

SNIFFING OUT DECOMPOSITION: INVESTIGATING THE RELIABILITY OF
HUMAN REMAINS DETECTION DOGS

By

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ABSTRACT

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The purpose of this study was to investigate the reliability of trained Human Remains Detection (HRD) dogs in the field. HRD dogs are trained to locate deceased individuals, typically in conjunction with law enforcement agencies, by using their enhanced olfactory systems to detect scents that humans cannot. Limited research has been conducted on both the strengths and weaknesses of these dogs and their abilities to locate human remains. This study focused on one North Carolina based organization that trains HRD dogs. Data were collected by distributing surveys and by observing regularly scheduled training exercises conducted by the organization. The collected data were used to design an experiment. Specifically, dogs were tasked with locating human bone samples buried under four common North Carolina soil types from the following regions: Southern Piedmont, Southern Coastal Plain, Atlantic Coast Flatwoods, and Tidewater Area. It was predicted that identifications of bone by the canines within the various soils would become faster over the course of experimentation, which could indicate an ability to learn and apply new skills quickly. Meaning, that even though a canine may not have been exposed to a specific soil type through training, their enhanced olfactory abilities and adaptability to new environments would make them well prepared to perform in

multiple locations, thus increasing their overall reliability. Results indicated that canines responded quicker and more reliably to the soil most local to their training region. Future recommendations would be to continue this research to see if other HRD teams report similar results.

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CHAPTER 1: INTRODUCTION

1.1 Overview of Human Remains Detection Dogs

The purpose of this study was to investigate the reliability of trained Human Remains Detection (HRD) dogs in the field and to understand the aid they can provide to law enforcement agencies and other experts. Trained search and rescue (SAR) dogs have been used for decades to locate missing persons in a variety of situations. One of the many types of trained SAR dogs includes Human Remains Detection or HRD dogs. These specially trained canines have the ability to locate the deceased remains of human individuals, typically in conjunction with law enforcement agencies (Vass, 2008). The main question of this project was: how does the type of soil that human bone is buried under affect a dog's ability to locate it? The results could reveal weaknesses and strengths in HRD dog abilities, as well as aid in training for both handlers and canines. Both results could lead to improvements in the way training occurs.

Previously published research has shown that a single trained search and rescue dog can be as effective as 20-30 trained human searchers in finding both living and nonliving individuals. This advantage over humans comes from a canine's relatively enhanced sense of smell (Highland Canine, 2015). Earlier research has continued to demonstrate high reliability and accuracy in scent detection by trained dogs and handlers, but there is room to further explore the capabilities of these canines (Highland Canine, 2015; Lit and Oberbauer, 2011). Therefore, there is a need to examine a trained canine's

reliability in locating human tissue on a larger scale to better understand the implications for other experts in the field. Specifically, trained HRD dogs could aid forensic anthropologists in the recovery of human remains from clandestine burials, often associated with criminal investigations. If the dogs are able to accurately locate scattered, buried, or otherwise hidden human remains, the forensic anthropologists may have a better chance at estimating a more concrete identification of the individual.

The use of trained dogs is expanding outside of the typical search and rescue, or drug detection roles typically associated with working dogs. Canines can be employed to detect explosives, minute levels of toxic chemicals in the environment, and even slight changes in a person's body that precede epileptic events (Browne, 2006). Focusing on HRD dogs is one piece of the canine olfactory puzzle. The results of this specific project could have impacts in several areas for both canines and handlers. On one hand, knowledge of the soils HRD dogs can detect human remains under could help multiple levels of law enforcement agencies recover bodies from homicides or cold cases in areas that previously did not utilize HRD dogs. However, the results could also demonstrate the implications of false negatives. It is equally possible that the HRD dogs could not be able to locate human bone under multiple soil types. Despite the possibilities, it is vital to understand the training methods employed that help to prepare both dogs and handlers to perform their duties in the field.

This thesis is comprised of data collected from surveys, field observation of search and rescue professionals, and an experiment that tested the accuracy of HRD dogs.

This research has utilized a multidisciplinary approach that encompasses several methodologies in order to better understand how HRD dogs and handlers work together to detect and locate deceased individuals. Understanding the use of HRD dogs requires knowledge of the domestication of canines, their relationships with humans, their biological ability to detect different scents, and finally, the way in which taphonomic processes affect a dog's ability to perform. The previously published studies related to HRD dog training and utilization have highlighted areas that need further investigation (Osterhelweg, 2008; Riezzo, 2014; Schoon, 1996). Past studies have repeatedly demonstrated that HRD dog training is a highly variable process due to the lack of consistency across the board (Lit and Oberbauer, 2011). The research conducted within this thesis seeks to further explore this topic.

1.2 Definition of Terms

First, it is important to understand the difference between the terms: canid, canine, and dog. Canid is a broad term for a species that belongs to the family *Canidae*, which covers 34 separate species, including wolves, dogs, foxes, and more (Vonholdt, 2017). Canine is another term for *Canis familiaris* (Wilson, 2005), which can also be referred to as the domestic dog, or just dog (Threshold, 2010; Wilson, 2005). The terms canine and dog are used interchangeably throughout this thesis since both terms reference the same species.

There are several terms that have specific definitions within the Human Remains Detection field that are important to define before moving further. The list of definitions

is not exhaustive to the field of canine scent detection but is meant to provide context to the terminology used specifically within this research project. The definitions include: the general types of human-scent detection working styles that exist; terminologies for the individuals who work alongside these canines; and definitions for commonly used commands and phrases used by experts in the field. All definitions are listed alphabetically.

- Active Alert: A canine's trained indication that includes behaviors such as digging, barking, or scratching (Rebmann, 2000; Threshold, 2014).
- Alert: A trained change in a canine's behavior in response to the recognition of an odor of decomposition; also called an *indication* (Judah, 2008; Judah and Sargent, 2014; Rebmann, 2000; Threshold, 2014).
- Dog Handler: The trained person who works with a dog (Judah, 2008 and Judah and Sargent, 2014).
- False Alert: A canine gives a trained indication, but no remains are found by human searchers (Rebmann, 2000; Threshold, 2014).
- Final Response: A behavior that has been trained for the canine to give to a handler in response to physically locating the source of a scent; can be demonstrated by active or passive alert (Judah, 2008; Judah and Sargent, 2014; Rebmann, 2000; Threshold, 2014).
- Interest: Any reaction to an odor; a noticeable, readable, physical change in the canine's behavior (Rebmann, 2000; Threshold, 2014).

- Miss: When a canine fails to alert in the known presence of the target odor (Rebmann, 2000; Threshold, 2014).
- Passive Alert: a canine's trained indication that includes behaviors such as sit or lay-down (Rebmann, 2000; Threshold, 2014).
- Scent Article(s): Object(s) left in the scent area that a dog is expected to indicate on (Rebmann, 2000; Threshold, 2014).
- Scent Cone: The dispersion of odor in a given environment (Rebmann, 2000; Threshold, 2014).
- Target odor/scent: A specific type of odor that the dog is being trained to locate and indicate on (Rebmann, 2000; Threshold, 2014).
- Tracking Dog: A dog that has been trained to follow an odor on the ground (Judah, 2008; Judah and Sargent, 2014).
- Trailing Dog: A dog that will follow the odor pathway left by the target individual either by sniffing the ground or by following a scent cone (Judah, 2008; Judah and Sargent, 2014).
- Trainer: A member of a specific discipline who instructs the canine-handler team using established methods and training guidelines (Judah, 2008; Judah and Sargent, 2014; Rebmann, 2000; Threshold, 2014).
- Wilderness Air Scent Dog: A dog that uses air scent techniques to detect a trained odor; usually in wooded areas (Judah, 2008; Judah and Sargent, 2014).

CHAPTER 2: PROJECT BACKGROUND RESEARCH

2.1 Biological Traits of Canines

There are specific qualities of canines that have likely made them helpful working companions to human groups over time. Their biological background and shared characteristics help to explain their natural social tendencies. Their enhanced olfactory systems explain why they have been utilized for thousands of years by different societies.

2.1.1 Common canine characteristics

Canines (*Canis familiaris*), also known as dogs, are a part of the family Canidae (DeVito, 2009; Rebmann, 2000). Other canids within the family Canidae include: wolves, jackals, and foxes (Schwartz, 1997; Threshold, 2010). All canids share certain characteristics, including: large canine teeth, blunt, non-retractable claws with five toes on the fore-feet and four toes on the hind-feet, and a long muzzle (Rebmann, 2000). Canids are unusual mammals in term of their litter sizes. Generally speaking, litter size in mammals is inversely related to body size, meaning that the larger the mammal, the smaller the number of offspring produced at once. However, canids are opposite in this regard because larger canids tend to produce larger litters than smaller ones (Schwartz, 1997: 4). Finally, canids are highly social animals. They tend to live in complex social groups, are highly adaptable, form pair bonds, hunt cooperatively, and share food among family members (Schwartz, 1997:4). Those characteristics are similar across all mammals.

Some researchers have argued that canids are one of the most variable animals on the planet because they have wild members of the family on all continents, (except for Australia which only has the dingo), and range from living in tropical rainforests to the frozen tundra (DeVito, 2009; Schwartz, 1997). Further, dogs are the only animals to be found in human societies across the world and are they are hypothesized to be the first animal to be domesticated by humans (DeVito, 2009; Schwartz, 1997, see Section 2.2). The diversity of the species and their high level of sociality is most likely why they have been used for thousands of years as companions to humans for hunting, herding, tracking, and more.

2.1.2 Canine olfactory abilities

Olfaction is simply defined as the act of smelling (Rebmann, 2000; Mesloh, 2002). There are many components of a canine's nose that contribute to its ability to identify different smells (Figure 1). A dog's nose includes the nostril and nasal cavity. There are olfactory receptor cells throughout a specialized epithelium that runs through the ethmo-turbinate bones of the nasal cavity (Correa, 2011). The olfactory part of the nasal mucous membrane has a rich supply of olfactory nerves that connect directly with the olfactory lobe in the dog's brain. Dogs also contain the vomeronasal organ, called Jacobson's organ, that is made up of a pair of elongated, fluid-filled sacs that open into the mouth and nose and is located above the roof of the mouth behind the upper incisors, which is pictured below in Figure 1 (Correa, 2011). In total, the olfactory system consists of soft tissue, bones, nerves, and portions of the brain (Rebmann, 2000). A dog's cool and

moist nose helps to capture and dissolve molecules in the air and bring them into the nasal cavity (Correa, 2011).

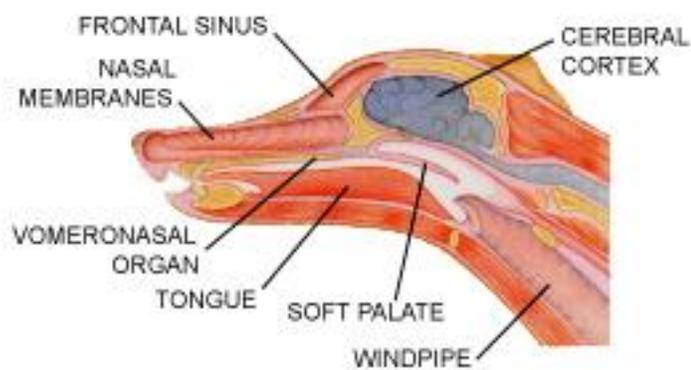


Figure 1: Anatomy of a dog's nose (Oberg, 2006)

The nasal structure of a dog has three main functions: respiration, olfaction, and accessory olfaction (Rebmann, 2000). Respiration includes breathing and the olfactory system consists of the soft tissues, bones, nerves, and portions of the brain that were discussed previously. Finally, accessory olfaction pertains to how dogs recognize other dogs and territories via sniffing urine and feces (Rebmann, 2000). These functions work together to allow dogs to detect scents that human nasal systems are not sensitive enough to distinguish (Rebmann, 2000). The biological differences between dogs and other species are part of what helps them excel as working animals and could be a major reason that dogs were widely used as companions to humans.

A dog's sniff is different than breathing. A sniff will interrupt the normal breathing pattern and allow for a series of short inhales and exhales (Correa, 2011). When a dog sniffs something, the muscles in the nostrils draw in air and scent particles travel into the nasal cavity with the rushing air. The air already in a dog's nose is forced back

deeper into the nasal cavity and the movement causes tiny wind currents to help pull in more scent as air is exhaled. Once the scent is inside the nose, mucus traps the scent particles and millions of receptors begin to process the scent (Castaldo, 2014). Dogs exhale air via slits that are off to the side of their noses. Doing this allows exhaled air to be pushed out to the side, which permits more fresh air to be directly inhaled in, which further increases the dog's ability to detect scents since they are not rebreathing the same air (Stejskal, 2013).

One of the main reasons for using canines as tracking companion comes from their exceptional noses. Whereas humans rely on eyesight as a primary sense, dogs rely on smelling as theirs. Castaldo's research demonstrated that dogs can smell an item with particle concentration levels at one to two parts per trillion (2014). Whereas humans have about five million olfactory receptors, reports have shown that bloodhounds have over 100 million (Rebmann, 2000), thus demonstrating their innate ability to detect scents humans cannot. Recently published research has demonstrated that canines have olfactory systems that surpass the current technology humans possess for detecting specific scents, including: accelerants, narcotics, or the scent of decomposition (Mesloh, 2002). This makes dogs important resources. The scent of living humans can be tracked by dogs via dead skin cells, perspiration, skin oils, and gas components. It has been demonstrated that dogs are able to locate these scents up to 48 hours after a person has passed the area (Mesloh, 2002).

Individually, dogs have varying levels of olfactory abilities. Both breed and age factors into the size of the canine olfactory bulb (Stejskal, 2013). The olfactory bulb grows as a puppy grows and it is assumed that the sense of smell increases as the bulb grows larger with age (Stejskal, 2013). There is also a high degree of variation in the genes that control the olfactory receptors in all breeds of canines. Research conducted on twenty different dog breeds by Tacher and colleagues indicated that some alleles for the olfactory reception were breed specific and some did not commonly appear across the general dog population (Stejskal, 2013; Tacher, 2005). This would help to explain why some dogs show more olfactory ability than others. Thus, further research on the abilities of various breeds of canines used for scent detection work is important in further understanding their olfactory capabilities.

2.2 The Human-Canine Relationship and Domestication

Humans and canines have developed a lasting relationship. Evidence for this extends back through the archaeological record for thousands of years. However, there is no definite timeline or explanation for how, why, or when dogs became domesticated. There is ample evidence in the archaeological record for the use of canines over time as well as for the bond that humans and canines share.

2.2.1 Canine domestication origins

Many hypotheses exist for the origin of dogs as a domesticated species. There is genetic evidence that suggests dogs and grey wolves diverged in the evolutionary

timeline roughly 100,000 years ago or more, and domestication of the dog is hypothesized to have occurred 10,000-15,000 years ago (DeVito, 2009). The latter date corresponds with some of the earliest archaeological record of purposeful dog burials, which date to ca 12,000-14,000 years ago in Siberia and surrounding regions (Morey, 2006). Other archaeological evidence supporting this claim comes from examples of incipient domestication of wild canids from caves in Europe, the Ukraine, and Siberia that date back 20,000-26,000 years ago. Canid skulls that were found in those caves demonstrated certain characteristics, such as reduction in overall skull size, shortened jaws, widened snouts, and compacted teeth (Clutton-Brock, 2017). Those changes are commonly found between wild and domesticated species, such as wolves and dogs.

Dogs and grey wolves are fairly similar genetically, but there are many morphological, behavioral, psychological, and neurobiological changes that occur during the domestication process (Hare, 2012). One of the main morphological differences is that dogs exhibit neotony, which is the retention into adulthood of characteristics typical of subadults, such as smaller skulls and smaller canine teeth (Schwartz, 1997; DeVito, 2009). In general, dogs display more of a puppylike appearance through adulthood than do wolves. This adaptation likely helped to make dogs more favorable and less threatening to human groups. Many of the differences observed are in behavioral traits rather than morphological ones, in particular, that dogs are highly social and more docile than their grey wolf counterparts.

The behavioral aspect of wolf pups being highly social is more likely to be the product of artificial selection, as it was possibly that desired trait that early human groups wanted to retain while breeding the animals (Schwartz, 1997; Vonholdt and Driscoll, 2017). The social aspect of dogs would have been beneficial to humans and also would have facilitated the expansion of canine use into many areas. However, some investigators argue that dogs were domesticated through a process termed self-domestication, which could have occurred when less aggressive or fearful wolves were selected for within their own population. Humans would have had no control or influence in the process (Hare, 2012; Vonholdt and Driscoll, 2017). Under the self-domestication hypothesis, it is argued that the less fearful wolves were more likely to enter human settlements in search of scrap food and resources. Those wolves had an advantage in reproduction due to their increased chance of survival and were therefore selected upon more frequently. Once a proto-dog hybrid was developed from this process, humans would have been able to continue the domestication process because the animals had a higher level of sociality and reduced fear (Hare, 2012). One of the main behavioral changes of a species during domestication is a reduction of aggression.

As the domestication process developed, dogs were adopted into many aspects of human life. As dogs became more incorporated into human populations, their functions and roles within the group shifted as well. Many dogs were used by humans to help with herding, hunting, transportation, and other forms of work. Through the combination of social zooarchaeological analysis of dog burials and ethnographic data within multiple

societies, more has been learned about the human-canine relationship. It is likely that the natural hunting abilities of dogs were one of the primary reasons they were used so heavily by certain populations. For example, the Jōmon hunter-gather groups in Japan (12,500-2350 BP) used dogs to help hunt boar and other large animals that inhabited nearby dense forests. Dogs were very adept at sniffing, tracking, chasing, and holding down prey until their human counterparts could retrieve their kill (Perri, 2016). These skilled hunting dogs were often prized and coveted, even earning their own burials after death. The symbolic importance of dogs has only continued to grow with time. By the 1300s, Europe had started the purposeful differentiation of dogs for the use of hunting specific prey, such as badgers or deer (Vonholdt and Driscoll, 2017). However, by the 1800s, the focus of breeding dogs shifted to form rather than function (Vonholdt and Driscoll, 2017). In turn, modern canine breeds began to develop that accentuated physical and behavioral differences within the species.

2.2.2 Modern canine breeds

Today, dogs are separated from one another by breed, which can be defined as a group of dogs with a common gene pool as well as similar appearance and function (American Kennel Club, 2017). There is still debate on how many breeds of dogs exist in the world. The American Kennel Club (AKC) recognizes 190 breeds (American Kennel Club, 2017). Alternatively, the World Canine Organization, known as the largest canine organization in the world, recognizes 344 breeds as of 2017 (Federation, 2017). However, both organizations only monitor pure-bred canines. Taking mixed-breeds or non-pure breeds into account, it is unknown how many variances of dog truly exist in the world.

According to the American Kennel Club (AKC), there are seven classifications for dogs. Each of the AKC recognized breeds can be broken down into one of the following groups: herding, hound (hunting), non-sporting, sporting, terrier, toy, and working (American Kennel Club, 2017). The World Canine Organization further breaks breeds down into ten identifiable groups; however, most overlap with the seven defined by the AKC. For the purposes of this research, classifications defined by the AKC will be used since that is the American standard and this research is based within the United States of America. The most commonly used dogs for HRD related work are those grouped into the working dog classification (Judah and Sargent, 2014). These groups of dogs include, but are not limited to: German Shepherds, Labradors, Belgium Malinois, Spaniels, and Collies. These breeds have been bred to have a combination of good temperament, drive, and energy to want to learn and work (Judah and Sargent, 2014).

However, each dog, much like a person, has its own level of motivation and dedication. Motivation can stem from different reward factors, including: praise, treats, or toys. Individual dogs respond differently to each. As demonstrated later in the results (see Section 4.2), each canine participant in the observational part of this project received a different reward as positive reinforcement for completing a task and no two rewards were the same between teams. Dedication also stems from the desire to work and focus. Dogs have varying levels of dedication and practice in HRD and scent detection work at a young age would normally reveal the drive a dog has to accomplish the tasks.

2.3 Canine and Law Enforcement Relationships

Aside from biological research, studies have been carried out on how working dogs perform within their trained disciplines. Whereas research has been conducted specifically on the use of HRD canines in a working capacity, there are several common themes and issues that arise from these data. Agencies are working to find ways to standardize the methods that are used by handlers and trainers in the human remains detection field.

2.3.1 Development of the Human Remains Detection dog field

Human Remains Detection dogs have developed over the past several decades as helpful resources to law enforcement and search and rescue agencies. As the field has developed, so has research relating to the dogs' accuracy and reliability. Schoon (1996) was one of the first to note the fact that there are no international standards in place for the way dogs are trained, certified, or used by professionals. Further, there are no standards in place for the way police or judiciary systems may involve identifications made by canines in court cases or criminal offenses. There are no rules that set consistency in how identifications by canines are handled in the eyes of the law. This affects reliability and legitimacy.

Schoon (1996) also commented on the lack of published information available as well as the lack of information concerning the reliability of canine identifications. Therefore, his research examined common variations in experimental training methods for scent tracking police dogs in the Netherlands. This study also brought to light several concerns related to dog effectiveness in the field. These concerns were: the fact that canine responses were tied to rewards, the influence of the handler, the varied motivation

between each canine, and the confusion of learning methods that could lead to false identification (Schoon, 1996). Later studies addressed some similar concerns related to handler bias and canine accuracy, as discussed below (Osterhelweg, 2008; Riezzo, 2014; Alexander, 2016).

The reliability, accuracy, and specificity of HRD canines was tested by Osterhelweg (2008). This study, while being conducted years after Schoon's study, still demonstrated similar concerns on the lack of scientific research on these canines. Therefore, an experiment was designed to help display the reliability that a well-trained HRD dog has when assisting with crime scene investigations. Carpet squares were contaminated with cadaver blood and trained dogs performed tests over a period of 65 days to test the accuracy of the canine detection. Results indicated excellent accuracy over the full-time period (Oesterhelweg, 2008). Later studies continue to indicate similar findings over time.

Another study examined how sensitive a dog's olfactory system is to diluted blood samples. Two Labrador Retrievers were used in the study and experimentation was carried out over the course of 16 months (Riezzo, 2014). The importance of the study was the fact that it attempted to remove confounding variables so that only the dog's ability was tested. For example, handlers were unaware of where blood samples were hidden, which reduced the possibility of mistakes or unintentional bias by the handlers. Further, the testing area was in an enclosed, confined room, and the blood was not visible or accessible to the dogs other than by scent (Riezzo 2014). The results showed that dogs

could detect human blood at very minute levels. However, the same concerns of Schoon (1996) revealed themselves in this study. The canine olfactory system is subject to variation between each individual canine, which could lead to varying results. This information is important to take note of for future experiments and was considered in the design of this project's experiment. Knowing that each dog can have different sensitivities to tissue samples could mean that the number of dogs in a study needs to be adjusted to account for that issue. This variance could also relate to the breed of the canine. Ways to understand these variances were addressed in the survey questions that were distributed to HRD organizations in the preliminary phase of this project.

Some of the most recent literature on the topic of HRD dogs touched on the experiment conducted during this research project. Alexander and colleagues (2016) examined how canines detect human tissue under sandy soil versus clayey soil. The dogs were able to locate the human tissue under the sandy soil at a faster rate than under the clayey soil. Sandy soil is less tightly condensed and therefore allows more scent to escape into the air than clayey soil, which is thicker and denser (Alexander, 2016). Soil context is important in terms of understanding the decomposition process. Human remains can decompose at different rates depending on the type of soil, and the research by Alexander and colleagues examined how the soil type could impact a dog's ability to detect the buried human remains (2016). This topic has been expanded within this research project by not only exploring more than two types of soil but as well as by exploring the training methods that could affect the outcome. However, the recent publication of this article

continues to reiterate the same concerns that were published in the 1990s. HRD dog training or certification is not standardized and this has an impact on the legitimacy of these canines in the eyes of the judiciary system and in understanding accuracy. Is there a possibility of standardizing HRD training or certification methods? Would that increase the legitimacy and accuracy of these specialized canines?

2.3.2 HRD dogs and the judiciary system

Alerts given by HRD dogs have been presented in court cases, but there are important regulations to consider. Under the federal and state court system within the United States, there are two classes of police working dogs: Human Scent Detector Dogs and Contraband Substance Detector Dogs (Judah, 2008). HRD dogs fall into the first category and narcotic or explosive detection dogs fall into the latter category. There are differences in how court systems recognize alerts provided by the two classifications of canines. For HRD dogs, an alert is only an indicator of a wrongdoing and must be supplemented in court with additional evidence (Judah, 2008). However, an alert from a Contraband dog equates to probable cause (Judah, 2008). Despite the differences in alert recognition, HRD dogs are held to the same standard as other police dogs in terms of the fact that the dogs need to be trained, certified, and reliable.

The decision to list HRD dogs as scent dogs rather than contraband dogs has been debated in several court cases. Currently, there are no federal or state case laws that have allowed just an alert from a trained Human Remains Detection dog to suffice as probable cause in order to obtain a search or arrest warrant. Therefore, an alert from an HRD dog must be corroborated by other evidence to be admissible (Judah and Sargent, 2014). The

federal case of *Kerr v. Lyford* (1999) highlighted that fact. During the investigation, an HRD dog was sent to a suspected crime scene and indicated on the presence of buried human remains in a yard as well as on residual scent left in a shed. Witnesses had already indicated such information as probable cause and the alert from the dog was used to help support the claims (*Kerr v. Lyford, 1999*). Alternately, in the state case of *Trejos v. The State of Texas* (2007), the evidence of two HRD dogs' alerts were deemed admissible in court because the dogs were proven to be certified and reliable (*Trejos v. State, 2007*). Three factors tied into the decision to allow the canines' alerts: whether or not the breed of dog worked well off lead; the ability of the dog to distinguish between human and nonhuman scents; and whether or not the dog had shown reliability in prior cadaver searches (Judah, 2014). In *Trejos v. State, (2007)*, experts in the HRD field were able to support those claims as facts for the two dogs in question. However, while the dogs' alerts were deemed admissible, they were still not enough to be used as probable cause. Other evidence was needed. These examples help to demonstrate the issues still present in how reliable HRD dog identifications can be in the eyes of the law.

However, improvements in the industry standards and "best practice" guidelines have helped to increase the legitimacy of HRD dogs in the eyes of the judiciary system. For individual trainers and dog handlers, it is important to keep up with the following: maintaining regular and accurate training and search logs; remaining up-to-date on the latest training techniques; and remaining ethical in all decision-making processes (Judah and Sargent, 2014). Through increased consistency in training and certification methods

and a dedication to following “best practice” guidelines, it may be possible for HRD dogs to receive more recognition in federal and state court systems in the future.

2.3.3 Current “best practices” In HRD training

While there are no national or international standards for training HRD dogs, there are some organizations that have formed to help create ideas for the “best practice” in this field. One organization is called The Scientific Working Group on Dog and Orthogonal Detector Guidelines, or SWGDOG. This organization was formed at Florida International University and is a partnership from several local, state, federal, and international agencies that use many types of scent-detection dogs, including HRD dogs. The goal of the SWGDOG is to enhance the performance and overall reliability of scent-detection dogs by establishing “best practice” guidelines for increased consistency across the discipline (Furton, 2017). By “best practice” the group means “a technique, method, process, activity, incentive or reward that is more effective at delivering a particular outcome” (Furton, 2017). “Best practices” differ from standards of training since standard means “something considered by an authority or by general consent as a basis of comparison; an approved model” (standard, n.d.). SWGDOG is not a certification organization or even a mandate that organizations are required to follow. Instead, it is a set of guidelines that experts from all levels of law enforcement agencies have worked together to create in hopes that other organizations will refer to it.

This organization (SWGDOG) shows how the scent-detection field has developed into an international field, as well as the limitations that still exist. There is clearly a gap that exists in understanding the reliability and performance of trained canines, due to the

highly variable methods of training that may exist between groups at differing organizations. Further research into the capabilities of specifically HRD dogs is important to further this field of study. There are many factors to be considered in the training of canines and organizations such as SWGDOG are finding ways to combine “best practices” from around the globe to create a more unified field.

2.4 Forensic Taphonomy, Volatile Organic Compounds, and Scent Theory in HRD Work

2.4.1 Basic concepts of forensic taphonomy

A basic understanding of forensic taphonomy is required to understand how variable canine olfaction can be based upon the situation and why there is a need to test HRD dog abilities. Taphonomic changes can not only explain what has happened to a body after death, but they can be used to help reconstruct various social aspects of a population (Tiseler, 2010). Forensic taphonomy is defined as the postmortem changes that occur to a body from death to the time of its discovery, the term was originally coined by I.A. Evremov in 1940. Forensic taphonomy has been used to aid many scientists in understanding how a body changes after death based upon specific factors (Haglund, 1997; Ubelaker, 1997; Tiseler, 2010). Factors that influence taphonomic changes include: weather, location, type of soil, weight or height of the individual, manner of burial, depth of burial, and more. The list of factors is nearly endless, which means there are several plausible circumstances in which decomposition of a body could occur.

As a body decomposes, it undergoes five distinct phases of decomposition: the fresh phase, inflation, deflation, disintegration, and skeletonization (Tibbett, 2008; Pokines and Symes, 2013). Each of these phases is characterized by specific patterns of change that range from initial body discoloration, to swelling from the release of gases, to the rupturing of skin, and finally to the overall decomposition of the body until only bones are left (Tibbett, 2008; Pokines and Symes, 2013). The level of decomposition a body has undergone is dependent upon the time it takes for the body to be discovered after death, otherwise known as the postmortem interval (Ubelaker, 1997). As decomposition occurs, the VOC profile changes and it is important to understand how environmental situations, time, and other factors contribute to the overall scent that a body releases and therefore, the overall scent that a trained dog can detect.

Much experimentation has been conducted over the past several decades to better understand how taphonomic changes occur under various circumstances. Locations such as the Body Farm at the University of Tennessee, Knoxville, have spent decades conducting experiments relating to taphonomic processes. For example, it has been documented that most odor and soft tissue is typically gone from a decedent after roughly six months of being buried (Ubelaker, 1997). However, this estimation is still heavily dependent on the location and time of year. Therefore, trained canines need to be exposed to many stages of decomposition to be able to recognize the changes that occur in the body as well as the changes of scent that occur throughout the decomposition process. Many types of sources are used when training HRD dogs, including: dry bone, blood,

muscle tissue, and more. While research in this specific field is developing, there are still many unknown factors involved in canine scent recognition and human decomposition. Part of the research conducted within this project examined the type of source materials used when training HRD dogs to better understand what techniques are already in place to account for the wide variation of decomposition and the related release of volatile organic compounds.

2.4.2 HRD dogs and Volatile Organic Compounds

Taphonomic changes in a body affect the amount of Volatile Organic Compounds, or VOCs, that are released into the air, which HRD dogs rely on to do their job (Forbes, 2014). Most HRD trainers and handlers call this “scent.” VOCs are organic compounds that easily become vapors and can be emitted by many sources, including deceased humans and nonhumans (U.S. National Library, n.d.). As decomposition of an individual occurs, the VOCs change and the specialized canines must be trained to recognize hundreds of various scents that humans cannot detect on their own (Forbes, 2014). Dogs, both trained and untrained, have a natural ability to detect scents that exist in minute levels. They can also ignore many non-target scents that can confound identification. Many scientific instruments, such as explosive detection devices, are unable to make those same distinctions with current technological standards. Dogs can also locate minuscule levels of chemicals that various instruments cannot (Browne, 2006).

As mentioned previously, canines rely on VOCs that get released into the air to locate deceased individuals (Forbes, 2014). The mechanisms by which canines do this is

still under investigation. Researchers at the Oak Ridge National Laboratory conducted a study to create a Decompositional Odor Analysis Database, or DOAD (Baxter, 2015). The goal of the study was to isolate the VOC signature of human decomposition and share that information with HRD dog teams to help focus training methods on correct scents (Baxter, 2015). Results showed that there are 424 specific chemicals that are released by a human body during decomposition. All of these compounds were affected by taphonomic conditions, such as temperature and location (Baxter, 2015). Through all the research on VOC profiles, it is still unknown exactly which chemicals a dog's nose detects out of the hundreds that are released. That knowledge has implications on how training is completed by HRD organizations. How is the accuracy of a dog tested if there is no definite answer to what the dog is sniffing?

To further understand canine olfactory abilities, Stadler and colleagues (2012) conducted research on the difference between natural and synthetic training materials that are commonly used to train HRD dogs. Using gas chromatography, it showed that natural training aids release hundreds of VOC profiles, whereas the synthetic aids that were used only produced seven VOC profiles (Stadler, 2012). This is important because there is still limited knowledge on which scents HRD dogs actually use to detect human tissue. Using synthetic aids may be oversimplifying the VOC profiles and could potentially lead to ineffective training and responses from canines (Stadler, 2012). Without a solid framework of training, a dog has no chance of being reliable. Therefore, part of my project seeks to understand how training varies between different organizations by asking

specific questions on training procedures through surveys. If different training aids are being used by organizations, does this negatively affect an HRD dog's ability to perform or to be considered reliable?

The Federal Bureau of Investigation (FBI) demonstrated similar results regarding the variance of VOCs in a 2008 study on clandestine burials (Hoffman, 2008). The researchers repeated a common theme in this case study by recognizing that canines use VOCs to detect human remains, but the experts are still unsure as to which specific VOCs are recognized by the canines. Again, taphonomic factors such as time since death, moisture, and temperature could have a direct impact on this (Hoffman, 2008). The results indicated that limiting training aids for HRD dogs could negatively affect their abilities to be accurate and reliable in the field (Hoffman, 2008). Canines should be exposed to as many scents as possible during training to increase the likelihood that they will alert to a scent while working a search. However, more research needs to be done to understand the relationship of taphonomic changes and VOCs to the training of HRD canines. Shadowing of HRD training exercises will help to explore the various types of scent articles that professionals use to teach dogs.

Understanding the importance of taphonomic changes in a body can directly impact the training methods used in HRD canines. The next step is to determine how those facts affect a dog's ability to locate human remains in different environmental conditions, which is where this research comes to play.

2.4.3 Scent theory and HRD work

The way that scent travels through the air is perhaps one of the most important aspects to consider in HRD dog utilization. Scent is released from a source, such as a deceased individual, as VOCs enter into the air and diffuse from an area of high concentration to an area of lower concentration (Rebmann, 2000). Factors such as wind speed, location, temperature, physical barriers, and time of day can impact the way scent travels through the air, which impacts a dog's ability to find the source (Judah and Sargent, 2014; Rebmann, 2000). Basic scent theory holds that these factors need to be considered when positioning your dog in the field to look for human remains. Figure 2 shows an example of a scent cone, or the area that scent moves according to the direction of the wind (Judah and Sargent, 2014; Rebmann, 2000).

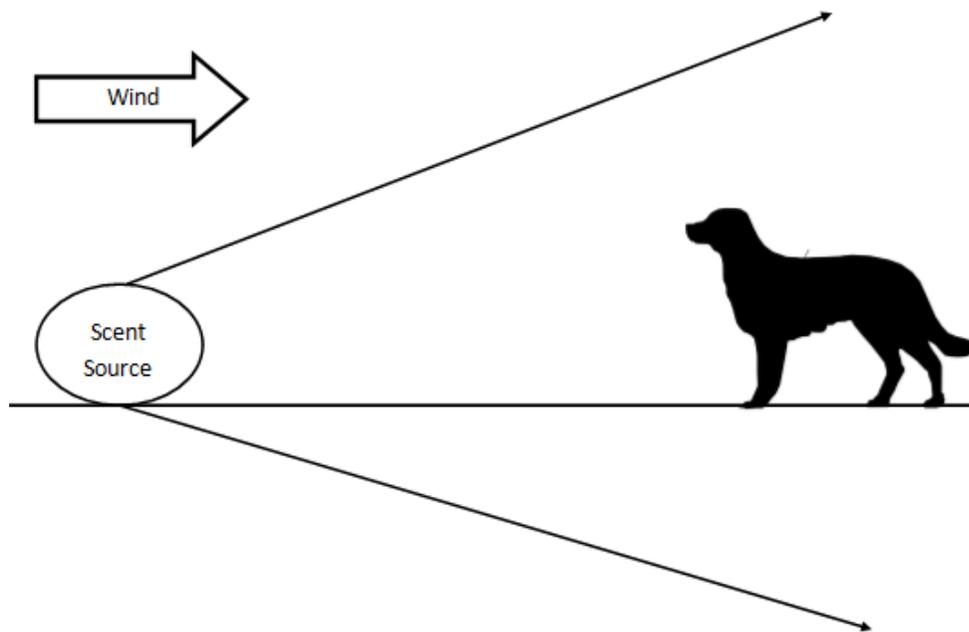


Figure 2: Basic scent cone. Thin arrows represent direction of scent.

It is important that handlers place their dogs in a direction that faces the wind, whenever possible, to aid the dog in picking up on scent that is being dispersed.

Scent can also become trapped in areas called scent pools, which are concentrations of scent that form usually right above or near a set of remains (Judah and Sargent, 2014; Rebmann, 2000). Conversely, some situations may lead to a scent void or an area where no scent is present. For example, warmer temperatures cause scent to rise and dissipate more quickly than do colder temperatures, meaning there may be a void where scent is expected (Judah and Sargent, 2014; Rebmann, 2000). It is crucial for the handler to be aware of environmental circumstances that will vary the release of scent in the air so that the dog has the best chances at success. Closely monitoring the dog's behavior and trusting the dog to perform as trained is vital in becoming a successful HRD team. Understanding the possible field limitations that could occur because of shifting winds are also important.

2.5 HRD Dog Limitations

While there have been several studies that attempt to discuss the specificity and reliability of trained HRD dogs, common ground is still hard to find in terms of measuring the data. Johnen and Fischer (2013) point out that methodological differences in the design of such studies make it hard to compare results across multiple sets of studies. There is limited consistency which makes accuracy harder to describe. This means that the highly variable methods of training used by different organizations can be

difficult to directly compare for accuracy. This information helps to confirm that more research is needed to help understand the differences discussed.

While more is understood now about how HRD dogs, and their noses, work, there is still a lot of room for experimentation and research to fully comprehend the canines' abilities and future potential in legal cases. To this day, there are no state, national, or international standards that exist for the training and certification of HRD dogs. As demonstrated through this review of the literature and relevant work, variations in training can have lasting effects on the reliability and accuracy of these canines. Whereas organizations such as SWGDOG have formed to help address issues of reliability and performance, more work needs to be done in this area. My project aims to address some of these issues by incorporating surveys, shadowing, and an experiment to test multiple aspects of canine and handler training within a single organization.

CHAPTER 3: METHODS AND MATERIALS

3.1 Surveying of Members of HRD Organizations

To begin to further investigate pertinent aspects of HRD dog training and abilities, I surveyed experts in the State of North Carolina from March-April 2017. This study followed protocols approved by the Humboldt County Institutional Review Board (approval no. 16-227). To start, I performed an internet-based inquiry for search and rescue organizations that train and utilize HRD dogs within North Carolina. This included identifying organizations that fit specific parameters for this project. Specifically, I wanted to focus on HRD training and not on other forms of canine detection work. The experimental component of this project that followed the survey and shadowing was based upon soil types common to the state of North Carolina. Therefore, dogs in this state were more appropriate than dogs from other states and served as a way to limit the population to a controllable size. Finally, this experiment attempted to understand training methods on a state level, meaning using more than one state could provide confounding evidence.

Contact information from the organization such as website address, physical address, and group name, were collected and organized into an Excel spreadsheet. The types of training the organization conducted, if listed online, was recorded as well. This includes HRD, live find, wilderness air scent, and any other type of training that the

organization may conduct. If the organization existed outside of the state or did not train HRD dogs, it was excluded from the list.

Based on the information gathered via the internet, eleven organizations were found to fit the criteria for this project. I emailed canine handlers and trainers at these organizations to invite them to participate in a survey aimed at understanding HRD training methods. The initial email to potential participants explained the purpose of the survey, provided directions for filling out the informed consent and accessing the survey, and also gave a deadline for participation. The survey was distributed after expressed informed consent (available in Appendix A) from the participants. Multiple handlers and trainers from the same organization were asked to take the survey to expand on responses and to highlight any training variances that may exist within a single organization. This also allowed for responses from individuals with varying levels of experience within the field.

Surveys were circulated to the selected organizations for dog handlers/trainers to complete via email using Google Forms. Google Forms is a free resource that does not limit the type of questions or amount of questions asked per survey, unlike other online survey outlets, and therefore was the most appropriate medium for dispersing the survey. Questions were phrased mostly in an open-ended manner to allow for more personalized and elaborate responses than a simple multiple-choice survey would allow. A copy of the survey is available in Appendix B, and example questions are included below:

- What type of training or certification process did you go through to be able to train canines?
- Once certified, are there any required steps for you to maintain certification as a trainer or dog handler? If so, what are the requirements?
- What are the requirements for a dog to be certified as an HRD dog?
- What type of alerts do you train your dogs to give when they have located a target scent? Are these alerts active or passive?
- Are the canines you work with trained in multiple fields? (i.e. HRD and live find?) Why or why not?

3.2 Shadowing of HRD Organization in North Carolina

The second part of this project included shadowing a specific organization to learn more about how HRD training occurs for both the dogs and handlers. The project complied with protocols approved by the Humboldt State University Institutional Review Board (Approval no. 17-043) and Institutional Animal Care and Use Committee (Protocol no. 17/18.A.22-E). Data were collected from November-December 2017. One local organization was contacted via email to participate in both the shadowing and the experiment parts of the project. The group was one of the organizations that also participated in the electronic survey; therefore, they were already familiar with me and the goals of my project. I asked if I could observe three separate training sessions of the organization and to take notes on certain aspects of training before conducting my field

experiment. Each training session lasted about four to five hours and the date, time, and the location was chosen ahead of time by members of the organization who coordinate regular training sessions. Each location was based in southeastern North Carolina. However, in order to protect the anonymity of the participants, the specific locations will not be released.

Before beginning, all participants were asked by the researcher to sign informed consent documents at the beginning of the day on the first training session they attended and were allowed time to ask questions about the observation period. Any risks associated with the research were shared with the participants and they were informed of their right to quit participating at any time. Handlers were also asked some demographic questions on the first training session, which included basic information about the handler and his/her experience, as well as information about the canine working alongside each handler. A copy of the demographic questionnaire is available in Appendix D. A code has been used to protect the anonymity of the participants and the names of the handlers and the canines will not be released. In total, there were seven teams of canines and handlers. The experience and age of both the handler and canine varied between each team. The breeds of the dogs included: English Springer Spaniels, Australian Shepherds, German Shepherd mixes, and Pit Bull mixes. The detailed demographic information for each participant is available in Tables 2 and 3 (See Section 4.2.1).

A standard observation form was used to observe standard training exercises that the organization uses to practice. The name of the handler and dog team being observed

was recorded, as well as the date, location, weather conditions, and description of the exercise area. From there, I recorded notes on the behavior of both the canine and handler from the beginning to end of each exercise. A copy of this form is available to view in Appendix E. The use of the form was to maintain consistency in observations between each exercise.

At the end of each training session the physical data sheets were scanned and backed-up digitally in a password protected Google Drive folder. The data from the background information form were added into an Excel document. The observational data were analyzed separately but followed similar backup and storage methods.

3.3 Experiment with HRD Organization in North Carolina

Following the survey and shadowing portion of this project, an experimental component was designed to quantitatively explore canine olfactory abilities and overall reliability, specifically to test an HRD dog's ability to locate human bone samples under different common types of North Carolina soil. Protocols were approved by both the Humboldt State University Institutional Review Board (Approval no. 17-115) and Institutional Animal Care and Use Committee (Protocol no. 17/18.A.49-A). Testing was conducted between July 2018 and August 2018.

Five teams of canines and handlers were used from the same professional organization that participated in being shadowed. Each handler and canine were previously shadowed and therefore demographic information from each participant had

already been collected. Further, each team was certified in Human Remains Detection work, which was a requirement for participation in the experiment. Because each team has varying levels of experience within the field, it allowed for more encompassing data to be collected and interpreted. Before data collection began for the experiment, informed consent forms were signed for each participant. A blank form is available for viewing in Appendix F.

The goal of the experiment was to understand if the type of soil human bone was buried under would affect the ability of an HRD dog to locate the sample. Soils from across North Carolina have different textures that range from sandy to clayey. The texture of the soil could impact the amount of scent from a source material that can be released into the air for detection by canines.

3.3.1 Materials

Four common soil types were used for this experiment. State soil surveys published by the North Carolina Department of Agriculture and Consumer Services were used to determine the most prevalent soil types across the state. North Carolina has six soil series, or groups of soils that have a similar arrangement of layers, as well as similar physical and chemical compositions, throughout the state (North Carolina, n.d.). The soil series can be broken down into the following regions: Southern Blue Ridge, Carolina and Georgia Sandhills, Southern Piedmont, Southern Coastal Plain, Atlantic Coast Flatwoods, and Tidewater Area (North Carolina, n.d.). For the scope of this project, only four of the six areas were selected for use in testing. Specifically, the soil was collected from the

latter four regions listed above. Samples came from the following counties: Union, Johnston, New Hanover, and Pasquotank, which are circled on the map in Figure 3.



Figure 3: Map of North Carolina

Per each soil type, four 16-ounce clear-glass mason jars were completely filled, sealed with a lid, and labeled on the lid based on location. The soil was taken from at least one inch below the surface layer using a trowel in order to avoid contamination from surface materials. This created a total of 16 jars of soil for use in the experiment. Each jar was given a reusable chalk label for numbering during testing. An example is below in Figure 4.



Figure 4: Example of Jar used in Experiment

As shown in Figure 4, the jars were sealed with a standard mason jar lid, and a twist off lid with pre-punctured holes was used on top. During testing, the sealed lid was removed, and the pre-punctured lid remained on the jar both to allow the scent to release into the air and to prevent soil from spilling in case the jar tipped over during testing.

This project had a focus on the impact of HRD work with forensic anthropologists, and thus the samples chosen were human bone rather than other tissues. Dry bone provides less of a scent profile than other tissues, such as blood or muscle attachments, but it also provides an extreme case study that examines the abilities of trained HRD dogs. As an added benefit, human bone is simpler to obtain, store, transport, and use more than once when compared to blood or other tissue.

Four human carpals (wrist bones) were purchased through Skulls Unlimited International for use during the experiment. Skulls Unlimited International is a reputable organization that provides legally and ethically obtained natural bone to academic and medical research communities. Before being sold, bones are cleaned with dermestid beetles and usually, bones are whitened and degreased using a chemical process. However, I contacted Skulls Unlimited directly and addressed by project topic with them. They have assisted HRD organizations and are able to provide bone that has not been chemically cleaned for training purposes. It was noted that using bone without any residual soft tissue left attached could limit the scent that was dispersed during testing and this limitation is addressed in the results section.

The subjects were canines and their respective handlers that were also shadowed during the observational period. In total, there were five teams that participated in the experiment and each had varying levels of experience. Further, the breeds, sex, and ages of the dogs differed. Background information was collected on each team and is available in Section 4.2.1 (Tables 2 and 3).

3.3.2 Methods

One week before testing began, one human carpal was buried two inches under the jar of soil for one of each type of soil set. Meaning, for each soil type, three jars contained only soil and the fourth contained both soil and a carpal. Gloves were used to place the bone in jars to prevent any contamination or scent mixture. Once the carpal was placed in a jar of soil, it was not removed until the end of all testing. This was done to eliminate confounding scent profiles or mixing of the soil samples. It also allowed the

scent of the human bone to dissipate throughout the soil for a longer period of time, which would serve to release more VOCs over time. All soil jars were stored indoors and away from other materials before and after testing. Jars were transported to and from testing locations via the researcher's personal car and only the researcher had access to the jars to avoid any accidental contamination.

Each set of jars was labeled 1-4 and the jar that contained the human bone was labeled with an "X" under the bottom, out of sight from the participants. Only I (the researcher) was aware of which jar contained the bone sample. All sets of jars of soils were spaced eight-paces, or about six to seven yards, apart across an open field at predetermined testing sites. Each set was separated as much as possible to avoid any issues of the scent crossing in the air and confusing the dog. Drawings of each of the testing locations are included below. (Figures 5 and 6). Note that the drawings are not to scale and are for reference only. Figure 7 shows the size and positioning of some of the jars from the second date of testing.

The following is a key for the abbreviations used in Figures 5 and 6:

- JC- Johnston County
- PC- Pasquotank County
- UC- Union County
- NHC- New Hanover County

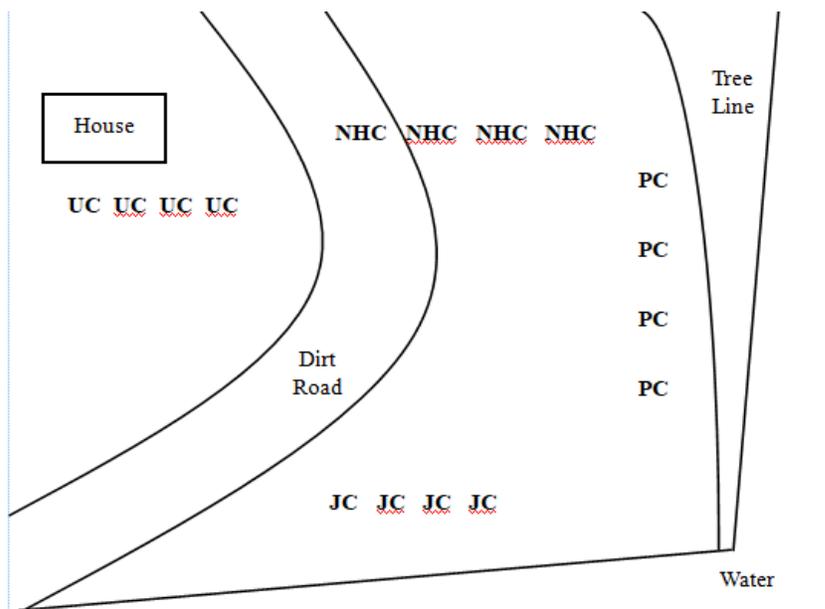


Figure 5: Map of Experiment Location One (Not to Scale)

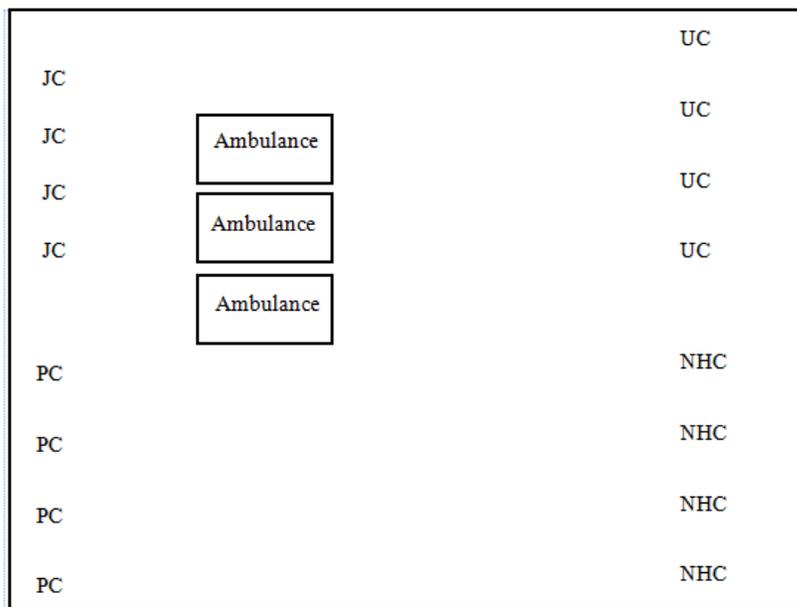


Figure 6: Map of Experiment Location Two (Not to Scale)



Figure 7: Image of jar spacing with arrows indicating the location of jars.

One at a time, handlers walked with their dog on lead past each jar in a set. Other handlers were not allowed to watch the testing process to avoid potential bias and handlers were not informed if the alert provided by their dog was correct or not. The time it took for each dog to alert to the bone under each set was recorded per each soil type onto a pre-printed data collection form, found in Appendix G. Any missed or false alerts, or periods of interest in jars were also recorded. It was up to the handler to tell me when their dog was providing a final indication on a jar. The testing was conducted twice per team over the course of two dates to examine accuracy over time in alerts. The numbering (1-4) of the sets of jars changed between each testing date in order to prevent bias in testing. However, the bone was never removed from its original jar during this process.

As mentioned, the handlers of the canines were not informed of which container had the samples to avoid any potential bias. A study by Lit and Oberbaur (2011) showed that the handler's belief that scent was present in a location affected handler identification of detection dog alerts. This means that the handler's behavior could affect outcomes of scent detection dogs. Results from the initial survey conducted in this project revealed mixed thoughts on handler bias and it was deemed necessary to create a blind experiment in order to avoid potential bias. Whether it is intentional or not, there is a chance that the accuracy and reliability of dogs are altered by the presence or actions of the handler. Therefore, only the researcher was aware of which mason jar contained the human bone. All collected data was scanned and saved in a Google Drive folder for storage and analysis.

CHAPTER 4: RESULTS

4.1 Surveying of North Carolina HRD Experts

Surveys were distributed to HRD organizations across the state to learn more about training methods and standards for HRD work. The electronic survey was emailed to a total of eleven organizations across North Carolina. After the three-week time-period, five responses were returned. Four of the five responses came from a single organization and the fifth was from a separate organization. When the email was distributed, it was asked that multiple individuals from an organization participate, not only to increase responses but to indicate if there were any variations within an organization for training methods. Two organizations reached out to me and asked questions about the purpose of my survey. One chose not to get involved and the other participated in the survey after a brief email exchange. After three weeks, the submission option for the survey was removed and the data was exported into a secure excel sheet for analysis. The responses indicated similarities in some areas and differences in others. The complete survey responses are available in Appendix H.

4.1.1 Demographic information from surveys

Each of the survey participants was asked to provide basic information about the length of time they have worked or volunteered at their present organization (see Table 1). Of the five participants, four worked/volunteered on a part-time basis with their respective search and rescue team and the fifth worked full-time.

Table 1: Survey Participants' Years of HRD Experience

Length of Time in Current Organization	Number of Responses
1-2 years	1
3-5 years	1
6-10 years	1
10+ years	2
Total Participants	5

One of the survey questions asked about specific breeds that were used by the organizations if any. The survey results indicated that whereas any dog is welcome to be trained as an HRD dog, there are certain breeds that do tend to perform better, including: German Shepherds, English Springer Spaniels, Malinois, Australian Shepherds, and Labradors. Respondents indicated that dogs with a high prey drive were most likely to succeed in this type of work, which is why specific breed tended to be less of a factor in deciding which dog to train or not. Prey drive is tied to high energy levels and can also equate to a high toy drive. This is an important quality for training purposes because it serves as motivation for the dog to learn and be rewarded for positive behavior. The breeds referenced above fall under the classification of herding or working dogs and these breeds are most likely to exhibit the high prey drive, as mentioned in the background chapter of this project. However, any dog is capable of having those qualities. There were no comments made about purebred dogs or mixed breeds. This could mean that no distinction is made between the two, so long as the dog can perform.

4.1.2 Training and maintaining an HRD dog

Several of the questions in the survey pertained to the training and maintenance of both the handler and the canine abilities. The responses from the five participants varied slightly, but there was a consensus that it takes about one-to-two years to fully train an HRD dog. During that time frame, many training methods and processes are used for both the handler and canine.

In the case of the handler, training methods to become certified to handle and train an HRD dog varied. The participant who indicated full-time involvement with their organization also stated that they went to school to become a canine trainer, which is where their experience stemmed from. Specific details on the school or specific techniques were not included in the response. The other four participants listed a combination of being a Search and Rescue Technician (SAR Tech), as well as taking various courses, attending national seminars, and participating in training sessions with multiple agencies as methods for learning. Some of the participants also noted the importance of being trained in wilderness and emergency survival. One participant stated that they had taken:

“classes in law of search and seizure, criminal procedure, crime scene preservation and preservation of evidence, certification in HazMat awareness and operations, and personal protective equipment.... I am also an NC Rescue Technician and EMT, and SAR Tech certified.... Trained and experienced in managing land search operations, and I teach the use of mapping, GPS, and GIS software in search planning and operations.”

Although the responses were mixed, there seemed to be an underlying indication that multiple methods of achieving certification are possible, even within the same

organization.

Participants were later asked if maintenance of certification as a trainer was required (Question 7, Appendix B). One stated “no” but the remaining participants indicated that regular practice and maintenance of up-to-date standards and skills are required. One respondent also listed that maintenance of skills as a SAR Tech is important as well as emergency response courses that are available through FEMA. One participant stated that they were to be tested for recertification every two years. However, no other responses matched that, and details were not provided as to what would be required for recertification.

Questions were also asked regarding the required training and maintenance of certifications for the canines (Questions 6 and 7, Appendix B). One participant clearly stated the requirements within their organization as:

“The operational dog -- working on or off lead -- must locate two out of up to three sources (one tissue, one dry bone and one evaluator's choice) in a reasonable amount of time in a 1-acre site, with no false indications. The dog must have an obvious final indication. The handler must describe his or her search strategy. Sources can be suspended, buried (shallow and deep) and in brush. Prior to certifying, the dog also must demonstrate obedience and agility, and must be social. The dog also must previously have passed his or her Canine Good Citizen evaluation.”

The other responses were not as in-depth but did state that the dog must meet the organizational standards. As for maintenance of certification, dogs must maintain the same responsibilities as their handlers. They must practice several times a month and undergo a process of recertification once every two years. Again, the specific tasks

associated with recertification were not elaborated on or discussed in the survey.

The responses from this series of questions iterate that there is variation in how training and maintenance is achieved. More importantly, much of the variation from these responses comes from members of the same organization. Therefore, individuals from a variety of backgrounds and experiences provide different insight as to how training and maintenance of an HRD dog can be completed. While the survey did not yield specific details from some of the responses, the overall message is clear: there is ample variation in the way both handlers and canines become experts in the HRD field.

4.1.3 The presence of handler bias in training

Question 13 in the survey was regarding handler bias and asked participants if they thought body language or tone of voice could impact a dog's decision to alert on a location. This question yielded very mixed responses. Two survey respondents answered "no" and the other three answered "yes." One answered with a strong "Absolutely." Another participant had the following response: "I have seen handlers in training unconsciously cue their dogs by giving repeated commands or reaching for rewards when they know the dog is at source. As flankers we will point this out to the handlers." The ones who answered "no" indicated that they are blind to where the sources are hidden in training, so they do not believe that they could possibly lead their dog to an alert since they were also unaware if the dog would be correct or not. This was an important question that I used later in my research to ensure that blind testing was completed during the experiment. I wanted to eliminate the possibility of bias within my field research. Even a slight gesture towards a treat pouch could act as an indication for the dog to alert

on a scent that may not be present. The results from this survey question were vital to the next phases of the research project.

4.1.4 Potential of standardized HRD training

One of the most informative questions of the survey was the open-ended question at the end that asked: “Do you feel that there should be a standard training method for HRD dogs on a state or national level? Why or why not?” (Question 14 in Appendix B). The responses to this question were a resounding “no.” All participants gave reasons as to why they felt this way. Some responses indicated that each dog learns in his own way, therefore it is not realistic to use a standard approach for each dog. It is similar to the way professors teach. Each has his or her own way of teaching material to students and there is not one single correct way to do so. Students also have their own ways of retaining new information, and every dog has its own motivation for performing well. Some are driven by toys, others by treats, and some by praise. The needs of the canine must be understood in order for training to be successful. Therefore, standardizing training methods would be disadvantageous in this regard. One participant summarized this point by succinctly stating: “No. All trainers and dogs are different individuals. There are more than one ways to train. Some training methods do not work for all dogs.”

Two respondents indicated that the question should be two-fold: meaning standardization in training and standardization in certification. Both agreed that standardization in training is not possible or realistic due to the reasons mentioned previously. However, there is a possibility of standardized certification procedures. One respondent stated being in favor of standard certification methods “to ensure measurable

levels of competency for handlers and dogs, I do support minimum standards of certification.” The other individual said that “there's no assurance the team will continue to work as hard after that. I believe that one ‘outside evaluation’ is appropriate because both handler and lead instructor benefit from that. But after that, it's up to senior handlers to continually evaluate the teams coming up and give them opportunities for growth and a wide range of training scenarios.” These variances in responses help to highlight the diversity of the field and the range of reliability and accuracy that could be expected from different organizations.

4.2 Results from Shadowing the Experts

The observational period, which concentrated on understanding training methods utilized by one specific HRD organization, was conducted on three separate dates between November-December 2017. The gaps between training sessions occurred because of the predetermined timing of schedules. All training dates fell on a Sunday and each date and location was coordinated in advanced by members of the training organization. Each of the training sessions occurred in a different, but previously used (by the handlers), location within southeastern North Carolina and focused on different aspects of canine and handler training. As mentioned previously, the specific locations for testing will not be listed to protect the anonymity of the participants.

The variance in training locations allowed both the handlers and the canines to practice skills in different environments to help increase reliability. The training sessions

started at 9:00 am and two of the three sessions ended around 1:30 pm. The final session lasted until 4:00 pm and was more extensive. Each day started with preliminary meetings to discuss the goals for the day and to explain the general types of exercises that were arranged for the handler/canine team to practice.

In total, there were seven participants during the three-day observational period. Not all participants attended each of the training dates that were used for the observational period, but some were present for all three. On the first date of interaction, after completing informed consent (Appendix C), each participant provided information regarding their qualifications in the search and rescue field through the demographic data form. A full list of questions can be found in Appendix D. It should be noted that the seven participants were not the only members of the organization- those were the only members that attended the selected training dates. During the training, an observational form was completed for each handler/canine team for the exercises that were conducted. Every participant was shadowed at least once with the exception of the Pink Team, because of both timing and their limited training and experience.

4.2.1 Demographic data

Gender of the handler participants was not recorded to help protect the anonymity of the individuals. Of the seven canine participants: five were male and two were female. Tables 2 and 3 list the demographic information for the handler and canine participants of each team. To protect anonymity, individual and canine names were replaced by colored team names, which were assigned at random. Each team name remained the same for both the observational period and the later experiment.

Table 2: Handler Demographic Data from Observations

Handler/Canine Team	Time with Present Organization	Time in Search & Rescue	Handler Certifications or Qualifications	Total Canines worked with	Cases Worked (estimated)
Red Team	20 years	20 years	SAR tech I, CPR, Med Resp., SCS 100-400, 700, 800, HazMat, Air Operations	4 total (1 at a time)	~300 total (30 with current dog)
Orange Team	2 years	2 years	SAR tech II; general obedience since 1995, SAR since 2015	1	4
Yellow Team	10 years	20 years	SAR Tech III, HRD, WAS, PA DNA field team member	4 total (1 at a time)	10 (with current dog)
Green Team	4 years	4 years	SAR tech II, WAS, HRD, Water recovery, disaster relief	1	10-20
Blue Team	20 years	20 years	SAR tech II, Man tracking, ICS, HRD-Advanced	1	~50
Purple Team	3 years	3 years	HRD, WAS	1	6
Pink Team	~7 months	~7 months	in training	1	NA

Table 3: Canine Demographic Data from Observations

Handler/Canine Team	Canine Age	Canine Sex	Canine Breed	Canine Concentration	Canine time in Training	Length in time certified
Red Team	5 years	Male	English Springer Spaniel	WAS, HRD, water recovery, first responder	5 years	4 years
Orange Team	2 years	Female	English Springer Spaniel	WAS, HRD	2 years	2 years
Yellow Team	4.5 years	Male	German Shepherd Mixed Breed	HRD, WAS	4 years	2 years
Green Team	3.5 years	Male	Pit Bull Mixed Breed	water recovery, rubble piles, WAS, HRD	3.5 years	3 years
Blue Team	8 years	Male	English Springer Spaniel	HRD, WAS, confined space	7 years	7 years
Purple Team	2 years	Female	Australian Shepherd	HRD, Search	1.5 years	1 year
Pink Team	11 months	Male	Mixed Breed	Training for air scent, HRD	~7 months	NA

All the participants except for one gained all of their experience in the search and rescue field through the organization they were currently working alongside. The time in the field ranged from roughly seven months to up to twenty years. This provided a wide range of experience to shadow and learn from as demonstrated by the number of cases that each team has worked alongside local law enforcement. The individual with only seven months of experience was also still in training for certification in search and rescue and was in the early process of training a canine for Wilderness Air Scent (WAS) work which must be learned before learning HRD work, per the regulations of this organization. As for the canine demographic, three of the canines were English Springer

Spaniels, two were mixed breeds, and one was an Australian Shepherd. Length of time in training and certifications achieved are listed in the table above.

4.2.2 General observational data

Over the course of the observational period, eighteen data forms were completed for the seven participating teams. Four were completed on the first date, nine on the second date, and five on the final date. Table 4 breaks down how many exercises were recorded per team.

Table 4: Number of Observations Collected per Team

Team Name	Exercises Recorded
Red Team	1
Orange Team	6
Yellow Team	3
Green Team	3
Blue Team	2
Purple Team	3
Pink Team	0
Total:	18

All participants except for the Pink Team were shadowed at least once. No observations were recorded on the Pink Team because they only participated in one exercise during the three days. It was not possible to shadow and take note of every exercise conducted over the observational period due to overlapping timing. Most times, multiple teams were completing different exercises at the same time and it was not possible to observe more than one at a time. Further, not all participants were present

during all three training dates during the observational period. Therefore, the presented data should be considered a snapshot of what typical training exercises would be for the organization.

The exercises included a combination of live-find practice and HRD searches. During live find exercises, one person would hide in a pre-determined search area and the assigned team would proceed to locate that “victim” alongside at least one other team member for support. The human remains detection exercises consisted of a combination of source materials, including: dry human bone, human bone with muscle attachments, human teeth, human placenta, and human blood on gauze or a similar fabric. All materials were legally donated by volunteers or sourced from reputable organizations and gloves were always used to protect both the individual and the source materials from any contamination during placement. Further, many of the sources were placed within containers to help prevent further contamination in case the dog picked up the material. Examples of containers include old pill bottles, Tupperware, or wired cages. There was always more than one source present in each test area and the materials would be laid out in the morning by one or two team members and allowed time to release scent before any dogs would practice in the area. Typically, materials were not buried, and would either be on the ground or at a slight elevation, such as hanging from a fence or tree limb.

Only one handler/dog team would participate in a specific exercise at a time and the remaining dogs remained inside a crate within the respective owner’s vehicle while not working. All dogs were properly equipped with water, shade from the heat, and were

provided all necessary comforts for their health and safety while in their crates. In each of the exercises, dogs were able to work off-lead, or without being on a leash. This freedom allowed the dogs to have more room to search a wider area. Each of the observations that were recorded are listed in Tables 5, 6, and 7 and are separated by date and location. On all three dates, the weather was sunny with a slight breeze. Temperatures, recorded in degrees Fahrenheit, ranged from the mid-50s to the upper-60s across all the dates.

Whereas the participants followed the same exercises, each displayed some differences in approaches used to work the exercises. Most handlers used the phrase “find koli” to search for human remains, which is a specialized term that is only used by the team during HRD work. It allowed the dog to focus since the word was not likely to be said in any other situation. Similarly, handlers used the phrase “show me” and “go check” as commands. “Show me” was a command to tell the dog to re-find the material (missing person or tissue sample). “Go check” was a directional command used to tell the dog to search a specific area more closely. The commands used by each team are included in Tables 5, 6, and 7.

4.2.3 Data from the first observational date

The first training location included an area with a small body of water as well as a wooded area. Table 5 below contains the data that were collected on that date.

Table 5: Observations from 11/19/2017 at First Location

Hander /Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
Orange Team	cadaver search on land- 5 items	mixed HRD samples (bone, tissue)	open path with 5 hidden samples on either side; lake to the left; lots of trees, pinecones, pine needles, sticks, etc.	find koli, check it, show me (after alert), no touch (of the items)	-dog sits for alert; sniffs at the ground (not the air), gets treats and praise for alerting
Orange Team	live find-volunteer hiding in the woods	live find (hiding person)	dirt path, lots of trees; high grass off on either side; path led to a small bridge	go find; let's go (when getting distracted)	-dog moves ahead as handler follows and keeps a distance; camera team walked through the path which caused a slight distraction; dog went too far and had to backtrack to find handler; exercise took longer than anticipated
Red Team	cadaver search on land- 5 items	mixed HRD samples (bone, tissue)	open path with 5 hidden samples on either side; lake to the left; lots of trees, pinecones, pine needles, sticks, etc.	find koli, check it, show me (after alert)	-handler told dog places to check and followed the dog; stayed close to the water as if the exercise was a drowning case; stopped walking when the dog got ahead but handler knew where he needed to come back to check again; dog jumps on handler's chest when alerting (will sit if can't jump); dog got into water multiple times and alerted (Stayed in water to show alert location)
Yellow Team	cadaver search on land- 5 items	mixed HRD samples (bone, tissue)	open path with 5 hidden samples on either side; lake to the left; lots of trees, pinecones, pine needles, sticks, etc.	come (when he ventures from the path); check (look for HRD); show me (after alert)	-dog's alert is lay-down; gets a Kong toy as a reward and they play for a minute after each find; dog goes wide and circles back a lot; very high energy; does not get rewarded with treats-only toy reward

The location used in the first observational date was open to the public and so there were a few interactions with people outside of the organization. For example, the Orange Team (Table 5) was slightly interrupted by a small camera crew who walked near the missing person exercise. However, the dog was able to remain focused and complete the objective, which indicated a strong foundation of obedience in the dog. Over the course of this training date, only two exercises were designed. One was a cadaver search with five sources laid out by a large body of water and the other was a missing person's exercise. The conditions remained the same throughout the date, but the methodologies of each team varied slightly. Most of the commands and terminology were consistent across the board, but methods of rewarding the canines varied. Some handlers used toys, while others used treats and praise to reward a dog for an alert.

4.2.4 Data from the second observational date

The second training date consisted of different exercises than the first date. The location was a private area with no public access. The location was also commonly used by the organization for training and meetings. It consisted of an open wooded area, an agility area for dogs, and an enclosed area with various materials, such as old vehicles, wood piles, debris, and more. Observations are recorded in Table 6 below.

Table 6: Observations from 11/26/2017 at Second Location

Handler /Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
Blue Team	HRD search in a dark tractor-	HRD residual scent on a towel; a bag	trailer with open doors; very dark inside;	find koli; check it; show me; easy	pump the dog up before going off lead; doesn't look at dog while working to help avoid accidental cues; dog alerted

Hander /Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
	trailer and a wood pile	of teeth in the trailer	grassy open area around it; wood pile close by	up/down for stairs (older dog); rehyped (lots of energy) for round 2 (woodpile)	outside of trailer but it was false (handler checked with others to see); dog tried to re-alert (handler bias-dog was looking at handler for clues); 2 false alerts but found both samples inside trailer; alerted on opposite side of woodpile where towel was; found the 2nd with no problem
Green Team	HRD search on land	dry bone- 6 items	multiple trailers; grassy area; fenced in area; some wood piles; bone on porch, under a rug, hanging from the fence; bone under trailers	hype up; find koli; check it; come back; put your nose on it	elevation problem; 2 sources up on the fence; sits and put paw on bag on porch; crawled under trailer to search; looked up for source; sniffed rug, looked interested (came back after and alerted on tooth); sat and barked- asked for a show me; 2nd elevated - kept looking at the ground
Green Team	HRD search in a dark tractor-trailer and a wood pile	HRD residual scent on a towel; a bag of teeth in the trailer	trailer with open doors; very dark inside; grassy open area around it; wood pile close by	find koli; check; show me	sits and faces handler; will bark for alert and sometimes paw at source; actually climbed the woodpile to check the area
Orange Team	"hot or not"- checking the area for HRD material and proofing off jars/containers	hair and salad dressing, empty fast food bag; NO HRD material	open shed area with woodpiles, large yard equipment, small trailer, random items used by FTC	find koli, go check	-dog did not indicate on anything which is good because all samples were blank; hair does not give off a scent; dog passed the exercise
Orange Team	HRD search on land	dry bone- 6 items	multiple trailers; grassy area; fenced in area; some	find koli; keep working	performed death roll on tooth (specific alert behavior but not a final indication); handler steps in place so dog thinks handler is still moving (trying

Handler /Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
			wood piles; bone on the porch, under a rug, hanging from the fence; bone under trailers		to avoid accidentally cueing the dog that a spot might be hot); started at one end and move down to the other; circled back after missing the fence; false alert on the first rug and no alert on the correct rug with tooth; picked up a femur and was told to drop it (behavior was corrected to sit); tried to pick up a random soda cup but didn't alert on it
Orange Team	HRD search in a dark tractor-trailer and a wood pile	HRD residual scent on a towel; a bag of teeth in the trailer	trailer with open doors; very dark inside; grassy open area around it; wood pile close by	find koli, show me	dog went straight for the woodpile even though the instructions were to check the trailer (testing the dog and handler); dog was hesitant to work in the dark trailer (used as training moment); dog sits for alert- show me; handler made some noise in the trailer to dog her used to the atmosphere; watch out for handler cues- Handler stopped in front of the 2nd towel in woodpile which may have cued dog to alert there
Purple Team	HRD search on land	dry bone- 6 items	multiple trailers; grassy area; fenced in area; some wood piles; bone on porch, under a rug, hanging from the fence; bone under trailers	work! (gets her super pumped and yells); go find it; show me	Dog went under one of the trailers and didn't want to move- handler told dog to check the other side since there was so much interest; not well trained on bones so dog struggled (but this is the point of practice); showed dog one of the bones to get it used to the exercise and praised dog when it went back for the show me; gets rewarded with toys and not treats
Yellow Team	HRD search on land	dry bone- 6 items	multiple trailers; grassy area; fenced in area; some wood piles; bone on the	show me; come; too far	was very excited and didn't want to give up toy after first alert (did this more than once); struggled with the toy; looked up and down a lot and finally found the rib on the fence; found all 6 sources

Hander /Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
			porch, under a rug, hanging from the fence; bone under trailers		
Yellow Team	HRD search in a dark tractor-trailer and a wood pile	HRD residual scent on a towel; a bag of teeth in the trailer	trailer with open doors; very dark inside; grassy open area around it; wood pile close by	go find; gets a toy reward- not food	lays down in front of source; found towel quickly; Handler showed him second source and went back to it; Dog went into the trailer on his own (other dogs needed more coaxing); found both inside

Matching with the first training date, there was a combination of live find and cadaver material exercises. There was also a “hot or not” exercise designed to test the dogs against false alerts. That exercised consisted of several containers in the test area that were similar to ones that are commonly used by the team to hold cadaver materials (pill bottles, jars, Tupperware, etc.). However, none of the containers held anything and they were all blank. The goal of the exercise was to make sure the dogs were not making an alert simply on the familiar container, but that they were actually searching for human remains. While only results from the Orange Team were collected, each team participated in the exercise and all dogs passed.

4.2.5 Data from the third observational date

The final training date (Table 7) was specialized in that the dogs were being introduced to water searches. The team paired with the local fire department and dive team to teach the dogs and handlers how to operate on a small boat in the water. The dogs

were tasked with getting familiar with both being on a boat and having a diver in the water. Further, there were other water-based exercises where the dogs attempted to locate human tissue that had been submerged several feet under the water. Because this was a new exercise, it was important to monitor the behavior of the dogs to see what their natural responses would be to alert to human remains material. Not all dogs responded the same way and it was important to allow the dogs to figure out how they wanted to alert their handler to the presence of human tissue and for the handler to positively reward the dog from those interactions.

Table 7: Observations from 12/17/2017 at Third Location

Handler/ Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
Blue Team	submerged diver in water; dog practiced alerting from the scent and took a hotdog from diver to overcome fear of mysterious thing in the water; 2 rounds each	human diver	dog is on boat with handler and captain; water is dark colored but only ranges from 5-10ft deep; no other people or boats in the immediate area	go check; get up (onto the front edge of the boat)	Round 1- showed dog the diver and gave diver hotdog so dog could see that diver had it; dog was unsure about the activity; Round 2- more confidence; let the dog do what it wanted in the boat; wandered and sniffed and got comfortable; round3- more attentive; ready to alert and find the diver (started to get the game)
Green Team	scent was submerged in containers (some open wire and others closed spice containers) with visible buoy on top; goal was practice with alerting in water- not so	placenta, teeth, mixed HRD (were 5; 2 sank and were removed later- worked with 3 floaters)	scents were separated around semi-sunk boats; not more than a few feet under water; scent sat in water for some time before being	find koli; get closer (to where the scent is coming from); get up (front of the boat)	Dog was very excited and jumped off the boat once (think it was going toward scent); did not jump off boat during diver practice; barks for alert; scent was very close together and was mixing in the wind, so it was getting difficult to tell if alert was real or for attention; found all 3 sources; captain moved

Hander/ Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
	much about finding hidden sources (one step at a time);		worked on; no other people or boats around the area; only the dog, handler, and captains (and myself) on the boat		the boat to be both with and against the wind for practice
Orange Team	submerged diver in water; dog practiced alerting from the scent and took a hotdog from diver to overcome fear of mysterious thing in the water; 2 rounds each	human diver	dog is on a boat with handler and captain; water is dark colored but only ranges from 5-10ft deep; no other people or boats in the immediate area	go check	Dog was very excited and jumped out of the boat into the water (good practice for handler and captain to stay calm and retrieve dog from water); handler got control quickly; dog was not scared of the diver, but it was a new experience for the dog
Purple Team	submerged diver in water; dog practiced alerting from the scent and took a hotdog from diver to overcome fear of mysterious thing in the water; 2 rounds each	human diver	dog is on a boat with handler and captain; water is dark colored but only ranges from 5-10ft deep; no other people or boats in the immediate area	go check; get up (onto the front edge of the boat)	Dog was scared of diver first round; Handler kept trying to give commands to dog instead of letting the dog work the scent on its own; Dog had never done boat work and is still new to HRD; was less scared of diver on round 2
Purple Team	scent was submerged in containers (some open wire and others closed spice containers) with visible buoy on top; goal was	placenta, teeth, mixed HRD (were 5; 2 sank and were removed later-worked with 3 floaters)	scents were separated around semi-sunk boats; not more than a few feet under water; scent sat in	find koli; get closer (to where the scent is coming from); get up (front of the boat)	performed much better than with diver practice; still in training for HRD and had never been on the boat; was trying to let dog find a natural alert and then train from that; dog laid down as alert and was able to find all 3 sources;

Hander/ Canine Team	Exercise Being Conducted	Human Tissue Being Used	Description of Field Site	Commands used by handler	Observations
	practice with alerting in water- not so much about finding hidden sources (one step at a time);		water for some time before being worked on; no other people or boats around the area; only the dog, handler, and captains (and myself) on the boat		captain moved the boat to be both with and against the wind for practice

Due to the scope of this training, the session lasted several hours longer than the first two training dates. The situations designed were new to all of the canines and it was important to take the time to allow the dogs and their handlers to become accustomed to the new circumstances. One of the canines, from the Orange Team, jumped off the boat and into the water during one of the exercises and both the handler and boat captain had to practice their recovery skills while staying calm. The training was not only important for the dogs, but for the handlers to learn new ways to work with their counterparts. Overall, the exercises helped to show how the dog and handler teams react and learn from new situations.

4.3 Results from the Experiment

The final part of this thesis was to conduct an experiment testing the reliability and accuracy of the HRD dogs that were shadowed during the observational

period using human bones buried under soils from various parts of the state. The experiment was conducted over two dates between July and August 2018 at two different locations. One location was previously used by the team during the observational period and the other was not. The experiment was supposed to be carried out for a total of three trials; however, impacts from Hurricane Florence in the area forced the experimental design to be altered. Further, staffing changes and personal situations between some of the organization's members also influenced the decisions to modify the experiment. All participants signed informed consent documents (Appendix F) and were notified that participation was completely voluntary. The same blank data collection form (Appendix G) was used to record data from each participant on each trial date for consistency.

The weather was hot and humid, and exercises began promptly at 8:00 am each session to help avoid overheating from both human and canine participants. Table 8 shows the recorded temperatures and humidity for the testing dates and times (Weather Spark, 2018).

Table 8: Weather Data from Experiments

Date and Time	Temperature Range (°F)	Humidity Range (%)	Wind Speed (mph) / Direction	Conditions
July 8, 2018; 8:00am- 11:00am	76-84	90-91	6-8 / North	Fair / Partly Cloudy
August 12, 2018; 8:00am- 11:00am	76-83	89-91	7-8 / South	Cloudy

Testing lasted less than two hours and the same participants were used for both testing dates. Due to unforeseen weather changes and minor canine illnesses, the data collection period took longer than anticipated. However, this allowed for the scent from the buried human bone to dissipate more into the soil, which allowed for more scent to be released over time. I was responsible for setting up and breaking down the experiment each date and participants were not allowed to watch others during testing. The potential for accidental bias was prevented as much as possible by limiting the participants' exposure to the testing site before and after testing.

Table 9 shows which jar contained bone per each soil, per each trial. Also, the names of the counties where the soil originated from have been abbreviated for future reference.

Table 9: Location of Bone per Soil

Soil Type	Jar Number Trial 1	Jar Number Trial 2
Pasquotank County (PC)	2	4
Union County (UC)	3	1
New Hanover County (NHC)	1	2
Johnston County (JC)	4	3

Table 10 below shows the collected data for all participants. Per each set of soil, several data points were collected. Any indications that a dog provided for a jar (whether correct or not) was listed. I also recorded which jar a dog made a final alert (or indication) on and how long each alert took. The correct jar per set is also listed. In some instances, more than one jar was alerted on by the canine, but only one final indication was provided. If more than one indication was provided, then each one is listed. Only one

jar was allowed for final indication. Every indication, final or otherwise, was confirmed by each handler and only indications confirmed by the handler were recorded in order to avoid bias as the observer. Table 10 has been arranged to show each set of data per team, broken down between Trials 1 and 2. As mentioned previously, team names have been changed to protect the anonymity of participants.

Table 10: Data from Experiment

Trial 1- Blue Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	0	2.03	0	4
PC	1, 4	2.27	4	2
NHC	2	2.39	2	1
UC	3	1.33	0	3
Trial 2- Blue Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	1	1.56	1	3
PC	1	1.25	1	4
NHC	0	1.26	0	2
UC	3	0.25	3	1
Trial 1- Green Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	3,2	2.18	3	4
PC	1,2	3.12	3	2
NHC	1	5.49	1	1
UC	3	1.16	3	3

Trial 2- Green Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	3,4	2.13	4	3
PC	2	4.52	2	4
NHC	4,2	0.59	2	2
UC	3,4	1.35	4	1

Trial 1- Red Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	1	1.12	1	4
PC	3	1.02	3	2
NHC	1	1.02	1	1
UC	4	0.58	4	3

Trial 2- Red Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	1,4	3.20	1	3
PC	2	0.41	2	4
NHC	2	2.03	2	2
UC	1	1.25	1	1

Trial 1- Orange Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	4	1.07	4	4
PC	0	1.41	0	2
NHC	3	1.34	3	1
UC	2	2.03	2	3

Trial 2- Orange Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	2	2.55	2	3
PC	1	3.20	1	4
NHC	1,2,3	3.29	3	2
UC	2	1.24	2	1

Trial 1- Yellow Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	0	3.43	0	4
FC	1,3	1.52	1,3	2
NHC	2	1.10	2	1
UC	0	0.22	0	3
Trial 2- Yellow Team				
Soil Type	Jar indicated	Time taken to indicate (minutes)	Final indication	Correct Jar
JC	4	1.17	4	3
PC	4	1.05	4	4
NHC	4	0.52	4	2
UC	0	1.34	0	1

An F-test was conducted to determine if the time taken for correct versus incorrect indications were of an equal variance. Results of the F-Test are available in Table 11. Because $P > 0.05$, the variances were determined to be equal, so a T-test for equal variances was performed to further understand patterns in the data.

Table 11: F-Test Data from Experiment

	<i>Incorrect Time</i>	<i>Correct Time</i>
Mean	1.760313	1.7075
Variance	1.075352	2.497221
Observations	32	8
df	31	7
F	0.430619	
P(F<=f) one-tail	0.05008	
F Critical one-tail	0.430446	

Table 12 has the results from the T-test, which further revealed statistical differences in the data collected from the correct versus incorrect alert times.

Table 12: T-Test Data from Experiment

	<i>Incorrect Time</i>	<i>Correct Time</i>
Mean	1.760313	1.7075
Variance	1.075352	2.497221
Observations	32	8
Pooled Variance	1.337275	
Hypothesized Mean Difference	0	
df	38	
t Stat	0.115536	
P(T<=t) one-tail	0.454314	
t Critical one-tail	1.685954	
P(T<=t) two-tail	0.908629	
t Critical two-tail	2.024394	

The data were further broken down to show trends over time. The median time taken for each team to make a final indication per soil type is recorded below in Table 13. Table 14 shows the number of each correct final indication for all the teams per each soil.

Each trial was out of five participants and the total was out of ten (total from five participants each trial).

Table 13: Median Time Taken for Final Indication (minutes)

Soil Type	Median Time Taken for Final Indication (minutes)		
	Trial 1	Trial 2	Total
Johnston County (JC)	2.03	2.13	2.08
New Hanover County (NHC)	1.34	1.26	1.30
Pasquotank County (PC)	1.52	1.25	1.46
Union County (UC)	1.16	1.25	1.24

Table 14: Correct Final Indication (number / percentage)

Soil Type	Correct Final Indication (number / percentage)		
	Trial 1 (out of 5)	Trial 2 (out of 5)	Total (out of 10)
Johnston County (JC)	1 / 0.20	0 / 0.00	1 / 0.10
New Hanover County (NHC)	2 / 0.40	2 / 0.40	4 / 0.40
Pasquotank County (PC)	0 / 0.00	1 / 0.20	1 / 0.10
Union County (UC)	1 / 0.20	1 / 0.20	2 / 0.20
Total Correct:	4 / 0.20	4 / 0.20	8 / 0.20

All the canines worked on lead, or with a leash. Some handlers chose to use a longer, 30-ft lead, whereas others preferred a standard 6-ft lead. The discretion was given to handlers so that they could all give their dog the best chance at success. There were several concerns regarding the overall performance of the dogs. First, the dogs did not have extensive experience in working with buried remains, which presented a novel

experimental design. Because of the lack of experience with the specific exercise, none of the dogs or handlers were at an advantage over the others, thus providing the same baseline of expectations for results. Further, there may have been some confounding scent residue that could have affected scent detection. For example, fresh deer tracks were found in the first testing area (July 8), which indicated that deer had recently been in the area. The lingering scent of the animals may have had an impact on the dogs' concentration on the task at hand. However, it would be difficult to confirm if that had any influence on the performance of the dogs. Also, it was noted that using only dry human bone, with no fresh decomposition (such as muscle attachments) included, could limit the scent profile. However, the goal of this project was to understand the aid HRD dogs could provide to forensic anthropologists, who primarily work with dry bone.

Finally, the high heat and humidity were cause for concern for both the handlers and dogs. The testing areas were limited in shade and although testing for all teams was conducted early in the morning and in under two hours, it is undeniable that the heat could have impacted the performance of the dogs. Taking all those factors into account, it is believed that the dogs and handlers performed to the best of their abilities.

CHAPTER 5: DISCUSSION

The data collected from this research built upon itself through surveys and shadowing to culminate as an experiment to test the reliability of Human Remains Detection dogs. Responses from the surveys revealed and reiterated the fact that standardization of HRD dog training is not realistic. There are both variations within and between state organizations both in how dogs and handlers are trained as well as in how certification is maintained. It is highly likely that extended research into training across a multi-state level would reveal similar results. Since many HRD organizations function on a volunteer basis and act as consultants to local law enforcement agencies, there are no national or international standards that are required to be adhered to by the groups. However, results from the surveys also indicate that there are alternative methods of achieving increased credibility and legitimacy in the eyes of the U.S. court system. For example, some survey respondents discussed that whereas training methodologies may vary, there was a possibility to standardize the way canines and their handlers achieve and maintain HRD certification. There are some organizations, such as SWGDOG, that are striving to create and maintain “best practice” guidelines, but at the end of the day, it is up to each search and rescue team to work toward achieving high levels of repeatable accuracy and reliability.

While survey responses were low, the result nonetheless helped to influence the decision to shadow one of the local HRD organizations, which allowed for more detailed observations on the variances in training approaches. Variances in the commands and

tactics used by handlers emphasized the fact that dogs each learn and work in their own ways. The surveys also highlighted the same point. Each dog was motivated to work by different means and rewards. Rewards could be food based, toy based, or even praise based. Within that, the type of treat, toy, or praise was subject to variation based upon the dog's incentive to work. Each participant in the observational period used specific toys or treats for their canine counterpart. No two teams used the same reward. However, the purpose of the reward remained the same for each team. A reward was used when a dog completed a task: either locating a missing person or identifying a cadaver material. The method of positive reinforcement was a very important aspect to training.

The teams from the shadowed organization did use similar sets of terminology, such as find koli, go check, and show me (See Tables 5, 6, and 7). The common commands stemmed from original training methods used to teach the dogs how to work. It is unknown what commands other organizations use or how those commands would compare with these. However, the use of the commands was consistent throughout the observational period. This highlighted that consistency was important in terms of helping dogs retain their training and to repeat their actions.

In terms of accuracy, the observed dogs did well in locating human tissue samples that were used in testing. However, there is always a potential for bias with the handler. Many times, handlers knew where human remains materials were placed within a given testing area. Subtle forms of bias included: standing close to the source material, looking a certain direction multiple times, or telling a dog to check the same area more than once.

Usually, a second person watching an exercise would help point out when a handler was possibly influencing their dog. The potential for bias to influence the dog's behavior was monitored and was important in terms of designing the final experiment.

The experiment with human bones in jars with the various soils yielded mixed results. None of the teams achieved a complete success rate; however, such a result was expected since the participants had not previously completed this type of exercise. Overall, the teams had a 20% success rate over the course of the two experiment dates (8/40 correct indications). The results can be compared to discern several patterns.

First, the soil marked NHC, for New Hanover County, was considered the "local soil" since its context matched what would be present in the organization's normal training area. Two of the teams were able to correctly locate bone in both Trials 1 and 2 for NHC. The remaining three teams failed to correctly locate the bone in that set of soil. However, the local soil did have the highest success rate when compared to the remaining soils. There was a 40% success rate for correct final indications on this soil type on both training dates. This could be tied to the fact that the dogs had previously worked around the soil and were familiar with its context.

Next, the Union County (UC) soil scored second highest, with a 20% success rate over both experiment dates. Finally, the remaining two soils, Pasquotank County (PC) and Johnston County (JC) each had a 10% success rate over the course of the experimentation. It is unknown whether any of the participants have worked with any of the latter three soil contexts in previous training or field world. However, the fact that the

dogs were able to correctly alert at least once to each soil type helps to forward the concept of canine reliability in new surroundings. However, further research should be conducted to continue to explore these patterns over the course of longer experimentation.

The time taken to make a final alert was also observed to see if any patterns were apparent. The median time taken for the teams to make a final indication per soil type was recorded and the two soils with the fastest median time were the Union County and New Hanover County soils, with 1.245 minutes and 1.30 minutes, respectively, over the course of both experiment dates (See Table 13). The median time could have been lower for the New Hanover County soil, but there was an outlier of one time that spanned 5.46 minutes. During that specific trial, the canine was distracted and had a difficult time concentrating on the task at hand. However, the dog did make a correct final indication. The times of final alerts correlates with the fact that the dogs were able to locate bone at a higher rate with those soils when compared to the other two soil samples. The remaining soils from Pasquotank and Johnston Counties had median final indications times of 1.465 minutes and 2.08 minutes, respectively. For an exercise that was new to the dog/handler team, these were relatively quick times to achieve.

The differences in median alerts times were compared between Trial 1 and Trial 2 to examine if there were any patterns or changes. The median time taken for a final alert on the New Hanover county (local) soil decreased slightly between Trials 1 and 2. However, since only two trials were conducted, more data would be needed to explore

whether or not the differences in times were significant or not. The same applies for the remaining three soil types, which showed a mix of increases and decreases in median alert times between trials 1 and 2.

The fact that dogs performed better, both in median time and correct final indications, with the New Hanover County soil was an interesting trend to note. It would make sense that the dogs would be able to perform faster with the soil that is considered local to their own region. However, this trend would also need to be examined on a larger scale to see if other organizations who train in different soil contexts report similar findings.

Alerts were confirmed by handlers, which required the handlers to ensure that they were paying attention and “reading their dog” to look for certain cues, such as changes in behavior or active or passive alerts. In some instances, the dog would show interest in a certain jar, but would not provide a trained alert (which includes sitting or laying down in front of the source material). Interest would include sniffing the jar longer than the other jars or appearing more active at the one jar than at another. The handler was typically aware of the common change of behavior their own dog experienced and was able to decipher and relay the appropriate information to me as I recorded data. Despite the interest in a jar not being an alert, it was still important. In terms of forensic investigations, HRD organizations would still relay to law enforcement experts any area where dogs had interest and the level of interest involved so that other professionals could further investigate that location. Therefore, whereas the interest may have not been

as conclusive as an alert, the information was still viable. It also showed the importance of a strong working relationship between the dog and handler.

The mixed results and low numbers from the experiment could tie into individual factors for each dog/handler team. As highlighted through the observational period, each dog and handler had varying levels of experience. From the researcher perspective, the variances in canine and handler response seemed to relate more to outside distractions, such as heat or motivation levels. There were some instances when the dogs seemed to be uninterested in completing the trials despite the handler doing their best to keep the dog focused. The heat was likely a factor as the dogs were tired quicker and needed more frequent breaks. Had the trials been run during a different time of the year, results could vary. All these factors help to reiterate how variable HRD work has the potential to be as well as how important it is to better understand the reliability and accuracy of HRD work.

CHAPTER 6: CONCLUSION

The research conducted within this thesis provided a glimpse into the accuracy of Human Remains Detection dogs. While there is still much to learn regarding the strengths and weaknesses of these canines, much information has been gleaned from this project. The concept of handler bias was present from the initial survey through the observations and into the final experiment. Whereas bias may be impossible to avoid completely, it should be acknowledged and confronted when applicable. Previously published research (See Chapter 2) has continued to iterate that there is variability in testing and comparing HRD organizations in terms of accuracy and reliability. It is believed that this project has helped to shed more light on the topic through a variety of methods.

Future exercises should be conducted to better understand how bias may affect canine alerts. A longitudinal study would be an excellent approach to understand how training begins for both a handler and canine. The risk of bias could be monitored more closely to see how and if it manifests over time. On a smaller scale, extending the experiment that was conducted within this project into many more trials would help to show a greater change over time in the ability of the dogs to make correct alerts. Unfortunately, natural disasters and personal obligations from members of the organization limited the capability of extending trials for this experiment. However, because the canines in this experiment performed better in soil from their own region, it would be interesting to see if the pattern would continue over time, or if the alerts provided for the other sets of soils would also become more reliable. This experiment

should also be conducted with other organizations across North Carolina. For example, would organizations based out of the Union County (UC) soil area perform better in that soil when compared to the remaining three soil types? The same experimental design could be used to test HRD organizations based from regions that match the other soil types to see if there are any overarching or shared patterns.

Despite the limitations of this project, the data have shown that there is reliability to be found in HRD teams and organizations. While no current standards are in place in terms of normalized certification procedures, many groups have worked to provide consistent training environments, terminology, and comradery. Each of these aspects is important in HRD dog utilization. The capacity for these groups to aid law enforcement agencies should not be minimalized or discredited. Instead, the inclusion of HRD organizations should be at the forefront for changes in investigations regarding clandestine graves, missing persons, and mass disaster recovery efforts. Dogs have a history that is deeply intertwined with humans and it is important to continue to understand how the dynamic of these two species can positively influence change across many professional fields.

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APPENDICES

APPENDIX A: Consent Form to Participate in HRD Survey

Purpose of this project:

This survey is being completed as part of a Master's level research project for a thesis with Humboldt State University. The goal of this project is to gain a better understanding of training methods that are used within different organizations that work with Human Remains Detection, or Cadaver, Dogs. The goal is to use this information to see if there can be standardization in the training methods across the state of North Carolina.

About the survey:

This survey will ask questions on the training methods used within your organization for Human Remains Detection, or Cadaver, Dogs. It will also ask about individual certification and training of each participant. You will have a period of three (3) weeks to complete this survey once you select 'yes' to participate. On average, the survey should take roughly 20 minutes to complete, depending on the detail of your responses. This survey is online based and is powered through Google Forms. The settings in this survey will not collect user email addresses and will not ask for names or personal contact information.

Participation in this survey is completely voluntary and results will be confidential. There are no risks associated with this survey. There are no benefits for participating in this survey. No personal information such as names or personal contact information will be distributed and all collected data will be stored in a password-protected document that only I, Kristen Nawn, have access to view for analysis.

Use of Survey Responses:

Responses to the survey will be compared and similarities and differences that exist within and between participating organizations will be discussed and analyzed.

This data will be used to inform future research on the ability of trained Human Remains Detection dogs to locate human tissue under various soil types. The training methods discussed in this survey will serve as a guide for how to conduct a future thesis-based experiment. Responses may be cited within this work that will be published as a thesis through Humboldt State University.

Contact Information:

If you have any questions, please feel free to contact me, Kristen Nawn, at kmn434@humboldt.edu. You may also contact my faculty advisor for this project, Shao Jing at js36@humboldt.edu.

The Investigator will answer any questions you have about this study. Your participation is voluntary

and you may stop at any time. If you have any concerns with this study or questions about your rights as a participant, contact the Institutional Review Board for the Protection of Human Subjects at irb@humboldt.edu or (707) 826-5165.

By agreeing to participate in this study, you understand your rights as a participant and you confirm that you are at least 18 years of age. You may print a copy of this document for your records. Thank you for participating in this research! Once you have agreed, a new link will take you to the survey.

APPENDIX B: Canine Training Methods Survey Questions

1. What is the name of the canine training organization that you are associated with?
2. How long have you worked with the organization you are currently with?
3. Do you work with or volunteer with this organization on a full time or part-time basis?
4. What type of training or certification process did you go through to be able to train canines?
5. Once certified, are there any required steps for you to maintain certification as a trainer or dog handler? If so, what are the requirements?
6. What is required for a canine to be considered certified in Human Remain Detection work within your organization?
7. Once certified, are there any required steps for the canine to maintain certification? If so, what are the requirements?
8. Are there certain breed of dogs that you and your organization tends to work with and train? If so, what breeds and why?
9. On average, how long does it take to train one canine in Human Remain Detection work?
10. Are the canines you work with trained in multiple fields? (i.e. HRD and live find?) Why or why not?
11. What type of alerts do you train your dogs to give when they have located a target scent? Are these alerts active or passive?
12. What type of response do you typically give a dog who has made a false alert on a target scent?
13. Does your body language or tone of voice affect a dog's decision to alert on a target scent, whether that alert is correct or not? Why or why not?
14. Do you feel that there should be a standard training method for HRD dogs on a state or national level? Why or why not?
15. Is there any other information related to training or use of HRD dogs that you would like to share?

APPENDIX C: Consent Form to Participate in Shadowing

Introduction:

You are invited to take part in a research project conducted by Kristen Nawn, through the Anthropology Department at Humboldt State University. Before agreeing, please read this form and ask any questions you may have regarding this project.

Purpose of this project:

This research is being completed as part of a Master's level research project for a thesis with Humboldt State University. The goal of this project is to gain a better understanding of training methods that are used by Brunswick Search and Rescue (BSAR) and to use this information to help create an experimental design to test canine abilities to locate human tissue under various soil types.

About this Research:

The observer, Kristen Nawn, will shadow three (3) half-day training sessions hosted by Brunswick Search and Rescue (BSAR) and take a survey on handler/canine demographic information. Observations will be made during training regarding the type of training exercise designed and carried out, commands given to dogs, and general notes on training practices.

Participation in this research is completely voluntary and results will be confidential. You may change your mind and refuse to participate at any time. There are no risks associated with this research. There are no benefits for participating in this research. No personal information such as names or personal contact information will be distributed and all collected data will be stored in a password-protected document that only I, Kristen Nawn, have access to view for analysis. A code will be used in place of your names in all reports and publications.

Use of Collected Data:

This data will be used to inform future research on the ability of trained Human Remains Detection dogs to locate human tissue under various soil types. The training methods observed in this research will serve as a guide for how to conduct a future thesis-based experiment. Responses may be cited within this work that will be published as a thesis through Humboldt State University.

Eligibility to Participate:

In order to be considered as a participant you must meet all of the following criteria:

- A) At least 18 years of age
- B) Current member of Brunswick Search and Rescue (BSAR)
- C) Must be responsible for a canine that is participating in training exercises with BSAR

Contact Information:

If you have any questions, please feel free to contact me, Kristen Nawn, at kmn434@humboldt.edu. You may also contact my faculty advisor for this project, Dr. Marissa Ramsier, at mas70@humboldt.edu.

The Investigator will answer any questions you have about this study. Your participation is voluntary and you may stop at any time. If you have any concerns with this study or questions about your rights as a participant, contact the Institutional Review Board for the Protection of Human Subjects at irb@humboldt.edu or (707) 826-5165.

By agreeing to participate in this study, you understand your rights as a participant and you confirm that you meet all minimum requirements. You may keep page one (1) of this document and request a copy of this signed form for your records.

APPENDIX E: Blank Observational Form for Shadowing

This form will be completed for each participant at each training session.

Date: _____

Weather Conditions: _____

Location: _____

Name of handler/canine being observed: _____

Exercise being conducted:

Human tissue type being used: _____

Description of field site:

Dog off or on lead: _____

Commands used by handler:

Observations of the exercise:

APPENDIX F: Consent Form to Participate in Experiment

Introduction:

You are invited to take part in a research project conducted by Kristen Nawn, through the Anthropology Department at Humboldt State University. Before agreeing, please read this form and ask any questions you may have regarding this project.

Purpose of this project:

This research is being completed as part of a Master's level research project for a thesis with Humboldt State University. The goal of this project is to test the reliability and accuracy of trained Human Remain Detection (HRD) Dogs used by Brunswick Search and Rescue (BSAR). The canines will be tested on their accuracy and reliability in locating human bone under various soil types common to the State of North Carolina.

About this Research:

The goal of this project is to test the reliability and accuracy of trained Human Remain Detection Dogs and their ability to locate human bone that has been buried under different soil types. Teams of dogs and handlers will be tasked with walking through four (4) sets of jars filled with different soils. One (1) of each sets of soils will contain one human bone sample and the dog will be asked to alert on which jar has the bone. The testing will take place over three (3) separate dates and each team will be asked to participate in all three dates. Each trial will be timed, and notes will be taken on which jar each dog alerts on, how long each alert takes, and any false alerts. This will be conducted as blind-testing, which means the handlers will not be made aware of where the human bone is in each set.

Participation in this research is completely voluntary and results will be confidential. You may change your mind and refuse to participate at any time. There are no risks associated with this research. There are no benefits for participating in this research. No personal information such as names or personal contact information will be distributed, and all collected data will be stored in a password-protected document that only I, Kristen Nawn, have access to view for analysis. A code will be used in place of your names in all reports and publications.

Use of Collected Data:

This data will be used to inform future research on the ability of trained Human Remain Detection dogs to locate human tissue under various soil types. Further, responses may be cited within this work that will be published as a thesis through Humboldt State University.

Eligibility to Participate:

In order to be considered as a participant you must meet all of the following criteria:

- A) At least 18 years of age
- B) Current member of Brunswick Search and Rescue (BSAR)
- C) Handler and canine must be certified in Human Remain Detection (HRD) Work
- D) Handler must be responsible for a canine that is participating in training exercises with BSAR
- E) Participants must be available for all three dates of testing

Contact Information:

If you have any questions, please feel free to contact me, Kristen Nawn, at kmn434@humboldt.edu. You may also contact my faculty advisor for this project, Dr. Marissa Ramsier, at mas70@humboldt.edu.

The Investigator will answer any questions you have about this study. Your participation is voluntary, and you may stop at any time. If you have any concerns with this study or questions about your rights as a participant, contact the Institutional Review Board for the Protection of Human Subjects at irb@humboldt.edu or (707) 826-5165.

By agreeing to participate in this study, you understand your rights as a participant and you confirm that you meet all minimum requirements. You may keep the first two pages of this document and request a copy of this signed form for your records.

APPENDIX G: Blank Experimental Observation Form

Date: _____

Weather Conditions: _____

Dog/Handler Team: _____

Trial Number: _____ of _____

Soil Type	Jar indicated on (1-4)	Time taken to indicate	Final indication	Correct Jar (1-4)

Other Observations:

APPENDIX H: Online Survey Responses

Participant One

What is the name of the canine training organization that you are associated with?	How long have you worked with the organization you are currently with?	Do you work with or volunteer with this organization on a full time or part time basis?	What type of training or certification process did you go through to be able to train canines?
Brunswick search and rescue	1-2 years	Part time	SAR Tech II

Once certified, are there any required steps for you to maintain certification as a trainer or dog handler? If so, what are the requirements?	What is required for a canine to be considered certified in Human Remain Detection work within your organization?	Once certified, are there any required steps for the canine to maintain certification? If so, what are the requirements?
Maintain proficiency in applicable skills	The certification requirements are specified in our SOPs	16 hours of training per month to include BSAR organized training sessions. Must re-certified every 2 years

Are there certain breeds of dogs that you and your organization tend to work with and train? If so, what breeds and why?	On average, how long does it take to train one canine in Human Remain Detection work?	Are the canines you work with trained in multiple fields? (i.e. HRD and live find?) Why or why not?
Any dog is welcome	I don't have enough experience to answer this	My dog is trained in live find and HRD. BSAR starts all canines in wilderness air scent then on HRD

What type of alerts do you train your dogs to give when they have located a target scent? Are these alerts active or passive?	What type of response do you typically give a dog who has made a false alert on a target scent?	Does your body language or tone of voice affect a dog's decision to alert on a target scent, whether that alert is correct or not? Why or why not?
Body slam for live find or to follow to source. Down at HRD source	No response	Absolutely. If location is known to handler the risk is that you will give the dog a cue of the correct source. I have worked hard to remain neutral so she can work out the problem on her own

Do you feel that there should be a standard training method for HRD dogs on a state or national level? Why or why not?	Is there any other information related to training or use of HRD dogs that you would like to share?
General guidelines are advisable but the standard should be with testing. Most breeds work differently. My dog can only do so many repetitions of a task in training before she gets bored.	No

Participant Two

What is the name of the canine training organization that you are associated with?	How long have you worked with the organization you are currently with?	Do you work with or volunteer with this organization on a full time or part time basis?	What type of training or certification process did you go through to be able to train canines?
Brunswick Search and Rescue, Inc.	10+ years	Part time	Industry standard number of hours per month (16); Certification bi annually with performance assessments in between;

Once certified, are there any required steps for you to maintain certification as a trainer or dog handler? If so, what are the requirements?	What is required for a canine to be considered certified in Human Remain Detection work within your organization?	Once certified, are there any required steps for the canine to maintain certification? If so, what are the requirements?
At least 16 hrs of training per month; SAR Tech Certification for the handler, CPR, ICS courses through FEMA;	Local certification testing; additional testing in between the bi annual testing.	Yes, participation in the team's regular training calendar for at least 50% of the trainings and searches offered;

Are there certain breeds of dogs that you and your organization tend to work with and train? If so, what breeds and why?	On average, how long does it take to train one canine in Human Remain Detection work?	Are the canines you work with trained in multiple fields? (i.e. HRD and live find?) Why or why not?
We do not exlude any breeds but seem to have more English Springer Spaniels than other breeds; other breeds: Malimois; German Shepherd, Pit Bull, Aussie	One year	Yes, as we never know for SURE in most cases whether a person is dead or alive at the beginning of that search; So we train in Wilderness Air Scent (live find) and HRD.

What type of alerts do you train your dogs to give when they have located a target scent? Are these alerts active or passive?	What type of response do you typically give a dog who has made a false alert on a target scent?	Does your body language or tone of voice affect a dog's decision to alert on a target scent, whether that alert is correct or not? Why or why not?
Active most often but can resort to digging if a buried person putting off enough scent. Sit and down. However, on the boat, in a drowning, the dog will tum to me and shake hands. No joke...	This is a question which could require a long explanation as the handler can never be absolutely sure in most cases that no scent is there. If they should false alert for sure, then either an ignoring or no, and redirect to another area.	No, we work blind problems so the handler does not know the location.

(Continued)

Do you feel that there should be a standard training method for HRD dogs on a state or national level? Why or why not?	Is there any other information related to training or use of HRD dogs that you would like to share?
There is a suggested industry standard which is outline in the SWGDOG's recommendations for training and certification. Teams and organizations are expected to follow that national standard.	These dogs are phenomenal and have proven their skills in many cases over the years. No other tool can detect the amount of HRD that a trained dog can.

Participant Three

What is the name of the canine training organization that you are associated with?	How long have you worked with the organization you are currently with?	Do you work with or volunteer with this organization on a full time or part time basis?	What type of training or certification process did you go through to be able to train canines?
Brunswick Search and Rescue	3-5 years	Full time	I am a k9 trainer. I have gone to school to become a dog trainer and have been working with k9's for 10 years.

Once certified, are there any required steps for you to maintain certification as a trainer or dog handler? If so, what are the requirements?	What is required for a canine to be considered certified in Human Remain Detection work within your organization?	Once certified, are there any required steps for the canine to maintain certification? If so, what are the requirements?
No.	After a dog has turned one-year-old they must be certified for wilderness air sent and then they can start to train for HRD and be evaluated.	K9 and handler must participate in trainings and stay as an active member to the team.

Are there certain breeds of dogs that you and your organization tend to work with and train? If so, what breeds and why?	On average, how long does it take to train one canine in Human Remain Detection work?	Are the canines you work with trained in multiple fields? (i.e. HRD and live find?) Why or why not?
Mostly sporting and working groups. These dogs have great stamina and energy level.	1 1/2 years	Yes. Most of our handlers do not work multiple dogs. Having as many skills under our belts is important when working in this field.

What type of alerts do you train your dogs to give when they have located a target scent? Are these alerts active or passive?	What type of response do you typically give a dog who has made a false alert on a target scent?	Does your body language or tone of voice affect a dog's decision to alert on a target scent, whether that alert is correct or not? Why or why not?
Sit, down, bark. Active.	If the target sent is there and I know it is there, I correct the dog and have him check the area again. If there is nothing there and he alerts, I do nothing.	I do not believe so. While my dog is working in an area I do not talk to him or give him commands except to direct him.

Do you feel that there should be a standard training method for HRD dogs on a state or national level? Why or why not?	Is there any other information related to training or use of HRD dogs that you would like to share?
No. All trainers and dogs are different individuals. There are more than one ways to train. Some training methods do not work for all dogs.	I do not use synthetic scent. I only use real sources of human remains and live finds. I prefer dogs That have a high prey drive and enjoy working. We try to make it a game for the dogs to keep it fun for them and exciting. My dog is a pitbull mix.

Participant Four

What is the name of the canine training organization that you are associated with?	How long have you worked with the organization you are currently with?	Do you work with or volunteer with this organization on a full time or part time basis?	What type of training or certification process did you go through to be able to train canines?
Linville-Central Rescue Squad	6-10 years	Part time	Classes, week-long national seminars, training with many different instructors, and 15 years of experience. Also classes in law of search and seizure, criminal procedure, crime scene preservation and preservation of evidence, certification in HazMat awareness and operations, and personal protective equipment. Hepatitis vaccinations. I am also a NC Rescue Technician and EMT, and Sarteck certified. High angle rescue (rope) training. Trained and experienced in managing land search operations, and I teach the use of mapping, GPS, and GIS software in search planning and operations.

Are there certain breeds of dogs that you and your organization tend to work with and train? If so, what breeds and why?	On average, how long does it take to train one canine in Human Remain Detection work?	Are the canines you work with trained in multiple fields? (i.e. HRD and live find?) Why or why not?
German Shepherds, Labs, but have trained many breeds.	About a year of cadaver work added on to SAR training.	Yes. As a rescue squad, we are primarily a search and rescue organization. We start all dogs (and handlers) with scent-discriminating tracking. After proficient, we allow them to progress to area search. We tend not to use the term "air scent" because that term just indicates whether a dog's nose is up or down (whether the scent at that moment is in the air or on the ground). Instead, we use terminology focused on the mission - the work the dog team has been assigned. That is either tracking or clearing a large area or sector. At about 18-24 months we do some brief testing/training to see if the dog can transfer to cadaver work. If so, that takes about another year.

(Continued)

Once certified, are there any required steps for you to maintain certification as a trainer or dog handler? If so, what are the requirements?	What is required for a canine to be considered certified in Human Remains Detection work within your organization?	Once certified, are there any required steps for the canine to maintain certification? If so, what are the requirements?
Our teams are "evaluated" by an outside evaluator, and then continually (regularly) evaluated by senior handlers during organized training. In addition, we require handlers to attend at least two levels of cadaver dog training at the Forensic Osteology Research Station (body farm) at Western Carolina University.	See answer to last question.	Again, see above answers

What type of alerts do you train your dogs to give when they have located a target scent? Are these alerts active or passive?	What type of response do you typically give a dog who has made a false alert on a target scent?	Does your body language or tone of voice affect a dog's decision to alert on a target scent, whether that alert is correct or not? Why or why not?
Depends on the dog and mission. Most dogs do a sit or down at the source. In a "wilderness" setting, or a large open area, we do like dogs to do a continual recall and refind until the handler arrives at the source.	Just move on. No reward. Help handler understand why and what the handler might have done to contribute to it.	Of course. Impossible to say otherwise. That's what training is for.

Do you feel that there should be a standard training method for HRD dogs on a state or national level? Why or why not?	Is there any other information related to training or use of HRD dogs that you would like to share?
<p>Absolutely not a "standard training method." That's just not possible. First, usually the person who is setting this up is either doing it the "way they learned it" or they are listening to only one person. Second, these attempts always end in arguments between big egos, things break up, and everyone goes their way! There is no right or wrong method (although I agree I've seen handlers do lots of stupid stuff). The training must be catered to the dog (e.g. two steps forward, one step back. . .) and the unit/team's eventual mission. Some teams are working cadaver in a recovery mission some time after the rescue missions were wrapped up and the subject never located. Some of these can be in wooded or wilderness settings. Training for those teams should be different than those doing close-up work, burials, and evidentiary searches for law enforcement. I also think that handlers (especially new handlers) should work with as many trainer/instructors as they can - certainly not just one. They should take away what seems right for them and their dog, and toss out the stuff that isn't.</p> <p>With regard to a standardized "certification" is that this is usually done once - on which the dog may have had a "good day" or a "bad day." And once certified, there's no assurance the team will continue to work as hard after that. I believe that one "outside evaluation" is appropriate, because both handler and lead instructor benefit from that. But after that it's up to senior handlers to continually evaluate the teams coming up and give them opportunities for growth and a wide range of training scenarios.</p>	At the local level, the best way is for agencies to work with handlers and organizations they know and trust by getting involved in mutual training, exercises, etc. At the state and national level (state Emergency Management agencies and FEMA) I can see the value of coding or typing teams (by level of training, type of mission, and days/hours able to be in the field).

Participant Five

What is the name of the canine training organization that you are associated with?	How long have you worked with the organization you are currently with?	Do you work with or volunteer with this organization on a full time or part time basis?	What type of training or certification process did you go through to be able to train canines?
Brunswick Search and Rescue	10+ years	Part time	<p>Team training and certification (recertification every two years) with Brunswick Search and Rescue. Team training with Air Search Rescue in Pittsburgh. Evaluation through the North Carolina Search and Rescue Advisory Council. Also, classes with nationally recognized search dog and cadaver dog trainers Linda Murphy, Marian Hardy, Bill Dotsen, Lisa Higgins, Deana Hudgins, Paul Martin, and others. Two cadaver dog workshops at Western Carolina University.</p> <p>One human remains detection disaster dog workshop with Superfit Canine in Virginia Beach.</p> <p>One search dog overview course with West Virginia University. One search dog overview course with the West Virginia Search and Rescue Network.</p>

Once certified, are there any required steps for you to maintain certification as a trainer or dog handler? If so, what are the requirements?	What is required for a canine to be considered certified in Human Remains Detection work within your organization?	Once certified, are there any required steps for the canine to maintain certification? If so, what are the requirements?
Weekly team training and recertification every two years.	The operational dog -- working on or off lead -- must locate two out of up to three sources (one tissue, one dry bone and one evaluator's choice) in a reasonable amount of time in a 1-acre site, with no false indications. The dog must have an obvious final indication. The handler must describe his or her search strategy. Sources can be suspended, buried (shallow and deep) and in brush. Prior to certifying, the dog also must demonstrate obedience and agility, and must be social. The dog also must previously have passed his or her Canine Good Citizen evaluation.	Weekly team training and recertification every two years.

(Continued)

Are there certain breeds of dogs that you and your organization tend to work with and train? If so, what breeds and why?	On average, how long does it take to train one canine in Human Remains Detection work?	Are the canines you work with trained in multiple fields? (i.e. HRD and live find?) Why or why not?
Working line German shepherds, field line English springer spaniels, Malinois, Australian shepherds and mixed breeds. Working or sporting breeds have known prey and hunt drive, and are more suited to field conditions encountered during search work.	A minimum of 1 year, but usually 2.	Yes, HRD and live find. Our reasoning is that our dogs must be prepared to respond to searches for both live and dead subjects. Also, there are many times that we don't know if the subject is dead or alive, so a dual-purpose dog is a good resource.

What type of alerts do you train your dogs to give when they have located a target scent? Are these alerts active or passive?	What type of response do you typically give a dog who has made a false alert on a target scent?	Does your body language or tone of voice affect a dog's decision to alert on a target scent, whether that alert is correct or not? Why or why not?
I train my dogs to give passive final indications, such as a sit or a down at source.	I'm not sure how to answer this because if the dog "alerts" on a target scent, it would not be a false "alert." If the dog happened to give a final indication where there is no target scent during training (assuming I know where all the target scent sources are), I would give neither a positive nor a negative response and command the dog to keep searching.	I have seen handlers in training unconsciously cue their dogs by giving repeated commands or reaching for rewards when they know the dog is at source. As flankers we will point this out to the handlers.

Do you feel that there should be a standard training method for HRD dogs on a state or national level? Why or why not?	Is there any other information related to training or use of HRD dogs that you would like to share?
I think this should be a two-part question: 1. Training and 2. Certification. Since handlers and dogs come with all sorts of backgrounds and skills, and operate in many different environments, I don't think one training method is appropriate. However, to ensure measurable levels of competency for handlers and dogs, I do support minimum standards of certification.	HRD dog teams (dog and handler) are just one of the tools search managers should use when looking for subjects presumed dead. Search managers should have a basic understanding of how HRD dogs, wilderness air scent dogs and trailing/tracking dogs can best be used to locate missing people.