD 1615.23). This stage was considered complete, and thus the study ended on Day 65 (ADD 1764.25) for both surface specimens.

Other Factors

The observations of the following decomposition factors were noted on a presence or absence basis: lividity, marbling, skin slippage, and mold. Lividity was present on all specimens during the placement on the first day, approximately two hours post-euthanization.

Marbling was only observed on Ground 2 (Figure 10). The small section of marbling was located on the left hind leg, near the tail, and was observed on Day 2 (ADD 61.36), though it was no longer visible by Day 3 (ADD 91.95). It is possible that marbling was located on the surfaces of the pigs that were not easily visible, as the specimens were not disturbed for full examinations.

Figure 10: Marbling present on Ground 2 on Day 2.

Skin slippage was not able to be observed while it was occurring on all specimens, though it most likely occurred on sections of the specimens that were not readily visible. Skin slippage was not observed for the saltwater specimens, though skin sloughage, where whole sections of skin are come off at once, did occur. Both saltwater specimens had sections of skin floating on the surface the entirety of the study, even while they were already skeletonized (Figure 11). The skin on the surface specimens mummified, and thus skin slippage was absent for these specimens.

Figure 11: Saltwater 1 (left) and Saltwater 2 (right) exhibiting skin sloughage.

Mold was not observed on either of the surface or the freshwater specimens. Algae were present on both saltwater specimens. It was located on both of the specimens as well as inside the tank (Figure 12).

Changes in pH

The normal pH range for saltwater is 7.8-8.4 (Paletta 1999). Freshwater pH is highly varied between environments, but 6.5-8.5 is considered a normal range (Berezina 1999). Only one specimen, Saltwater 1, was not in the normal range for

Figure 12: Saltwater 1 (left) and Saltwater 2 (right) both had algae present.

their environment, as the pH dropped to below 7.8 by Day 31. No significant changes in pH were seen between specimens. While the initial pH differed between saltwater and freshwater, over time they began to overlap. A complete listing of all pH levels can be seen in Table 7.

Table 7: pH of Water of Submerged Specimens

	Specimen			
Date	**Saltwater 1**	**Saltwater 2**	**Freshwater 1**	**Freshwater 2**
Day 1 (July 22, 2009)	7.8	7.8	8.2	8.2
Day 2 (July 23,2009)	7.8	7.8	7.8	8.0
Day 3 (July 24, 2009)	7.8	7.8	7.4	7.8
Day 11 (August 1, 2009)	-	-	7.4	-
Day 31 (August 21, 2009)	7.4	7.8	N/A	8.0
Day 38 (August 28, 2009)	7.6	7.8	N/A	N/A

V. DISCUSSION

The purpose of this study was to test the longstanding generalization that a body decomposing one week on the surface of the ground would appear equivalent to a body decomposing two weeks in the water (Mann et al. 1990). This generalization makes no differentiation between a saltwater and a freshwater environment, even though the environments differ greatly in many ways (e.g. scavenger activity, salinity, and bacteria content). Any or all of these factors could possibly affect the decomposition rate. In order to test this generalization, two pigs were placed and left to decompose simultaneously in one of three environments: on the surface, submerged in freshwater, and submerged in saltwater. The results of the present study were that the 2 freshwater specimens skeletonized by Day 11 (ADD 333.59) and Day 22 (ADD 663.12), respectively. The 2 saltwater specimens were found to be skeletonized on Day 38 (ADD 1128.14), but the exact timing is not known as skeletonization occurred completely beneath the water's surface. The 2 surface specimens were the slowest to reach skeletonization, on Day 65 (ADD 1764.25).

The first notable result is that both freshwater specimens skeletonized before any of the others. This result was unexpected, as it was hypothesized due to anecdotal evidence that the surface specimens would decompose before any of the submerged specimens. The potential reasons why the freshwater specimens decomposed faster than the surface and the saltwater specimens are listed below.

Effects of High Heat

It is important to note that this study took place during one of the hottest Texas summers on record (Lindell 2009). This particular region of central Texas had 68 days over 37.78° Celsius (100° Fahrenheit). The record of 69 days over 37.78° Celsius (100° Fahrenheit) was set in 1925 (Lindell 2009). To contrast, a typical year has only 12 days over 37.78° Celsius (100° Fahrenheit), and there were 27 days over 37.78° Celsius (100° Fahrenheit) throughout the entirety of the present study.

The first unforeseen factor that contributed to the freshwater specimens decomposing faster than the surface specimens was the termination of maggot activity on the surface specimens by the conclusion of Day 6 (ADD 183.02). The first wave of maggot masses were found to be deceased on both surface specimens by the second check on Day 5 (ADD 151.51), but new maggot masses were seen mixing in with the deceased ones. The death of the maggot is probably

the result of the high heat on this day, with an ambient temperature of 40° Celsius (104° Fahrenheit) at the afternoon check, with a heat index of up to 42.2° Celsius (108° Fahrenheit). By the end of Day 6 (ADD 183.02), all maggot masses on both surface specimens were observed to be deceased. This day had similarly high heat, with an ambient of 42° Celsius (108° Fahrenheit), and a heat index of 45.5° Celsius (114° Fahrenheit).

The maggot masses on both the freshwater specimens, however, remained living and active, presumably because the water temperatures were on average 4.45° Celsius (8° Fahrenheit) lower than the ambient temperature. For Days 5 to 6, the minimum difference was 2.22° Celsius, and the maximum difference was 6.66° Celsius (4 to 12° Fahrenheit).

After both waves of maggot masses were found to be deceased at the conclusion of Day 6 (ADD 183.02), no new maggots or blowflies were seen on the surface specimens. Without maggots, decomposition on these specimens slowed. No evidence of maggots dying in high heat was found in the anthropological literature, but some anecdotal evidence was found in agricultural literature, which was related to killing maggots in fertilizer piles (e.g. Swinker 2004). These results are surprising, especially as maggot masses have been noted to have an internal temperature of over 37° Celsius (100° Fahrenheit) in the past (Higley and Haskell 2000). The reason individual maggots are able to survive when the mass

is near lethal temperatures is thought to be due to an internal rotation. This constant rotation means no individual stays at the center of the mass, where heat is the highest, for a long period of time (Gunn 2009, Higley and Haskell 2000). The results of the present study suggest that an upper limit to decomposition should be put in place, similar to the lower limit of 0° Celsius. The lower limit is understood to be the temperature at which decomposition slows, because the temperature is too cold to promote maggot activity (Micozzi 1991). Similarly, the fact that the maggot masses died, presumably due to the high temperatures, suggest an upper limit should be instituted, at which the maggot masses will die due to heat, and thus decomposition will slow considerably. Based on the present study, the upper limit should be within the range of 42-45° Celsius (108-114° Fahrenheit), but further research is needed to verify this upper limit.

Due to heat, the beginning of mummification was observed on the surface specimens by Day 9 (ADD 274.34). Although some maceration was seen around the ribs, decomposition languished until rain occurred on Day 52 (ADD 1480.43). After the rain rehydrated the specimens, the carcasses attracted unknown scavengers that were able to get inside the pen, as noticed by the limbs being pulled away from the torso. These disturbances were more pronounced by Day 58 (ADD 1615.23). By Day 65 (ADD 1764.25), the remains of both surface specimens were scattered, comingled, and missing.

The record high heat of this time period might have accelerated the results, as heat is often stated to be linked to accelerated decomposition (Mann 1990, Micozzi 1991). But as noted previously, the high temperatures most likely resulted in the death of the maggot masses on the surface carcasses, so decomposition was actually slowed by the heat in these specimens. The decomposition was so slow in the surface specimens, in spite of the high heat, that it took 1764 .25 ADD before the 20-30 pound (9-13.6 kg) specimens were determined to be skeletonized. This was unexpected, as current research states that skeletonization for a 150 pound (68 kg) carcass should be complete between 1200-1285 ADD (Mehgysi 2005, Vass 1992), and will almost certainly be completed by 1400 ADD (Simmons et al. 2010), no matter what the environment. Presence or absence of insects has also been stated by Simmons et al. (2010) to be the sole variable that influences rate of decomposition. In spite of the fact that insects were once present on the surface specimens, they still decomposed at a slower rate than the saltwater specimens, which had no presence of insects at all. Additionally, the saltwater specimens skeletonized at a faster rate than expected (1128.14 ADD) in spite of an absence of insects, due to the large amounts of skin sloughage present on both specimens. Thus, the present study demonstrates that these generalizations cannot always be reliable, in spite of the quantifiable measure of ADD, as they were not supported in this instance, and could lead to

inaccurate estimations of the PMI if utilized. Further testing is needed on the effects of high heat before such generalizations are utilized in the future.

A side effect of the high heat and drought conditions was an infestation of the pen by bees searching for water on Day 13 (ADD 392.80), which caused unsafe conditions that prevented a check in the second week. A refill of the on-site water tower enticed the majority of the bees to leave the pen and return to the water tower, but a small group remained in the pen for the remainder of the study, congregated around Freshwater 2's tank.

Insect Development

No maggots were able to pupate and become adult flies, though for differing reasons between environments. On the surface specimens, this was due to the high heat killing all maggots before they were able to pupate. For the submerged freshwater specimens, some maggots drowned trying to swim to the edge of the tank, and those that were able to reach the edge and scale down the side of the tank eventually drowned in the wading pool (Appendix D).

Comparison between Water Environments

In addition to decomposing more quickly than the surface specimens, the freshwater specimens also decomposed faster than the saltwater specimens. Although this result was expected, the most logical reason for the difference was unanticipated. As noted previously, both freshwater specimens had abdominal protrusions, with sections of the intestines bursting through the skin. This occurred on Day 2 (ADD 61.36) for Freshwater 1 and on Day 3 (ADD 91.95) for Freshwater 2. As this occurred on both freshwater specimens, but not on either saltwater specimen, it was assumed to be associated with the water type, most likely as the result of osmosis or a similar process. In Alley's (2007) study, specimens that were submerged in either freshwater or chlorinated water all had abdominal protrusions present at the inception of bloating. Thus the lack of abdominal protrusions seems to be specific to the specimens in saltwater. This could be because bodies in freshwater absorb water, rapidly increasing blood volume, while saltwater draws fluid out of the blood (Boyle et al. 1997).

These abdominal protrusions were significant as they seemed to be the main attractant for the blowflies to these specimens, and thus accelerated decomposition through the maggot masses' destruction of soft tissue (Mann et al. 1990). In contrast, neither saltwater specimen had any internal organs protruding or any blowfly activity. These two factors appear to be correlated, but further

research is necessary to retest these results and see if they are replicable.

Due to the commitment to not disturb the carcasses natural floatation process, it was disappointing to find that skeletonization on the saltwater specimens had progressed completely beneath the water surface, and thus could not be precisely observed or timed. As such, this study can only state that decomposition for both saltwater specimens was complete by Day 38 (ADD 1128.14), but could have occurred much sooner.

Water temperatures did not vary significantly between freshwater and saltwater. It is worth mentioning, however, that in the present study freshwater and saltwater were in a homogenous climate. In reality, freshwater and saltwater would rarely coexist in the same area and climate.

Surprisingly, none of the submerged specimens followed O'Brien's (1997) flotation sequence. No specimen was ever observed to sink, unless the saltwater specimens sank and refloated in the six to seventeen hours between checks. There is no chance the freshwater specimens ever sank and refloated, as that would have resulted in the demise of the maggot masses and been immediately apparent. In Alley's (2007) study, which was conducted in the same area and utilized the same tanks, all specimens remained floating throughout the study until they became skeletonized and sank. Buoyancy is related to the medium's displacement and density, as well as the density of the object, which in this case

is the deceased body (Donoghue and Minnigerode 1977). It is possible that the relatively small size of the tank, the small size of the pigs, or a lack of correlation between pig and human buoyancy could all be reasons why the specimens did not sink as predicted by O'Brien's (1997) buoyancy sequence, which was developed based on humans. Furthermore, the lack of sinking allowed the freshwater specimens a prolonged, continuous period of differential decomposition. The lack of sinking also allowed the saltwater specimens to appear to still be floating, in spite of the fact that the internal organs and bones had fallen out the bottom, leaving only the shell of skin remaining afloat.

Applicability of Results

The results of the present study should be applicable to remains found in shallow, stagnant waters, as blowflies and thus maggots would not typically have continued access to remains found in large, turbulent bodies of water, such as a lake or ocean, due to water action. In these situations, however, aquatic scavengers would most likely be present. Aquatic scavengers (e.g. fish, crustaceans, mollusks, turtles, echinoderms, and more rarely sharks and rays) have been shown to be destructive to soft tissue (Boyle et al. 1997; Mottonen and Nuutila 1977; Rodriguez 1997; Sorg et al. 2002; Teather 1994) as well as attract secondary predators, such as fish, to the remains. These scavengers will

eviscerate soft tissue and organs, comparable to blowflies and other terrestrial scavengers, though marine scavengers are capable of damage to the bones as well (Rodriguez 1997; Sorg et al. 2002).

Summary

The results of this study did not support the longstanding generalization that a body decomposing one week on the surface of the ground is equivalent to a body decomposing two weeks in the water (Mann et al. 1990), or that decomposition in water takes twice as long as decomposition on the surface. All submerged specimens were fully skeletonized before the surface specimens, which was most likely due to the maggot masses on the surface specimens dying, considerably slowing decomposition. This result was unexpected, and important for several reasons. First, it shows a demonstrated need for an upper limit to ADD calculations, similar to the lower limit already in place. If the results of the present study are replicable, it would verify that high heat, possibly in the range of 42-45° Celsius (108-114° Fahrenheit), can considerably slow decomposition by killing the maggot masses present on the carcass. Secondly, the present study demonstrates that previous stated generalizations regarding the amount of ADD at which skeletonization is ensured to be completed (Mehgysi 2005, Simmons et al. 2010, Vass 1992) were not supported by this study, and might need further

consideration and refinement. Additionally, the present study demonstrates that specimens in freshwater and saltwater can have very different processes and velocities of decomposition, and thus should not be thought to be exactly alike and lumped together indiscriminately. One area of differentiation was that the freshwater specimens attracted insect activity, while saltwater specimens did not, which contributed to differential decomposition rates between water environments.

VI. CONCLUSION

The present study set out to test the longstanding generalization that a body decomposing in the water would take twice as long as one on the surface (Mann et al. 1990). Overall, the generalization was not supported by the results of this study, as the freshwater specimens were the first to fully decompose, then the saltwater specimens, and finally the surface specimens. Furthermore, the freshwater specimens appeared to decompose faster than the saltwater specimens, possibly due to the presence of abdominal protrusions, which attracted blowflies to these specimens. In contrast, the saltwater specimens were never observed to have any significant insect activity. This disparity further shows the need to differentiate between freshwater and saltwater when attempting to create or utilize generalizations to estimate the postmortem interval (PMI) of bodies submerged in water.

The results of the present study are important to forensic anthropologists as they demonstrate a need for an upper limit to ADD calculations, similar to the lower limit already in place. The results of the present study give an estimate that the upper limit could possibly be in the range of 42-45° Celsius (108-114°

Fahrenheit), but further testing is needed to refine and verify this limit. High heat in this study was shown to considerably slow decomposition by killing the maggot masses present on the carcass. The present study also demonstrates that previously stated generalizations about the amount of ADD at which skeletonization should be complete (Mehgysi 2005, Simmons et al. 2010, Vass 1992) were not supported and might need further refinement. While generalizations, such as a body decomposing in the water will take twice as long as one on the surface (Mann 1990), or that a carcass will be skeletonized by 1200-1285 ADD (Mehgysi 2005, Simmons et al. 2010, Vass 1992), can be useful, they should not be taken as infallible. Further testing, especially using sound experimental study designs is always necessary in order to verify and improve ideas about decomposition rates and their relationships to other variables, such as insects or temperature.

Though it is a limitation of the study that the sample sizes are small, it is a larger sample than those used in the formation of the generalization, which was based on subjective observation and experience. This generalization has been oft-repeated, but this study was the first known attempt to test the generalization using an experimental study design. This testing of the generalization is significant in light of the forensic community's commitment to redefining standards in the context of the *Daubert* ruling, which has resulted in calls for

longitudinal, experimental studies of this nature, instead of reliance on independent case studies or observer experience (Christensen and Crowder 2009).

As this was a pilot study, ideally the methodology should be repeated utilizing a larger sample size and consisting of human subjects. The study should also be repeated in different seasons and climates, in order to test the replicability of the results. As practical constrictions on research make it difficult to conduct experimental studies in natural aquatic environments, such as those in which bodies are typically recovered, future studies could also utilize longitudinal surveys of individual case studies, modeled after studies such as Boyle et al. (1997). With a large enough sample size and utilizing appropriately comparable aquatic environments (e.g. not considering bathtubs, swimming pools, or hot tubs equivalent to other freshwater environments such as lakes), the author believes that overarching generalizations could be developed, such as the ones by Boyle et al. (1997) in regards to saltwater environments. To make the results of longitudinal surveys and experimental research even more applicable, it might be useful to possibly compare regions and environments using quantifiable measures, like Accumulated Degree Days, and utilize a uniform methodology when possible (Love and Marks 2003).

Simmons et al. (2010) propose that studies of decomposition should no

longer exist in isolation, but be compiled and compared using quantifiable measures, such as Accumulated Degree Days (ADD), in order to better produce standards in the field of forensic anthropology. This is important with the recent *Daubert* ruling, which requires replicable, testable results for methods that are testified to in a court of law (Christensen and Crowder 2009). Better field methods also allow forensic anthropologists to better be more prepared to predict the PMI in a forensic case setting, which could possibly aid investigators in the identification of the individual.

APPENDIX A: ACCUMULATED DEGREE DAY DATA

Date	Low	High	Average	ADD
22-Jul	22.95	38.41	30.68	
23-Jul	23.11	38.42	30.68	61.36
24-Jul	23.15	38.02	30.585	91.945
25-Jul	18.85	38.99	28.92	120.865
26-Jul	21.31	39.98	30.645	151.51
27-Jul	23.88	39.13	31.505	183.015
28-Jul	23.64	39.01	31.325	214.34
29-Jul	25.42	36.58	31	245.34
30-Jul	20.95	37.04	28.995	274.335
31-Jul	19.19	37	28.095	302.43
1-Aug	24.13	38.18	31.155	333.585
2-Aug	24.07	37.54	30.805	364.39
3-Aug	19.03	37.78	28.405	392.795
4-Aug	20.32	38.26	29.29	422.085
5-Aug	19.21	38.97	29.09	451.175
6-Aug	21.18	39.78	30.48	481.655
7-Aug	19.89	38.98	29.435	511.09
8-Aug	23.01	37.25	30.13	541.22
9-Aug	23.95	37.86	30.905	572.125
10-Aug	23.34	38.26	30.8	602.925
11-Aug	22.44	39.28	30.86	633.785
12-Aug	19.56	39.11	29.335	663.12
13-Aug	16.3	37.11	26.705	689.825
14-Aug	19.45	37.67	28.56	718.385
15-Aug	21.8	38.28	30.04	748.425
16-Aug	22.36	38.39	30.375	778.8
17-Aug	21.52	37.41	29.465	808.265
18-Aug	22.4	36.73	29.565	837.83
19-Aug	21.84	36.69	29.265	867.095

20-Aug	23.7	38.98	31.34	898.435
21-Aug	20.42	38.48	29.45	927.885
22-Aug	18.32	38.69	28.505	956.39
23-Aug	21	39.98	30.49	986.88
24-Aug	19.43	38.69	29.06	1015.94
25-Aug	19.98	38.06	29.02	1044.96
26-Aug	19	38.84	28.92	1073.88
27-Aug	16.88	38.16	27.52	1101.4
28-Aug	17.31	36.16	26.735	1128.135
29-Aug	18.66	36.38	27.52	1155.655
30-Aug	18.31	35.09	26.7	1182.355
31-Aug	18.02	33.23	25.625	1207.98
1-Sep	18.36	33.81	26.085	1234.065
2-Sep	16.5	36.06	26.28	1260.345
3-Sep	17.85	37.01	27.43	1287.775
4-Sep	21.57	33.05	27.31	1315.085
5-Sep	21.08	32.26	26.67	1341.755
6-Sep	19.33	35.19	27.26	1369.015
7-Sep	15.09	36.02	25.555	1394.57
8-Sep	17.02	34.56	25.79	1420.36
9-Sep	17.58	27.6	22.59	1442.95
10-Sep	16.07	20.78	18.425	1461.375
11-Sep	15.19	22.91	19.05	1480.425
12-Sep	15.03	20.96	17.995	1498.42
13-Sep	16.08	28.2	22.14	1520.56
14-Sep	17.89	26.75	22.32	1542.88
15-Sep	17.26	30.99	24.125	1567.005
16-Sep	15.59	31.69	23.64	1590.645
17-Sep	19.55	29.62	24.585	1615.23
18-Sep	19.36	29.9	24.63	1639.86
19-Sep	17.92	30.84	24.38	1664.24
20-Sep	16.15	32.17	24.16	1688.4
21-Sep	21.18	34.85	28.015	1716.415
22-Sep	12.76	24.42	18.59	1735.005
23-Sep	11.45	17.97	14.71	1749.715
24-Sep	11.82	17.25	14.535	1764.25
TOTALS			65 days	1764.25

APPENDIX B: TEMPERATURE READINGS

	Environmental Temperatures (°Fahrenheit)				
Date	**Saltwater 1**	**Saltwater 2**	**Freshwater 1**	**Freshwater 2**	**Ambient**
22-Jul	96	96	94	92	102
23-Jul(A)	92	92	92	92	102
(B)	90	92	90	92	94
24-Jul(A)	92	90	92	90	102
(B)	90	92	92	90	98
25-Jul(A)	92	94	94	92	100
(B)	92	94	94	92	98
26-Jul(A)	94	92	96	96	104
(B)	92	92	94	92	98
27-Jul(A)	96	96	96	96	108
(B)	90	92	92	92	94
28-Jul(A)	94	96	96	96	108
(B)	90	90	90	90	94
29-Jul(A)	90	92	92	92	104
(B)	88	90	88	90	98
30-Jul	78	78	80	80	76
31-Jul	92	92	92	92	100
1-Aug	86	88	90	90	94
2-Aug	88	90	88	90	98
3-Aug	N/A	N/A	N/A	N/A	N/A
4-Aug	N/A	N/A	N/A	N/A	N/A
5-Aug	96	96	98	96	108
6-Aug	100	102	N/A	102	108
7-Aug	96	98	N/A	96	110
8-Aug	N/A	N/A	N/A	N/A	N/A
9-Aug	N/A	N/A	N/A	N/A	N/A
10-Aug	92	92	N/A	92	98
11-Aug	N/A	N/A	N/A	N/A	N/A
12-Aug	82	82	N/A	84	76
13-Aug	N/A	N/A	N/A	N/A	N/A

14-Aug	**82**	**86**	**N/A**	**82**	**92**
15-Aug	N/A	N/A	N/A	N/A	N/A
16-Aug	N/A	N/A	N/A	N/A	N/A
17-Aug	94	94	N/A	94	102
18-Aug	N/A	N/A	N/A	N/A	N/A
19-Aug	92	92	N/A	92	98
20-Aug	N/A	N/A	N/A	N/A	N/A
21-Aug	86	86	N/A	86	96
22-Aug	N/A	N/A	N/A	N/A	N/A
23-Aug	N/A	N/A	N/A	N/A	N/A
24-Aug	94	98	N/A	98	110
25-Aug	N/A	N/A	N/A	N/A	N/A
26-Aug	96	94	N/A	98	110
27-Aug	N/A	N/A	N/A	N/A	N/A
28-Aug	78	78	N/A	80	90
29-Aug	N/A	N/A	N/A	N/A	N/A
30-Aug	N/A	N/A	N/A	N/A	N/A
31-Aug	74	80	N/A	N/A	94
1-Sep	N/A	N/A	N/A	N/A	N/A
2-Sep	N/A	N/A	N/A	N/A	102
3-Sep	N/A	N/A	N/A	N/A	N/A
4-Sep	N/A	N/A	N/A	N/A	N/A
5-Sep	N/A	N/A	N/A	N/A	N/A
6-Sep	N/A	N/A	N/A	N/A	N/A
7-Sep	N/A	N/A	N/A	N/A	N/A
8-Sep	N/A	N/A	N/A	N/A	N/A
9-Sep	N/A	N/A	N/A	N/A	N/A
10-Sep	N/A	N/A	N/A	N/A	N/A
11-Sep	N/A	N/A	N/A	N/A	N/A
12-Sep	N/A	N/A	N/A	N/A	70
13-Sep	N/A	N/A	N/A	N/A	N/A
14-Sep	N/A	N/A	N/A	N/A	N/A
15-Sep	N/A	N/A	N/A	N/A	N/A
16-Sep	N/A	N/A	N/A	N/A	N/A
17-Sep	N/A	N/A	N/A	N/A	90
18-Sep	N/A	N/A	N/A	N/A	N/A
19-Sep	N/A	N/A	N/A	N/A	N/A
20-Sep	N/A	N/A	N/A	N/A	N/A
21-Sep	N/A	N/A	N/A	N/A	N/A

22-Sep	N/A	N/A	N/A	N/A	N/A
23-Sep	N/A	N/A	N/A	N/A	N/A
24-Sep	N/A	N/A	N/A	N/A	78

APPENDIX C: PHOTOGRAPH LOG

Subject	Direction	Date	Check
Tub		07/22/09	1
Close up of tub		07/22/09	1
Broad of tub		07/22/09	1
Basket as water full (Saltwater 2)		07/22/09	1
Becca Bones		07/22/09	1
Pools		07/22/09	1
Aerial view of roof with ribbons to deter vultures		07/22/09	1
(left to right) Ground 1 Freshwater 1 Saltwater 1	East	07/22/09	1
(left to right) Saltwater 2 Freshwater 2 Ground 2		07/22/09	1
Saltwater 1 on ground		07/22/09	1
Freshwater 1 on ground		07/22/09	1
Ground 1 on ground		07/22/09	1
Saltwater 2 on ground		07/22/09	1
Freshwater 2 on ground		07/22/09	1
Ground 2 on ground		07/22/09	1
Becca Bones		07/22/09	1
Saltwater 1 floating		07/22/09	1
Saltwater 2		07/22/09	1
Ground 1	East	07/22/09	1
Ground 2	East	07/22/09	1
Saltwater 1	East	07/22/09	1
Freshwater 2	West	07/22/09	1
Air thermometer (in respect to Ground 1)	East	07/22/09	1
Freshwater 1	West	07/22/09	1
Freshwater 1	East	07/22/09	1
Saltwater 1	East	07/22/09	1
Saltwater 2	East	07/22/09	1

Freshwater 1	West	07/22/09	1
Freshwater 2	West	07/22/09	1
Ground 1	East	07/22/09	1
Ground 2	East	07/22/09	1
Sky 6:55 pm	North	07/22/09	1
End of Day 1	West	07/22/09	1
End of Day 1	North	07/22/09	1
Locked up, End of Day 1	East	07/22/09	1
Bug in Freshwater 1's water pool, east side	West	07/23/09	1
Saltwater 1	East	07/23/09	1
Saltwater 1	North	07/23/09	1
Saltwater 1	West	07/23/09	1
Saltwater 1	South	07/23/09	1
Saltwater 2	East	07/23/09	1
Saltwater 2	South	07/23/09	1
Saltwater 2	West	07/23/09	1
Freshwater 2	East	07/23/09	1
Freshwater 2	South	07/23/09	1
Freshwater 2	West	07/23/09	1
Freshwater 1	West	07/23/09	1
Freshwater 1	North	07/23/09	1
Freshwater 1	East	07/23/09	1
Freshwater 1 close up belly		07/23/09	1
Ground 1	East	07/23/09	1
Ground 1	South	07/23/09	1
Ground 1	West	07/23/09	1
Ground 1	North	07/23/09	1
Ground 1 face		07/23/09	1
Ground 1 nose		07/23/09	1
Ground 2	East	07/23/09	1
Ground 2	South	07/23/09	1
Ground 2	West	07/23/09	1
Ground 2	North	07/23/09	1
Ground 2 close face	West	07/23/09	1
Ground 2 close belly	West	07/23/09	1
Ground 2 close crotch	West	07/23/09	1
Ground 1 close up right armpit	West	07/23/09	1
Ground 2 close left armpit	East	07/23/09	1

Saltwater 1 blood bubble	East	07/23/09	2
Saltwater 1 in basket	East	07/23/09	2
Saltwater 1	East	07/23/09	2
Saltwater 1	North	07/23/09	2
Saltwater 1	West	07/23/09	2
Saltwater 2	East	07/23/09	2
Saltwater 2	South	07/23/09	2
Saltwater 2	West	07/23/09	2
Saltwater 2 close up on film	East	07/23/09	2
Freshwater 2	South	07/23/09	2
Freshwater 2	West	07/23/09	2
Freshwater 2	East	07/23/09	2
Freshwater 2 close up		07/23/09	2
Freshwater 1	West	07/23/09	2
Freshwater 1	North	07/23/09	2
Freshwater 1	East	07/23/09	2
Freshwater 1 face		07/23/09	2
Freshwater 1 bowel		07/23/09	2
Freshwater 1 chest		07/23/09	2
Ground 1	East	07/23/09	2
Ground 1	South	07/23/09	2
Ground 1	West	07/23/09	2
Ground 1	North	07/23/09	2
Ground 1 face		07/23/09	2
Ground 1 ants	West	07/23/09	2
Ground 2	East	07/23/09	2
Ground 2	South	07/23/09	2
Ground 2	West	07/23/09	2
Ground 2	North	07/23/09	2
Ground 2 face		07/23/09	2
Ground 2 flies		07/23/09	2
Ground 2 crotch		07/23/09	2
Ground 2 marbling	East	07/23/09	2
Ground 2 marbling	East	07/23/09	2
Saltwater 1	East	07/24/09	1
Saltwater 1	North	07/24/09	1
Saltwater 1	West	07/24/09	1
Saltwater 1 close up		07/24/09	1
Saltwater 1 close up		07/24/09	1

Saltwater 2	East	07/24/09	1
Saltwater 2	South	07/24/09	1
Saltwater 2	West	07/24/09	1
Saltwater 2 close up		07/24/09	1
Freshwater 2	East	07/24/09	1
Freshwater 2	South	07/24/09	1
Freshwater 2	West	07/24/09	1
Freshwater 2 close	West	07/24/09	1
Freshwater 1	West	07/24/09	1
Freshwater 1	North	07/24/09	1
Freshwater 1	East	07/24/09	1
Freshwater 1 face		07/24/09	1
Freshwater 1 bowel	North	07/24/09	1
Freshwater 1 bowel	West	07/24/09	1
Ground 2	East	07/24/09	1
Ground 2	South	07/24/09	1
Ground 2	West	07/24/09	1
Ground 2	North	07/24/09	1
Ground 1	East	07/24/09	1
Ground 1	South	07/24/09	1
Ground 1	West	07/24/09	1
Ground 1	North	07/24/09	1
Ground 2 marbling	East	07/24/09	1
Freshwater 1 from door	East	07/24/09	2
Freshwater 1 from door	East	07/24/09	2
Saltwater 1	East	07/24/09	2
Saltwater 1	North	07/24/09	2
Saltwater 1	West	07/24/09	2
Saltwater 2	East	07/24/09	2
Saltwater 2	South	07/24/09	2
Saltwater 2	West	07/24/09	2
Saltwater 2 face	East	07/24/09	2
Freshwater 2	East	07/24/09	2
Freshwater 2	South	07/24/09	2
Freshwater 2	West	07/24/09	2
Freshwater 2 bowel		07/24/09	2
Freshwater 2 blood		07/24/09	2
Freshwater 1	South	07/24/09	2
Freshwater 1	West	07/24/09	2

Freshwater 1	North	07/24/09	2
Freshwater 1	East	07/24/09	2
Freshwater 1 arm skin	North	07/24/09	2
Freshwater 1 bowel	North	07/24/09	2
Ground 1	East	07/24/09	2
Ground 1	South	07/24/09	2
Ground 1	West	07/24/09	2
Ground 1	North	07/24/09	2
Ground 1 ants	North	07/24/09	2
Ground 1 flies	North	07/24/09	2
Ground 1 ants in eye	North	07/24/09	2
Ground 1 ants close up	North	07/24/09	2
Ground 1 flies	South	07/24/09	2
Ground 1 flies close	South	07/24/09	2
Ground 2	East	07/24/09	2
Ground 2	South	07/24/09	2
Ground 2	West	07/24/09	2
Ground 2	North	07/24/09	2
Ground 2 face	North	07/24/09	2
Ground 2 eye close up	North	07/24/09	2
Ground 2 blood and insects	South	07/24/09	2
Ground 2 marbling	East	07/24/09	2
Freshwater 1 intestines	East	07/24/09	2
Saltwater 1 skin bubble	East	07/24/09	2
Ground 1 from outside pen	West	07/24/09	2
Bug on Saltwater 1's right leg	South	07/25/09	1
Close on bug on Saltwater 1's right leg	South	07/25/09	1
Saltwater 1	East	07/25/09	1
Saltwater 1	North	07/25/09	1
Saltwater 1	West	07/25/09	1
Saltwater 1 film	East	07/25/09	1
Saltwater 2	East	07/25/09	1
Saltwater 2	South	07/25/09	1
Saltwater 2	West	07/25/09	1
Saltwater 2	East	07/25/09	1
Saltwater 2	East	07/25/09	1
Freshwater 2	East	07/25/09	1
Freshwater 2	South	07/25/09	1

Freshwater 2	West	07/25/09	1
Freshwater 2 intestines	West	07/25/09	1
Freshwater 2 mouth	West	07/25/09	1
Freshwater 2 mouth	West	07/25/09	1
Freshwater 2 intestines	North	07/25/09	1
Freshwater 1	West	07/25/09	1
Freshwater 1	North	07/25/09	1
Freshwater 1	East	07/25/09	1
Freshwater 1 arm skin	North	07/25/09	1
Freshwater 1 stomach deflated	North	07/25/09	1
Freshwater 1 bowel	West	07/25/09	1
Ground 1	East	07/25/09	1
Ground 1	South	07/25/09	1
Ground 1	West	07/25/09	1
Ground 1	North	07/25/09	1
Ground 1 close skin bubble	West	07/25/09	1
Ground 1 close maggots	West	07/25/09	1
Ground 1 close maggots	West	07/25/09	1
Ground 1 zoom out maggots	West	07/25/09	1
Ground 1 maggots pectoral	West	07/25/09	1
Ground 2	East	07/25/09	1
Ground 2	South	07/25/09	1
Ground 2	West	07/25/09	1
Ground 2	North	07/25/09	1
Ground 2 mouth close	North	07/25/09	1
Ground 2 mouth close maggots	North	07/25/09	1
Ground 2 mouth maggots and ants	North	07/25/09	1
Saltwater 1	East	07/25/09	2
Saltwater 1	North	07/25/09	2
Saltwater 1	West	07/25/09	2
Saltwater 1 skin bubble	North	07/25/09	2
Saltwater 2	East	07/25/09	2
Saltwater 2	South	07/25/09	2
Saltwater 2	West	07/25/09	2
Saltwater 2 close arm	South	07/25/09	2
Freshwater 2	South	07/25/09	2
Freshwater 2	West	07/25/09	2
Freshwater 2	East	07/25/09	2
Freshwater 2 close blood/flies	South	07/25/09	2

Freshwater 2 close blood/flies/face	South	07/25/09	2
Freshwater 2 intestines flies	South	07/25/09	2
Freshwater 2 intestines flies	South	07/25/09	2
Freshwater 1	West	07/25/09	2
Freshwater 1	North	07/25/09	2
Freshwater 1	East	07/25/09	2
Freshwater 1	North	07/25/09	2
Freshwater 1	North	07/25/09	2
Ground 1	East	07/25/09	2
Ground 1	South	07/25/09	2
Ground 1	West	07/25/09	2
Ground 1	North	07/25/09	2
Ground 1 close maggots	West	07/25/09	2
Ground 1 close maggots forearm	West	07/25/09	2
Ground 1 belly ants/maggots	West	07/25/09	2
Ground 1 close maggots hindlegs	West	07/25/09	2
Ground 1 close maggots hindlegs	West	07/25/09	2
Ground 1 close maggots anal	South	07/25/09	2
Ground 1 close maggots anal	South	07/25/09	2
Ground 2	East	07/25/09	2
Ground 2	South	07/25/09	2
Ground 2	West	07/25/09	2
Ground 2	North	07/25/09	2
Ground 2 close face ants	West	07/25/09	2
Ground 2 close necks ants	West	07/25/09	2
Ground 2 face close	West	07/25/09	2
Ground 2 close maggots belly	West	07/25/09	2
Ground 2 close maggots belly	West	07/25/09	2
Saltwater 1	East	07/26/09	1
Saltwater 1	North	07/26/09	1
Saltwater 1	West	07/26/09	1
Saltwater 1 skin bubble	East	07/26/09	1
Saltwater 2	East	07/26/09	1
Saltwater 2	South	07/26/09	1
Saltwater 2	West	07/26/09	1
Freshwater 2	South	07/26/09	1
Freshwater 2	West	07/26/09	1
Freshwater 2	East	07/26/09	1
Freshwater 1	West	07/26/09	1

Freshwater 1	North	07/26/09	1
Freshwater 1	East	07/26/09	1
Freshwater 1 bowel	North	07/26/09	1
Freshwater 1 arm skin	North	07/26/09	1
Freshwater 1 bowel maggots	North	07/26/09	1
Freshwater 1 bowel maggots	West	07/26/09	1
Freshwater 2 arm maceration	West	07/26/09	1
Ground 1	East	07/26/09	1
Ground 1	South	07/26/09	1
Ground 1	West	07/26/09	1
Ground 1	North	07/26/09	1
Ground 1 back maggots	East	07/26/09	1
Ground 1 butt maggots	South	07/26/09	1
Ground 1 close butt maggots	South	07/26/09	1
Ground 1 right leg	East	07/26/09	1
Ground 1 right leg	East	07/26/09	1
Ground 1 right leg zoom out	South	07/26/09	1
Ground 2	East	07/26/09	1
Ground 2	South	07/26/09	1
Ground 2	West	07/26/09	1
Ground 2	North	07/26/09	1
Ground 2 mouth close	North	07/26/09	1
Ground 2 stomach close	West	07/26/09	1
Ground 2 right leg	South	07/26/09	1
Ground 2 right leg close	South	07/26/09	1
Ground 2 back close	East	07/26/09	1
Saltwater 1	East	07/26/09	2
Saltwater 1	North	07/26/09	2
Saltwater 1	West	07/26/09	2
Saltwater 1 close left arm	East	07/26/09	2
Saltwater 2	East	07/26/09	2
Saltwater 2	South	07/26/09	2
Saltwater 2	West	07/26/09	2
Saltwater 2 close side bloating	East	07/26/09	2
Freshwater 2	East	07/26/09	2
Freshwater 2	South	07/26/09	2
Freshwater 2 close bowel	South	07/26/09	2
Freshwater 2 close flies right side	South	07/26/09	2
Freshwater 2 close bowel	West	07/26/09	2

Freshwater 2	West	07/26/09	2
Freshwater 2 close maceration left arm	East	07/26/09	2
Freshwater 2 maceration left arm	South	07/26/09	2
Freshwater 2 close left arm	South	07/26/09	2
Freshwater 2 close left arm	South	07/26/09	2
Freshwater 1	West	07/26/09	2
Freshwater 1	North	07/26/09	2
Freshwater 1	East	07/26/09	2
Freshwater 1 face missing	North	07/26/09	2
Freshwater 1 maggots bowel	West	07/26/09	2
Freshwater 1 close maggots bowel	West	07/26/09	2
Ground 1	East	07/26/09	2
Ground 1	South	07/26/09	2
Ground 1	North	07/26/09	2
Ground 1	West	07/26/09	2
Ground 1 close belly	West	07/26/09	2
Ground 1 close hind legs	South	07/26/09	2
Ground 1 close left hind	South	07/26/09	2
Ground 1 dead maggots back	East	07/26/09	2
Ground 1 dead maggots back	East	07/26/09	2
Ground 1 dead maggots back	East	07/26/09	2
Ground 1 close neck	aerial east	07/26/09	2
Ground 2	East	07/26/09	2
Ground 2	South	07/26/09	2
Ground 2	North	07/26/09	2
Ground 2	West	07/26/09	2
Ground 2 right leg	West	07/26/09	2
Ground 2 back close	East	07/26/09	2
Ground 2 close ants left belly	East	07/26/09	2
Ground 2 close ants right forearm	East	07/26/09	2
bug on Saltwater 1's right forearm	South	07/27/09	1
Saltwater 1	East	07/27/09	1
Saltwater 1	North	07/27/09	1
Saltwater 1	West	07/27/09	1
Saltwater 1 head missing	North	07/27/09	1
Saltwater 2 head missing	North	07/27/09	1
Saltwater 2	East	07/27/09	1

Saltwater 2	South	07/27/09	1
Saltwater 2	West	07/27/09	1
Saltwater 2 side ballooned	East	07/27/09	1
Freshwater 2	East	07/27/09	1
Freshwater 2	South	07/27/09	1
Freshwater 2	West	07/27/09	1
Freshwater 2 head maggots	North	07/27/09	1
Freshwater 2 intestines packed with eggs	West	07/27/09	1
Freshwater 2 skeletonization right side	South	07/27/09	1
Freshwater 2 skeletonization left side	South	07/27/09	1
Freshwater 2 skeletonization chin	South	07/27/09	1
Freshwater 1	West	07/27/09	1
Freshwater 1	North	07/27/09	1
Freshwater 1	East	07/27/09	1
Freshwater 1 top of abdominal cavity (south)	North	07/27/09	1
Freshwater 1 arm skin	North	07/27/09	1
Freshwater 1 head missing	North	07/27/09	1
Freshwater 1 maggot mass	South	07/27/09	1
Freshwater 1 maggot mass	South	07/27/09	1
Freshwater 1 maggot mass	West	07/27/09	1
Ground 1	East	07/27/09	1
Ground 1	South	07/27/09	1
Ground 1	West	07/27/09	1
Ground 1	North	07/27/09	1
Ground 1 north of left ear	South	07/27/09	1
Ground 1 hindquarters	East	07/27/09	1
Ground 1 north of left arm	South	07/27/09	1
Ground 1 maggot mass stomach	West	07/27/09	1
Ground 1 maggot mass stomach	West	07/27/09	1
Ground 2	East	07/27/09	1
Ground 2	South	07/27/09	1
Ground 2	West	07/27/09	1
Ground 2	North	07/27/09	1
Ground 2 under right arm	West	07/27/09	1
Ground 2 under right arm	West	07/27/09	1
Ground 2 south of right leg	West	07/27/09	1

Ground 2 hindquarters	South	07/27/09	1
Ground 2 west side	East	07/27/09	1
Saltwater 1 bug on arm	East	07/27/09	2
Saltwater 1	East	07/27/09	2
Saltwater 1	North	07/27/09	2
Saltwater 1	West	07/27/09	2
Saltwater 1 head missing	North	07/27/09	2
Saltwater 2	East	07/27/09	2
Saltwater 2	South	07/27/09	2
Saltwater 2	West	07/27/09	2
Saltwater 2 head missing	North	07/27/09	2
Freshwater 2	East	07/27/09	2
Freshwater 2	South	07/27/09	2
Freshwater 2	West	07/27/09	2
Freshwater 2 intestines packed with eggs	West	07/27/09	2
Freshwater 2 right side	South	07/27/09	2
Freshwater 2 head maggots	South	07/27/09	2
Freshwater 2 left arm	South	07/27/09	2
Freshwater 2 left arm close	South	07/27/09	2
Freshwater 2 left arm	South	07/27/09	2
Freshwater 2 head/neck	West	07/27/09	2
Freshwater 2 head/neck close	West	07/27/09	2
Freshwater 1	West	07/27/09	2
Freshwater 1	North	07/27/09	2
Freshwater 1	East	07/27/09	2
Freshwater 1 head missing	North	07/27/09	2
Freshwater 1 arm skin maggots	North	07/27/09	2
Freshwater 1 arm skin maggots	North	07/27/09	2
Freshwater 1 arm skin maggots	North	07/27/09	2
Freshwater 1 maggots right side	East	07/27/09	2
Freshwater 1 maggots abdomen	East	07/27/09	2
Freshwater 1 lower half	North	07/27/09	2
Freshwater 1 maggots left side	North	07/27/09	2
Ground 1	East	07/27/09	2
Ground 1	South	07/27/09	2
Ground 1	West	07/27/09	2
Ground 1	North	07/27/09	2
Ground 1 behind left ear	South	07/27/09	2

Ground 1 behind left ear	North	07/27/09	2
Ground 1 dead maggots back	East	07/27/09	2
Ground 1 hindquarters	East	07/27/09	2
Ground 1 stomach	West	07/27/09	2
Ground 1 stomach	West	07/27/09	2
Ground 2	East	07/27/09	2
Ground 2	South	07/27/09	2
Ground 2	West	07/27/09	2
Ground 2	North	07/27/09	2
Ground 2 head	North	07/27/09	2
Ground 2 dead maggots stomach	West	07/27/09	2
Ground 2 right leg	South	07/27/09	2
Ground 2 hindquarters	South	07/27/09	2
Ground 2 dead maggots back	East	07/27/09	2
Ground 2 ants right side of neck	North	07/27/09	2
Ground 2 ants right side of neck close	North	07/27/09	2
Saltwater 1	East	07/28/09	1
Saltwater 1	North	07/28/09	1
Saltwater 1	West	07/28/09	1
Bug on Saltwater 1's right leg	North	07/28/09	1
bug on Saltwater 1's right leg close	North	07/28/09	1
Film on Saltwater 1	East	07/28/09	1
Saltwater 2	East	07/28/09	1
Saltwater 2	South	07/28/09	1
Saltwater 2	West	07/28/09	1
Saltwater 2 head missing	North	07/28/09	1
Freshwater 2	East	07/28/09	1
Freshwater 2	South	07/28/09	1
Freshwater 2	West	07/28/09	1
Freshwater 2 close intestines	South	07/28/09	1
Freshwater 2 close intestines	South	07/28/09	1
Freshwater 2 close intestines	South	07/28/09	1
Freshwater 2 chest cavity	South	07/28/09	1
Freshwater 2 chest cavity and head	South	07/28/09	1
Freshwater 2 chest (sun)	West	07/28/09	1
Freshwater 2 close ribs/maggots	South	07/28/09	1
Freshwater 2 crotch	South	07/28/09	1
Freshwater 1	West	07/28/09	1
Freshwater 1	North	07/28/09	1

Freshwater 1	East	07/28/09	1
Freshwater 1 right side of abdomen (east)	East	07/28/09	1
Freshwater 1 right leg	East	07/28/09	1
Freshwater 1 left leg	East	07/28/09	1
Freshwater 1 ribs (west)	East	07/28/09	1
Freshwater 1 head missing	North	07/28/09	1
Freshwater 1 right arm	East	07/28/09	1
Freshwater 1 head missing	North	07/28/09	1
Freshwater 1 head missing	North	07/28/09	1
Freshwater 1 head missing	South	07/28/09	1
Freshwater 1 head missing close	South	07/28/09	1
Ground 1	East	07/28/09	1
Ground 1	South	07/28/09	1
Ground 1	West	07/28/09	1
Ground 1	North	07/28/09	1
Ground 1 abdomen	West	07/28/09	1
Ground 1 hindquarters	West	07/28/09	1
Ground 1 hindquarters	South	07/28/09	1
Ground 2	East	07/28/09	1
Ground 2	South	07/28/09	1
Ground 2	West	07/28/09	1
Ground 2	North	07/28/09	1
Ground 2	North	07/28/09	1
Ground 2 abdomen	West	07/28/09	1
Ground 2 hindquarters	South	07/28/09	1
personal photo		07/28/09	1
personal photo		07/28/09	1
personal photo		07/28/09	1
personal photo		07/28/09	1
Bug on Saltwater 1's right leg	East	07/28/09	2
Saltwater 1	East	07/28/09	2
Saltwater 1	North	07/28/09	2
Saltwater 1	West	07/28/09	2
Saltwater 1 head missing	South	07/28/09	2
Saltwater 1 head missing close	South	07/28/09	2
bee in Saltwater 2's tub	East	07/28/09	2
Saltwater 2	East	07/28/09	2
Saltwater 2	South	07/28/09	2

Saltwater 2	West	07/28/09	2
Freshwater 2	South	07/28/09	2
Freshwater 2	West	07/28/09	2
Freshwater 2	East	07/28/09	2
Freshwater 2 abdomen west side	South	07/28/09	2
Freshwater 2 chest cavity	South	07/28/09	2
Freshwater 2 head maggots	South	07/28/09	2
Freshwater 2 right side	North	07/28/09	2
Freshwater 2 maggots crawling on side of tubs	East	07/28/09	2
Freshwater 2 maggots crawling on side of tubs	West	07/28/09	2
Freshwater 2 maggots head	North	07/28/09	2
Freshwater 2 maggots head blurry	North	07/28/09	2
Freshwater 2 maggots head west	North	07/28/09	2
Freshwater 2 maggots head	North	07/28/09	2
Freshwater 2 right arm	North	07/28/09	2
Freshwater 2 righ arm	North	07/28/09	2
Freshwater 2 left leg slippage blurry	North	07/28/09	2
Freshwater 2 right leg slippage	North	07/28/09	2
Freshwater 1	West	07/28/09	2
Freshwater 1	North	07/28/09	2
Freshwater 1	East	07/28/09	2
Freshwater 1 chest cavity verts visible	East	07/28/09	2
Freshwater 1 ribs (west)	East	07/28/09	2
Freshwater 1 right arm	East	07/28/09	2
Freshwater 1 left leg	East	07/28/09	2
Freshwater 1 right leg	East	07/28/09	2
Freshwater 1 right leg skin slippage	East	07/28/09	2
Ground 1	East	07/28/09	2
Ground 1	South	07/28/09	2
Ground 1	West	07/28/09	2
Ground 1	North	07/28/09	2
Ground 2	East	07/28/09	2
Ground 2	South	07/28/09	2
Ground 2	West	07/28/09	2
Ground 2	North	07/28/09	2
Ground 2 back	East	07/28/09	2
Ground 1 hindquarters	South	07/28/09	2

Ground 2 hindquarters	South	07/28/09	2
Ground 2 ants right side of neck	North	07/28/09	2
Saltwater 1	East	07/29/09	1
Saltwater 1	North	07/29/09	1
Saltwater 1	West	07/29/09	1
Saltwater 1 bugs	North	07/29/09	1
Saltwater 1 head missing	East	07/29/09	1
Saltwater 2	East	07/29/09	1
Saltwater 2	South	07/29/09	1
Saltwater 2	West	07/29/09	1
Freshwater 2	East	07/29/09	1
Freshwater 2	South	07/29/09	1
Freshwater 2	West	07/29/09	1
Freshwater 2 chest cavity	South	07/29/09	1
Freshwater 2 hindquarters	South	07/29/09	1
Freshwater 2 left arm	South	07/29/09	1
Freshwater 2 right arm	South	07/29/09	1
Freshwater 2 head	West	07/29/09	1
Freshwater 2 right arm	West	07/29/09	1
Freshwater 2 chest cavity	West	07/29/09	1
Freshwater 1	West	07/29/09	1
Freshwater 1	North	07/29/09	1
Freshwater 1	East	07/29/09	1
Freshwater 1 hindquarters	East	07/29/09	1
Freshwater 1 chest cavity verts visible	East	07/29/09	1
Freshwater 1 ribs	North	07/29/09	1
Freshwater 1 left arm	North	07/29/09	1
Freshwater 1 head missing	North	07/29/09	1
Freshwater 1 head missing	North	07/29/09	1
Freshwater 1 chest	West	07/29/09	1
Freshwater 1 right arm	East	07/29/09	1
Freshwater 1 right leg	East	07/29/09	1
Freshwater 1 left leg	East	07/29/09	1
Freshwater 1 ribs	South	07/29/09	1
Ground 1	East	07/29/09	1
Ground 1	South	07/29/09	1
Ground 1	West	07/29/09	1
Ground 1	North	07/29/09	1
Ground 2	East	07/29/09	1

Ground 2	South	07/29/09	1
Ground 2	West	07/29/09	1
Ground 2	North	07/29/09	1
Ground 1	East	07/29/09	2
Ground 1	South	07/29/09	2
Ground 1	West	07/29/09	2
Ground 1	North	07/29/09	2
Ground 1 hindquarters	South	07/29/09	2
Ground 2	East	07/29/09	2
Ground 2	South	07/29/09	2
Ground 2	West	07/29/09	2
Ground 2	North	07/29/09	2
Ground 2 hindquarters	South	07/29/09	2
Ground 2 chest where left arm rests	South	07/29/09	2
Saltwater 2	East	07/29/09	2
Saltwater 2	South	07/29/09	2
Saltwater 2	West	07/29/09	2
Live maggots on bottom of Freshwater 2's tub	East	07/29/09	2
Live maggots on bottom of Freshwater 2's tub	East	07/29/09	2
Freshwater 2	East	07/29/09	2
Freshwater 2	South	07/29/09	2
Freshwater 2	West	07/29/09	2
Freshwater 2 left leg	South	07/29/09	2
Freshwater 2 right leg	South	07/29/09	2
Freshwater 2 crotch	South	07/29/09	2
Freshwater 2 crotch	South	07/29/09	2
Freshwater 2 chest cavity	South	07/29/09	2
Freshwater 2 left arm	South	07/29/09	2
Freshwater 2 right arm	South	07/29/09	2
Freshwater 2 chest cavity	West	07/29/09	2
Freshwater 2 head	West	07/29/09	2
Freshwater 1	West	07/29/09	2
Freshwater 1	North	07/29/09	2
Freshwater 1	East	07/29/09	2
Freshwater 1 hindquarters	North	07/29/09	2
Freshwater 1 head	North	07/29/09	2
Freshwater 1 left arm	North	07/29/09	2

Freshwater 1 right arm	North	07/29/09		2
Freshwater 1 hindquarter and chest	North	07/29/09		2
Freshwater 1 maggots at bottom of tub	West	07/29/09		2
Freshwater 1 maggots at bottom of tub	West	07/29/09		2
Saltwater 1	West	07/29/09		2
Saltwater 1	North	07/29/09		2
Saltwater 1	East	07/29/09		2
water refilling in Saltwater 2's	South	07/29/09		2
Saltwater 1	East	07/30/09	N/A	
Saltwater 1	North	07/30/09	N/A	
Saltwater 1	West	07/30/09	N/A	
Saltwater 2	East	07/30/09	N/A	
Saltwater 2	South	07/30/09	N/A	
Saltwater 2	West	07/30/09	N/A	
Freshwater 2	East	07/30/09	N/A	
Freshwater 2	South	07/30/09	N/A	
Freshwater 2	West	07/30/09	N/A	
Freshwater 2 hindquarters	South	07/30/09	N/A	
Freshwater 2 chest	South	07/30/09	N/A	
Freshwater 2 chest close	South	07/30/09	N/A	
Freshwater 2 head	South	07/30/09	N/A	
Freshwater 2 right arm	South	07/30/09	N/A	
Freshwater 2 left arm	South	07/30/09	N/A	
Freshwater 1	West	07/30/09	N/A	
Freshwater 1	North	07/30/09	N/A	
Freshwater 1	East	07/30/09	N/A	
Freshwater 1 close verts	East	07/30/09	N/A	
Freshwater 1 close skin patch	East	07/30/09	N/A	
Freshwater 1 skin patch north end	North	07/30/09	N/A	
Freshwater 1 dead maggots by pump	North	07/30/09	N/A	
Ground 1	East	07/30/09	N/A	
Ground 1	South	07/30/09	N/A	
Ground 1	West	07/30/09	N/A	
Ground 1	North	07/30/09	N/A	
Ground 1 hole by left arm close	North	07/30/09	N/A	
Ground 1 abdomen	West	07/30/09	N/A	
Ground 1 hindquarters	South	07/30/09	N/A	

Ground 2	East	07/30/09	N/A
Ground 2	South	07/30/09	N/A
Ground 2	West	07/30/09	N/A
Ground 2	North	07/30/09	N/A
Ground 2	West	07/30/09	N/A
Ground 2 hindquarters	South	07/30/09	N/A
Ground 2 west side	East	07/30/09	N/A
Freshwater 2 right leg close	South	07/30/09	N/A
Saltwater 1	East	07/31/09	N/A
Saltwater 1	North	07/31/09	N/A
Saltwater 1	West	07/31/09	N/A
Saltwater 1 hindquarters	North	07/31/09	N/A
Saltwater 1 head	North	07/31/09	N/A
Saltwater 2	East	07/31/09	N/A
Saltwater 2	South	07/31/09	N/A
Saltwater 2	West	07/31/09	N/A
Saltwater 2 hindquarters	East	07/31/09	N/A
Saltwater 2 head	East	07/31/09	N/A
Freshwater 2	East	07/31/09	N/A
Freshwater 2	South	07/31/09	N/A
Freshwater 2	West	07/31/09	N/A
Freshwater 2 hindquarters	South	07/31/09	N/A
Freshwater 2 chest	South	07/31/09	N/A
Freshwater 2 head	South	07/31/09	N/A
Freshwater 2 live maggots outside of tub	East	07/31/09	N/A
Freshwater 2 left leg	South	07/31/09	N/A
Freshwater 1	East	07/31/09	N/A
Freshwater 1	North	07/31/09	N/A
Freshwater 1	West	07/31/09	N/A
Freshwater 1 north end of tub	North	07/31/09	N/A
Ground 1	East	07/31/09	N/A
Ground 1	South	07/31/09	N/A
Ground 1	West	07/31/09	N/A
Ground 1	North	07/31/09	N/A
Ground 1 behind left ear	South	07/31/09	N/A
Ground 1 hindquarters	South	07/31/09	N/A
Ground 1 abdomen	West	07/31/09	N/A
Ground 1 left leg	southeast	07/31/09	N/A

Ground 2	East	07/31/09	N/A
Ground 2	South	07/31/09	N/A
Ground 2	West	07/31/09	N/A
Ground 2	North	07/31/09	N/A
Ground 2 left shoulder maceration	East	07/31/09	N/A
Ground 2 left shoulder maceration	East	07/31/09	N/A
Ground 2 left hindquarter	East	07/31/09	N/A
Ground 2 hindquarters	South	07/31/09	N/A
Ground 2 hindquarters close	South	07/31/09	N/A
Ground 2 right leg	South	07/31/09	N/A
Saltwater 1	East	08/01/09	N/A
Saltwater 1	North	08/01/09	N/A
Saltwater 1	West	08/01/09	N/A
Saltwater 1 hindquarters	North	08/01/09	N/A
Saltwater 1 head	North	08/01/09	N/A
Saltwater 2	East	08/01/09	N/A
Saltwater 2	South	08/01/09	N/A
Saltwater 2	West	08/01/09	N/A
vertebra floating in Saltwater 2 tank	West	08/01/09	N/A
Saltwater 2 hindquarters	East	08/01/09	N/A
Saltwater 2 head	East	08/01/09	N/A
Freshwater 2	East	08/01/09	N/A
Freshwater 2	South	08/01/09	N/A
Freshwater 2	West	08/01/09	N/A
Freshwater 2 hindquarters	South	08/01/09	N/A
Freshwater 2 chest	South	08/01/09	N/A
Freshwater 1	East	08/01/09	N/A
Freshwater 1	South	08/01/09	N/A
Freshwater 1	West	08/01/09	N/A
Freshwater 1 close	South	08/01/09	N/A
Ground 1	East	08/01/09	N/A
Ground 1	South	08/01/09	N/A
Ground 1	West	08/01/09	N/A
Ground 1	North	08/01/09	N/A
Ground 1 hindquarters	South	08/01/09	N/A
Ground 1 abdomen	South	08/01/09	N/A
Ground 1 head	South	08/01/09	N/A
Ground 2	East	08/01/09	N/A
Ground 2	South	08/01/09	N/A

Ground 2	West	08/01/09	N/A
Ground 2	North	08/01/09	N/A
Ground 2 hindquarters	South	08/01/09	N/A
Ground 2 chest	South	08/01/09	N/A
Ground 2 head	South	08/01/09	N/A
Freshwater 1 basket broad	West	08/01/09	N/A
Freshwater 1 basket top left	West	08/01/09	N/A
Freshwater 1 basket middle center	West	08/01/09	N/A
Freshwater 1 basket bottom middle	West	08/01/09	N/A
Freshwater 1 basket top middle	West	08/01/09	N/A
Freshwater 1 basket top right	West	08/01/09	N/A
Freshwater 1 tank basket returned	West	08/01/09	N/A
Ground 1 left leg	southeast	08/01/09	N/A
Freshwater 1 basket broad	West	08/02/09	N/A
Freshwater 1 basket top left	West	08/02/09	N/A
Freshwater 1 basket bottom left	West	08/02/09	N/A
Freshwater 1 basket bottom middle	West	08/02/09	N/A
Freshwater 1 basket bottom right	West	08/02/09	N/A
Freshwater 1 basket top right	West	08/02/09	N/A
Freshwater 1 basket top middle	West	08/02/09	N/A
Freshwater 1 basket middle left	West	08/02/09	N/A
Freshwater 1 basket top left	West	08/02/09	N/A
Saltwater 1	East	08/02/09	N/A
Saltwater 1	North	08/02/09	N/A
Saltwater 1	West	08/02/09	N/A
Saltwater 2	East	08/02/09	N/A
Saltwater 2	South	08/02/09	N/A
Saltwater 2	West	08/02/09	N/A
Saltwater 2 phalange floating middle of tank	East	08/02/09	N/A
Saltwater 2 phalange floating west side of tank	East	08/02/09	N/A
Freshwater 2	East	08/02/09	N/A
Freshwater 2	South	08/02/09	N/A
Freshwater 2	West	08/02/09	N/A
Freshwater 2	West	08/02/09	N/A
Freshwater 2 hindquarters	South	08/02/09	N/A
Freshwater 2 chest	South	08/02/09	N/A
Freshwater 2 head	South	08/02/09	N/A

Freshwater 1 tank basket returned	West	08/02/09	N/A
Ground 1	East	08/02/09	N/A
Ground 1	South	08/02/09	N/A
Ground 1	West	08/02/09	N/A
Ground 1	North	08/02/09	N/A
Ground 1 hindquarters	South	08/02/09	N/A
Ground 1 torso/head	South	08/02/09	N/A
Ground 2	East	08/02/09	N/A
Ground 2	South	08/02/09	N/A
Ground 2	West	08/02/09	N/A
Ground 2	North	08/02/09	N/A
Ground 2 hindquarters	South	08/02/09	N/A
Ground 2 torso/head	South	08/02/09	N/A
Saltwater 1	East	08/03/09	N/A
Saltwater 1	North	08/03/09	N/A
Saltwater 1	West	08/03/09	N/A
Saltwater 2	East	08/03/09	N/A
Saltwater 2	South	08/03/09	N/A
Saltwater 2	West	08/03/09	N/A
Where the bees were centrally located	East	08/03/09	N/A
Ground 1	East	08/03/09	N/A
Ground 1	North	08/03/09	N/A
Ground 1	West	08/03/09	N/A
Ground 1	South	08/03/09	N/A
Ground 2	North	08/03/09	N/A
Ground 2	West	08/03/09	N/A
Ground 2	South	08/03/09	N/A
Freshwater 2	West	08/03/09	N/A
Saltwater 1	East	08/05/09	N/A
Saltwater 1	North	08/05/09	N/A
Saltwater 1	West	08/05/09	N/A
Saltwater 2	East	08/05/09	N/A
Saltwater 2	South	08/05/09	N/A
Saltwater 2	West	08/05/09	N/A
Freshwater 2	East	08/05/09	N/A
Freshwater 2	South	08/05/09	N/A
Freshwater 2	West	08/05/09	N/A
Freshwater 1	West	08/05/09	N/A

No picture, can't rename (computer)	#VALUE!	08/05/09	N/A
Ground 1	East	08/05/09	N/A
Ground 1	South	08/05/09	N/A
Ground 1	West	08/05/09	N/A
Ground 1	North	08/05/09	N/A
Ground 1 hindquarters	South	08/05/09	N/A
Ground 1 hindquarters	South	08/05/09	N/A
Ground 1 chest/head	South	08/05/09	N/A
Ground 1 abdomen	South	08/05/09	N/A
Ground 2	East	08/05/09	N/A
Ground 2	South	08/05/09	N/A
Ground 2	West	08/05/09	N/A
Ground 2	North	08/05/09	N/A
Ground 2 hindquarters	South	08/05/09	N/A
Ground 2 head	South	08/05/09	N/A
Ground 2 abdomen	South	08/05/09	N/A
Bees in Freshwater 2's tub north end	East	08/05/09	N/A
Freshwater 1's bones (broad)	South	08/05/09	N/A
Freshwater 1's bones (close west side)	South	08/05/09	N/A
Freshwater 1's bones (close middle 1)	South	08/05/09	N/A
Freshwater 1's bones (close middle 2)	South	08/05/09	N/A
Freshwater 1's bones (close east side bottom)	South	08/05/09	N/A
Freshwater 1's bones (close east side top)	South	08/05/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
becca		08/06/09	N/A
Saltwater 1	East	08/06/09	N/A
Saltwater 1	North	08/06/09	N/A
Saltwater 1	West	08/06/09	N/A

Saltwater 2	East	08/06/09	N/A
Saltwater 2	South	08/06/09	N/A
Saltwater 2	South	08/06/09	N/A
Saltwater 2	West	08/06/09	N/A
Freshwater 2	East	08/06/09	N/A
Freshwater 2	South	08/06/09	N/A
Freshwater 2	West	08/06/09	N/A
Ground 1	East	08/06/09	N/A
Ground 1	South	08/06/09	N/A
Ground 1	North	08/06/09	N/A
Ground 1	West	08/06/09	N/A
Ground 2	East	08/06/09	N/A
Ground 2	South	08/06/09	N/A
Ground 2	North	08/06/09	N/A
Ground 2	West	08/06/09	N/A
Saltwater 1	East	08/07/09	N/A
Saltwater 1	North	08/07/09	N/A
Saltwater 1	West	08/07/09	N/A
Saltwater 2	East	08/07/09	N/A
Saltwater 2	South	08/07/09	N/A
Freshwater 2	South	08/07/09	N/A
Freshwater 2	West	08/07/09	N/A
Freshwater 2	East	08/07/09	N/A
Ground 1	East	08/07/09	N/A
Ground 1	South	08/07/09	N/A
Ground 1	South	08/07/09	N/A
Ground 1	West	08/07/09	N/A
Ground 1	North	08/07/09	N/A
Ground 2	East	08/07/09	N/A
Ground 2	South	08/07/09	N/A
Ground 2	West	08/07/09	N/A
Ground 2	North	08/07/09	N/A
Pan of water	East	08/08/09	N/A
Pan of sugar water	East	08/08/09	N/A
Pans	South	08/08/09	N/A
Pans in relation to pen	South	08/08/09	N/A
Saltwater 1	East	08/10/09	N/A
Saltwater 1	North		N/A
Saltwater 1	West		N/A

Saltwater 2	East		N/A
Saltwater 2	South		N/A
Saltwater 2	West		N/A
Saltwater 2	North		N/A
Freshwater 2	East		N/A
Freshwater 2	South		N/A
Freshwater 2	West		N/A
Freshwater 2 top half	North		N/A
Freshwater 2 hindquarters	North		N/A
Ground 1	East		N/A
Ground 1	South		N/A
Ground 1	West		N/A
Ground 1	North		N/A
Ground 2	East		N/A
Ground 2	South		N/A
Ground 2	West		N/A
Ground 2	North		N/A
Ground 2 hindquarters	North		N/A
Ground 2 torso/head	North		N/A
Ground 2 head	South		N/A
Ground 2 head	South		N/A
Ground 1 hindquarters	North		N/A
Ground 1 torso/head	North		N/A
Ground 1 head	South		N/A
Freshwater 1 processed	N/A	08/11/09	N/A
Freshwater 1 processed	N/A	08/11/09	N/A
Freshwater 1 processed	N/A	08/11/09	N/A
Freshwater 1 processed	N/A	08/11/09	N/A
Freshwater 1 processed	N/A	08/11/09	N/A
Freshwater 1 processed	N/A	08/11/09	N/A
Saltwater 1	East	08/12/09	N/A
Saltwater 1	North	08/12/09	N/A
Saltwater 1	West	08/12/09	N/A
Saltwater 2	East	08/12/09	N/A
Saltwater 2	South	08/12/09	N/A
Saltwater 2	West	08/12/09	N/A
Freshwater 2	South	08/12/09	N/A
Freshwater 2	East	08/12/09	N/A
Freshwater 2	West	08/12/09	N/A

Freshwater 2 sections (1 of 2)	North	08/12/09	N/A
Freshwater 2 sections (2 of 2)	North	08/12/09	N/A
Ground 1	East	08/12/09	N/A
Ground 1	South	08/12/09	N/A
Ground 1	West	08/12/09	N/A
Ground 1	North	08/12/09	N/A
Ground 2	East	08/12/09	N/A
Ground 2	South	08/12/09	N/A
Ground 2	West	08/12/09	N/A
Ground 2	North	08/12/09	N/A
No picture, can't rename (computer error)	N/A		N/A
Flies in Saltwater 1's pool	East	08/14/09	N/A
Saltwater 1	East	08/14/09	N/A
Saltwater 1	North	08/14/09	N/A
Saltwater 1	West	08/14/09	N/A
Saltwater 2	East	08/14/09	N/A
Saltwater 2	South	08/14/09	N/A
Saltwater 2	West	08/14/09	N/A
Freshwater 2	East	08/14/09	N/A
Freshwater 2	South	08/14/09	N/A
Freshwater 2	West	08/14/09	N/A
Ground 1	East	08/14/09	N/A
Ground 1	South	08/14/09	N/A
Ground 1	West	08/14/09	N/A
Ground 1	North	08/14/09	N/A
Ground 2	East	08/14/09	N/A
Ground 2	South	08/14/09	N/A
Ground 2	West	08/14/09	N/A
Ground 2	North	08/14/09	N/A
Freshwater 2	North	08/14/09	N/A
Freshwater 2	North	08/14/09	N/A
Saltwater 1	East	08/17/09	N/A
Saltwater 1	North	08/17/09	N/A
Saltwater 1	West	08/17/09	N/A
Saltwater 2	East	08/17/09	N/A
Saltwater 2	South	08/17/09	N/A
Saltwater 2	West	08/17/09	N/A
Freshwater 2	South	08/17/09	N/A

Freshwater 2	North	08/17/09	N/A
Freshwater 2 close hindquarters	North	08/17/09	N/A
Freshwater 2 close torso	North	08/17/09	N/A
Ground 1	East	08/17/09	N/A
Ground 1	South	08/17/09	N/A
Ground 1	West	08/17/09	N/A
Ground 1	North	08/17/09	N/A
Ground 1 close face	North	08/17/09	N/A
Ground 1 close right arm	North	08/17/09	N/A
Ground 1 close abdomen	North	08/17/09	N/A
Ground 2	East	08/17/09	N/A
Ground 2	South	08/17/09	N/A
Ground 2	West	08/17/09	N/A
Ground 2	North	08/17/09	N/A
Ground 2 close face	North	08/17/09	N/A
Ground 2 close left shoulder	South	08/17/09	N/A
Ground 2 hindquarters	South	08/17/09	N/A
Ground 2 close right leg	South	08/17/09	N/A
Ground 2 close right arm	South	08/17/09	N/A
Ground 2 close left shoulder	South	08/17/09	N/A
Freshwater 2	West	08/17/09	N/A
Freshwater 2	West	08/17/09	N/A
Saltwater 1	East	08/19/09	N/A
Saltwater 1	North	08/19/09	N/A
Saltwater 1	West	08/19/09	N/A
Saltwater 2	East	08/19/09	N/A
Saltwater 2	South	08/19/09	N/A
Saltwater 2	West	08/19/09	N/A
Freshwater 2	East	08/19/09	N/A
Freshwater 2	South	08/19/09	N/A
Freshwater 2	West	08/19/09	N/A
Ground 1	East	08/19/09	N/A
Ground 1	South	08/19/09	N/A
Ground 1	West	08/19/09	N/A
Ground 1	North	08/19/09	N/A
Ground 2	East	08/19/09	N/A
Ground 2	South	08/19/09	N/A
Ground 2	West	08/19/09	N/A
Ground 2	North	08/19/09	N/A

Ground 1 hindquarters aerial	South	08/19/09	N/A
Ground 1 abdomen aerial	South	08/19/09	N/A
Ground 1 head aerial	South	08/19/09	N/A
Ground 2 hindquarters aerial	South	08/19/09	N/A
Ground 2 abdomen aerial	South	08/19/09	N/A
Ground 2 head aerial	South	08/19/09	N/A
western skyline	West	08/21/09	N/A
Saltwater 1	East	08/21/09	N/A
Saltwater 1	North	08/21/09	N/A
Saltwater 1	West	08/21/09	N/A
Saltwater 2	East	08/21/09	N/A
Saltwater 2	South	08/21/09	N/A
Saltwater 2	West	08/21/09	N/A
Freshwater 2	East	08/21/09	N/A
Freshwater 2	South	08/21/09	N/A
Freshwater 2	West	08/21/09	N/A
Freshwater 2	North	08/21/09	N/A
Freshwater 2	North	08/21/09	N/A
Freshwater 2	North	08/21/09	N/A
Ground 1	East	08/21/09	N/A
Ground 1	South	08/21/09	N/A
Ground 1	West	08/21/09	N/A
Ground 1	North	08/21/09	N/A
Ground 2	East	08/21/09	N/A
Ground 2	South	08/21/09	N/A
Ground 2	West	08/21/09	N/A
Ground 2	North	08/21/09	N/A
Saltwater 2's water bubbling when refilled	East	08/21/09	N/A
Saltwater 1	East	08/24/09	N/A
Saltwater 1	North	08/24/09	N/A
Saltwater 1	West	08/24/09	N/A
Saltwater 1 close	West	08/24/09	N/A
Saltwater 2 close	East	08/24/09	N/A
Saltwater 2	East	08/24/09	N/A
Saltwater 2	South	08/24/09	N/A
Saltwater 2	West	08/24/09	N/A
Freshwater 2	East	08/24/09	N/A
Freshwater 2	South	08/24/09	N/A

Freshwater 2	West	08/24/09	N/A
Freshwater 2	North	08/24/09	N/A
Freshwater 2	North	08/24/09	N/A
Ground 1	East	08/24/09	N/A
Ground 1	South	08/24/09	N/A
Ground 1	West	08/24/09	N/A
Ground 1	North	08/24/09	N/A
Ground 1 close face	North	08/24/09	N/A
Ground 1 hindquarters	South	08/24/09	N/A
Ground 1 abdomen	South	08/24/09	N/A
Ground 1 toso	South	08/24/09	N/A
Ground 1 head	South	08/24/09	N/A
Ground 2	East	08/24/09	N/A
Ground 2	South	08/24/09	N/A
Ground 2	West	08/24/09	N/A
Ground 2	North	08/24/09	N/A
Ground 2 head close	North	08/24/09	N/A
Ground 2 hindquarters	South	08/24/09	N/A
Ground 2 abdomen	South	08/24/09	N/A
Ground 2 head	South	08/24/09	N/A
Ground 2 left shoulder maceration	South	08/24/09	N/A
Ground 1	East	08/26/09	N/A
Ground 1	South	08/26/09	N/A
Ground 1	West	08/26/09	N/A
Ground 1	North	08/26/09	N/A
Ground 1 hindquarters	South	08/26/09	N/A
Ground 1 abdomen	South	08/26/09	N/A
Ground 1 head	South	08/26/09	N/A
Ground 2	East	08/26/09	N/A
Ground 2	South	08/26/09	N/A
Ground 2	West	08/26/09	N/A
Ground 2	North	08/26/09	N/A
Ground 2 hindquarters	South	08/26/09	N/A
Ground 2 abdomen	South	08/26/09	N/A
Ground 2 head	South	08/26/09	N/A
Freshwater 2	East	08/26/09	N/A
Freshwater 2	South	08/26/09	N/A
Freshwater 2	West	08/26/09	N/A
Saltwater 1	East	08/26/09	N/A

Saltwater 1	North	08/26/09	N/A
Saltwater 1	West	08/26/09	N/A
Saltwater 2	East	08/26/09	N/A
Saltwater 2	South	08/26/09	N/A
Saltwater 2	West	08/26/09	N/A
Saltwater 2 close strainer first pass	East	08/26/09	N/A
Saltwater 1 floating bones	East	08/26/09	N/A
Saltwater 1 floating bones	East	08/26/09	N/A
Saltwater 1 floating skin patches	East	08/26/09	N/A
Saltwater 2 close strainer second pass	East	08/26/09	N/A
Saltwater 1 tub after straining	East	08/26/09	N/A
Saltwater 1 tub close after straining	East	08/26/09	N/A
Saltwater 2 tub after straining	East	08/26/09	N/A
Saltwater 2 tub after straining	South	08/26/09	N/A
Ground 1	East	08/28/09	N/A
Ground 1	South	08/28/09	N/A
Ground 1	West	08/28/09	N/A
Ground 1	North	08/28/09	N/A
Ground 1 hindquarters	South	08/28/09	N/A
Ground 1 abdomen	South	08/28/09	N/A
Ground 1 torso	South	08/28/09	N/A
Ground 1 head	South	08/28/09	N/A
Vultures circling	West	08/28/09	N/A
Vultures circling	West	08/28/09	N/A
Vultures circling	West	08/28/09	N/A
Ground 2	East	08/28/09	N/A
Ground 2	South	08/28/09	N/A
Ground 2	West	08/28/09	N/A
Ground 2	North	08/28/09	N/A
Vultures circling	West	08/28/09	N/A
Ground 2	East	08/28/09	N/A
Ground 2 hindquarters	South	08/28/09	N/A
Ground 2 abdomen	South	08/28/09	N/A
Ground 2 head	South	08/28/09	N/A
Vultures circling	West	08/28/09	N/A
Vultures circling	West	08/28/09	N/A
Vultures circling	West	08/28/09	N/A
Freshwater 2	East	08/28/09	N/A
Freshwater 2	South	08/28/09	N/A

Freshwater 2	West	08/28/09	N/A
Saltwater 1	East	08/28/09	N/A
Saltwater 1	North	08/28/09	N/A
Saltwater 1	West	08/28/09	N/A
Saltwater 2	East	08/28/09	N/A
Saltwater 2	South	08/28/09	N/A
Saltwater 2	West	08/28/09	N/A
Saltwater 1 basket pulled	South	08/28/09	N/A
Saltwater 1 basket north side	East	08/28/09	N/A
Saltwater 1 basket south	East	08/28/09	N/A
Saltwater 1 basket sourth	East	08/28/09	N/A
Saltwater 1 basket south close skin	East	08/28/09	N/A
Saltwater 1 basket center	East	08/28/09	N/A
Saltwater 1 basket pulled	East	08/28/09	N/A
Saltwater 2 basket pulled	East	08/28/09	N/A
Saltwater 2 basket close east	East	08/28/09	N/A
Saltwater 2 basket close west	East	08/28/09	N/A
Saltwater 2 basket close center	East	08/28/09	N/A
Saltwater 2 basket close center	East	08/28/09	N/A
Saltwater 2 basket close center	East	08/28/09	N/A
Saltwater 2 basket pulled	East	08/28/09	N/A
Freshwater 2's bones laid out	North	08/28/09	N/A
Freshwater 2's bones bottom left	North	08/28/09	N/A
Freshwater 2's bones center left	North	08/28/09	N/A
Freshwater 2's bones top left	North	08/28/09	N/A
Freshwater 2's bones top center	North	08/28/09	N/A
Freshwater 2's bones top right	North	08/28/09	N/A
Freshwater 2's bones center right	North	08/28/09	N/A
Freshwater 2's bones center center	North	08/28/09	N/A
Vultures circling	South	08/30/09	N/A
Vultures circling	South	08/30/09	N/A
Vultures circling	South	08/30/09	N/A
Vultures circling	South	08/30/09	N/A
Vultures on tree	North	08/30/09	N/A
Vultures on tree	North	08/30/09	N/A
Vultures circling	West	08/30/09	N/A
Saltwater 1 tank	North	08/30/09	N/A
Saltwater 2 tank	West	08/30/09	N/A
Ground 1	East	08/30/09	N/A

Ground 1	South	08/30/09	N/A
Ground 1	West	08/30/09	N/A
Ground 1	North	08/30/09	N/A
Ground 1 hindquarters	South	08/30/09	N/A
Ground 1 abdomen	South	08/30/09	N/A
Ground 1 torso	South	08/30/09	N/A
Ground 1 head	South	08/30/09	N/A
Ground 2	East	08/30/09	N/A
Ground 2	South	08/30/09	N/A
Ground 2	West	08/30/09	N/A
Ground 2	North	08/30/09	N/A
Ground 2 hindquarters	South	08/30/09	N/A
Ground 2 abdomen	South	08/30/09	N/A
Ground 2 head	South	08/30/09	N/A
Saltwater 1 basket pulled	East	08/30/09	N/A
Saltwater 1 basket top left	East	08/30/09	N/A
Saltwater 1 basket bottom left	East	08/30/09	N/A
Saltwater 1 basket center	East	08/30/09	N/A
Saltwater 2 basket pulled	East	08/30/09	N/A
Saltwater 2 basket top left	East	08/30/09	N/A
Saltwater 2 basket bottom left	East	08/30/09	N/A
Saltwater 2 basket bottom center	East	08/30/09	N/A
Saltwater 2 basket top center	East	08/30/09	N/A
Saltwater 2 basket top right	East	08/30/09	N/A
Saltwater 2 basket center right	East	08/30/09	N/A
Saltwater 2 basket bottom right	East	08/30/09	N/A
Saltwater 2 basket top center	East	08/30/09	N/A
Freshwater 2's bones left	GEFARL	09/01/09	N/A
Freshwater 2's bones center	GEFARL	09/01/09	N/A
Freshwater 2's bones right	GEFARL	09/01/09	N/A
Freshwater 2's bones bottom left	GEFARL	09/01/09	N/A
Freshwater 2's bones bottom center	GEFARL	09/01/09	N/A
Freshwater 2's bones bottom center	GEFARL	09/01/09	N/A
Freshwater 2's bones bottom right	GEFARL	09/01/09	N/A
Freshwater 2's bones top right	GEFARL	09/01/09	N/A
Freshwater 2's bones top left	GEFARL	09/01/09	N/A
Ground 1	East	09/02/09	N/A
Ground 1	South	09/02/09	N/A
Ground 1	West	09/02/09	N/A

Ground 1	North	09/02/09	N/A
Ground 1 hindquarters	South	09/02/09	N/A
Ground 1 abdomen	South	09/02/09	N/A
Ground 1 head	South	09/02/09	N/A
Ground 2	East	09/02/09	N/A
Ground 2	South	09/02/09	N/A
Ground 2	West	09/02/09	N/A
Ground 2	North	09/02/09	N/A
Ground 2 hindquarters	South	09/02/09	N/A
Ground 2 abdomen	South	09/02/09	N/A
Ground 2 head	South	09/02/09	N/A
Saltwater 1	North	09/02/09	N/A
Saltwater 2	South	09/02/09	N/A
Saltwater 1 basket pulled	East	09/02/09	N/A
Saltwater 1 basket bottom center	East	09/02/09	N/A
Saltwater 1 basket center center	East	09/02/09	N/A
Saltwater 1 basket top right	East	09/02/09	N/A
Saltwater 2 basket pulled	East	09/02/09	N/A
Saltwater 2 basket top left	East	09/02/09	N/A
Saltwater 2 basket bottom left	East	09/02/09	N/A
Saltwater 2 basket bottom center	East	09/02/09	N/A
Saltwater 2 basket top center	East	09/02/09	N/A
Saltwater 2 basket right	East	09/02/09	N/A
Ground 1	East	09/12/09	N/A
Ground 1	South	09/12/09	N/A
Ground 1	West	09/12/09	N/A
Ground 1	North	09/12/09	N/A
Ground 1 hindquarters	South	09/12/09	N/A
Ground 1 abdomen	South	09/12/09	N/A
Ground 1 head	South	09/12/09	N/A
Ground 1 limb pulled east	South	09/12/09	N/A
Ground 2	East	09/12/09	N/A
Ground 2	South	09/12/09	N/A
Ground 2	West	09/12/09	N/A
Ground 2	North	09/12/09	N/A
Ground 2 hindquarters	South	09/12/09	N/A
Ground 2 abdomen	South	09/12/09	N/A
Ground 2 head	South	09/12/09	N/A
Pen southeast side collapsing	North	09/12/09	N/A

Pen north east side collapsing	South	09/12/09	N/A
Pen north east side collapsing	South	09/12/09	N/A
becca	South	09/17/09	N/A
becca	South	09/17/09	N/A
becca	South	09/17/09	N/A
Ground 1	East	09/17/09	N/A
Ground 1	South	09/17/09	N/A
Ground 1	West	09/17/09	N/A
Ground 1 bone scattered southeast	South	09/17/09	N/A
Ground 1 bone scattered southeast close	South	09/17/09	N/A
Ground 1 limb pulled east	South	09/17/09	N/A
Ground 1 hindquarters	West	09/17/09	N/A
Ground 1 hindquarters	West	09/17/09	N/A
Ground 1	North	09/17/09	N/A
Ground 2	East	09/17/09	N/A
Ground 2	East	09/17/09	N/A
Ground 2 limb scattered southeast	East	09/17/09	N/A
Ground 2 limb scattered southeast close	East	09/17/09	N/A
Ground 2	East	09/17/09	N/A
Ground 2	South	09/17/09	N/A
Ground 2 limb scattered east	South	09/17/09	N/A
Ground 2 limb scattered east	South	09/17/09	N/A
Ground 2	West	09/17/09	N/A
Ground 2	West	09/17/09	N/A
Saltwater 2 bones pulled	North	09/17/09	N/A
Saltwater 2 bones pulled close bottom	East	09/17/09	N/A
Saltwater 2 bones pulled close center	East	09/17/09	N/A
Saltwater 2 bones pulled close left	East	09/17/09	N/A
Saltwater 2 bones pulled close left	East	09/17/09	N/A
Saltwater 2 bones pulled close top	East	09/17/09	N/A
Saltwater 2 bones pulled close top	East	09/17/09	N/A
Vulture feather in pen wall (southeast right)	West	09/17/09	N/A
Pen north east side collapsing(left)	South	09/17/09	N/A
Pen north east side collapsing(right)	South	09/17/09	N/A
Pen west side collapsing (right)	East	09/17/09	N/A
Pen south side collapsing (right)	North	09/17/09	N/A

Pen collapsing, whole view	North	09/17/09	N/A
Pen collapsing whole view	East	09/17/09	N/A
Vulture inside pen	South	09/24/09	N/A
Vulture inside pen	South	09/24/09	N/A
Vulture inside pen	South	09/24/09	N/A
Bones co-mingled and scattered-NE	South	09/24/09	N/A
Bones co-mingled and scattered-NE	South	09/24/09	N/A
Bones co-mingled and scattered-all	South	09/24/09	N/A
Bones co-mingled and scattered-close	South	09/24/09	N/A
Bones co-mingled and scattered-close	South	09/24/09	N/A
Bones co-mingled and scattered-close	South	09/24/09	N/A
Bones co-mingled and scattered-close	South	09/24/09	N/A
Bones co-mingled and scattered-close Ground 1	South	09/24/09	N/A
Bones co-mingled and scattered-close Ground 1	South	09/24/09	N/A
Bones co-mingled and scattered-close Ground 2	South	09/24/09	N/A
Bones co-mingled and scattered-close	South	09/24/09	N/A
Bones co-mingled and scattered-close	South	09/24/09	N/A

APPENDIX D

Third Instar maggots trying to escape Freshwater 1's tank to pupate were foiled by the wading pool, and drowned.

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