# THE SEARCH FOR HUMAN REMAINS IN THE SEARCH AND RESCUE ENVIRONMENT

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## Author's Note

This paper contains background material for a series of presentations to the Virginia Search and Rescue community. The presentation itself contains pictures illustrating various subjects described in this paper. My underlying premise is that by developing realistic understandings and mental images related to the search for human remains, the probability of finding those remains via organized search efforts may increase.

The information contained within this paper is a result of research, interviews, experiments by, or the personal experiences of the author and several colleagues within the Search and Rescue Tracking Institute (SARTI).

This project was originally undertaken in response to questions that emerged while searching for the shallow or clandestine graves of victims of criminal activity. The scope expanded as other questions emerged related to the finding of human remains in general. This paper, and accompanying presentation, is limited to those issues that have emerged in the field. It is not intended to be a comprehensive review of the subject, nor do I consider myself a subject matter expert. I certainly welcome any feedback, corrections, or further information on the subject.

Wherever possible I have attempted to give credit to all sources of information. Any omissions are unintentional, and would be corrected upon notification.

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## Introduction:

Human remains are often not found through organized search efforts. Rather, they are more frequently discovered accidentally, as a result of later investigative leads, or not found at all. When found accidentally, it is by individuals who are often hunting, hiking, or wandering through the area.[1]

There are many factors that make the discovery of human remains difficult, including whether or not efforts were made to conceal the remains, skeletal remains often blend into the baseline environment, they are difficult to recognize by untrained searchers, and the influence of predation on and scattering of skeletal remains. The search for human remains is an exercise in clue awareness. One is essentially looking for a rather small object(s) in a large landscape, subject to changes or influences that may conceal the remains. [2]

Virginia-based Search and Rescue personnel, including ground teams, man-trackers, and other specialized resources are increasingly involved in searches for possible clandestine graves[3] or the surface remains of missing persons. The intent of this report and accompanying presentation is to (1) generate further discussion about, and (2) assist personnel in developing strategies for identifying and locating human remains more efficiently. One central strategy that should be considered is briefing field teams in a manner that helps them develop appropriate "mental" or search images specific to the detection of human remains.

## On Developing Search Images:

A search and rescue professional is constantly scanning the environment for clues related to the presence or passage of the search subject. The process of recognizing potential clues as relevant is very complex. As noted by Stoffel[4], the searcher unconsciously "makes a comparison between the environment and a personal preconceived standard image (the mental image of what they are looking for). Based upon this comparison, the brain makes an instantaneous decision to take action". That is, to treat the potential clue as relevant or not relevant.

Most experienced searchers possess mental images of what to look for with respect to a missing person based upon cumulative experience in the field. That degree of field experience lessens as the search mission moves along the continuum from live subject to dead subject, from dead subject to decomposing subject, and from decomposing subject to non-intact human remains or clandestine graves.

So we must ask ourselves whether or not the searchers we dispatch into the field have a realistic image of what they are tasked to look for? And can we brief searchers in a manner that (1) assists them in developing more accurate mental images or expectations

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[1] Morton, Robert J, et al: 475; Baldwin, Hayden B et al: 1
[2] Powell, 2006: 32
[3] An "unmarked burial site(s) containing the human remains of murder victims": Powell, 2007: 1
[4] Stoffel, 2006

with respect to the field identification of human remains, and (2) increases the overall success of search and rescue field teams on missions involving deceased individuals? In order to begin this discussion, and perhaps answer these questions, it is important to have a realistic understanding of the process of human decomposition.

## Human Decomposition

Most individuals do not have experience with human remains in various states of decomposition. They often rely upon concepts or ideas about how remains may appear that do not reflect reality. These often come from television, movies, or other mediums. Even experienced searchers can misjudge how remains may appear given the specific situation, the passage of time, and the influence of environmental factors.[5]

Thus it is important to educate searchers about what they might be looking for given the specific search event they find themselves in. Searchers who are experienced in locating human remains understand, for example, how well human remains can blend into the baseline environment. A briefing about human decomposition, and how it may appear, may increase the chances that said remains will be detected.

The decomposition of a human begins approximately 4 minutes after death.[6] The act of decomposition is the result of "a complex assortment of processes ranging from enzymatic digestions and bacterial action to environmental conditions". Among the most significant environmental conditions are temperature and degree of moisture.

The process of decomposition has two predominant stages: pre-skeletonization and post-skeletonization.[7]

**Summary of Categories and Stages of Decomposition[8]:**

1. Fresh
    a. Fresh, no discoloration or insect activity
    b. Fresh burned
2. Early Decomposition
    a. Pink-white appearance with skin slippage and some hair loss
    b. Green to gray discoloration, some flesh relatively fresh
    c. Discoloration to brownish shades particularly at fingers, nose, and ears; some flesh relatively fresh
    d. Bloating with green discoloration
    e. Post-bloating following rupture of the abdominal gates, with discoloration going from green to dark
    f. Brown to black discoloration of arms and legs, skin has leathery appearance
3. Advanced Decomposition

[5] One very experienced searcher summarized this by saying, "We've been stumbling around blind".
[6] Vass et al, 2002: 1
[7] Vass et al, 1992:1
[8] Vass, 2007

   a. Decomposition of tissues causes sagging flesh, caving in of the abdominal cavity, often accompanied by extensive maggot activity
   b. Moist decomposition in which there is bone exposure
   c. Mummification with some retention of internal structures
   d. Mummification of outer tissues only, with internal organs lost through autolysis or insect activity
   e. Mummification with bone exposure of less than one-half of the skeleton
   f. Adipocere development ("grave wax")
4. Skeletonization
   a. Bones with greasy substance and decomposed tissue, sometimes with body fluid still present
   b. Bones with desiccated tissue or mummified tissue covering less than one half of the skeleton
   c. Bones largely dry but still retaining some grease
   d. Dry bone
5. Extreme Decomposition
   a. Skeletonization with bleaching
   b. Skeletonization with exfoliation

The change from pre to post-skeletonization has several key hallmarks, each with a variety of factors influencing onset. This would include, but is not limited to, temperature, moisture, predation, and presence of trauma.

Among the many factors influencing decomposition is whether or not the body is above or below ground. In general, bodies above ground decompose more quickly than those below ground. The slower rate of below-ground decomposition is due largely to decreasing gaseous diffusion. This limits micro and macro-organisms. The overall effect is that carbon dioxide is increased, resulting in anaerobic conditions. [9]

**Rates of Decomposition**:

While it is important to understand the process of decomposition, it is equally important to understand that the rate of decomposition is affected by a number of variables. Mann [10] rates those variables in descending order of influence as: temperature, access by insects, burial and depth, carnivores, trauma, humidity, rainfall, body size, clothing (incomplete list). The impact and interrelationship of these variables with respect to the rate of decomposition will vary in any given situation.

Bass[11] notes that any description of decomposition rates must be qualified, and may not apply to all situations. Rather, they should simply be seen as baseline descriptions. The following information assesses outdoor decomposition rates in Tennessee, without the influence of extensive predation.

[9] Vass et al , 1992: 2
[10] Mann et al, 104
[11] Bass: 182

Blowflies (calliphoridae) will be attracted to a corpse within minutes. This is, however, greatly influenced by temperature. Flies will not be active ("egg laying") when temperatures are below 52 degrees Fahrenheit. They will lay eggs in body orifices. This would include the eyes, ears, mouth, nose, vagina or rectum. A wound would also constitute an orifice in the sense that it permits entry into the body. At this fresh stage, egg masses may be visible, most often appearing as fine white sawdust.

During the first week after deposit, the corpse may appear somewhere in the continuum between fresh to bloated. During this phase the maggots have hatched and are active. Bone may be exposed in the face. Changes will include skin slippage from the body and hair slippage from the scalp. Other noticeable indicators include odor, body fluids emerging from body orifices, changes in vein color to dark green or blue, and abdominal bloating. Volatile fatty acids (VFA's) are beginning to kill vegetation in the immediate area.

In the following 3 weeks (the bloat to decay phase), maggot activity and bloating has decreased. When still present, the skin may appear dry and leathery. The soft tissue and bones are covered in various molds. The volatile fatty acids (VFA's) have caused a dark staining around the body, and have killed vegetation in whatever direction they have flowed. One may also find the presence of adipocere (or "grave wax).

The bloat to decay phase is followed by a drying phase, which occurs during the first year of exposure. This may include bone bleaching due to sunlight, the presence of moss or algae when the remains are in the shade, and the indicators of activity by rodents (bone gnawing).

Bass notes that winter decay rates are slower due, in part, to decreased temperatures.

**Role of Temperature and Humidity:**

Human decomposition is most significantly impacted by temperature. It occurs more quickly in higher temperatures or humidity. Both are correlated with activity by flies and maggots. Insect larvae are primarily responsible for the destruction of soft tissue. Where the access to the body is prevented, the decay rate will be reduced. Covering a body with branches or rolling a body in a carpet does not prevent access by flies.[12] The presence of clothing on a body does not significantly impact the rate of decomposition. Rather, clothing protects the maggots from sunlight.

In cold weather, decay rates slow down or may cease altogether. This is largely due to the cessation of fly activity (egg laying) below 52 degrees. Those eggs laid prior to colder weather will hatch and thrive as long as they remain sheltered from the cold. This is possible because the large mass of maggots will produce its own heat. The body may only display discoloration in the skin rather than evidence any sign of decay. Where there is a lack of humidity, mummification can occur.

[12] Morton et al: 476

**Role of Trauma to the Body:**
Penetrating wounds or trauma allow quicker access by egg-laying flies. These bodies will decay much more quickly than bodies without trauma. This is an important consideration for search and rescue personnel involved in the search for a victim of suspected homicide. In Virginia, the three top methods of fatal injuries of homicide victims are by: firearm (71.2%), sharp instrument (12.1%), and blunt instrument (6.1%).[13] Each of these produces trauma or wounds to the body.

**Precipitation:** Mann notes that precipitation has very little impact on maggot activity, as they tend to remain within the body cavity during that time.

**Body Weigh and Size:** Neither has a significant impact on decomposition rates.

## The Role of Predation on Surface Remains:

Predation or scavenging activities by animals has a significant impact on decay rates, as well as the recovery rates of remains. Scavengers can cause extensive destruction of soft tissue and bone.[14] They also may scatter or destroy remains. Unfortunately this is an area for which little research exists.

In his work on studying scavenging of child sized remains, Morton notes (478) a variety of scavengers who used remains as a food source. This included red foxes, turkey vultures, opossums, raccoons, crows, and striped skunks. In our own studies we've also noted predation by coyotes, domestic dogs, and turtles. This is obviously only a partial list of scavengers who have been responsible for predation on human remains.

Significant findings include the following[15]:

1. Invertebrate activity (blowfly cycle) is limited or non-existent during colder temperatures. That is, there was no colonization activity in the remains.
2. When invertebrate colonization was successful, vertebrates would not scavenge until after the maggots migrated away from the remains.
3. Invertebrate colonization may result in the destruction of all soft tissue within 6 days.
4. Crows and other birds may feed on maggots during the colonization phase.
5. Where invertebrates are unsuccessful at colonization, scavengers feed on remains more quickly.
6. Barriers to colonization, or any large scale colonization, may include weather, burial of remains, or quick predation by scavengers.
7. Scavengers were able to reduce surface deposit corpses to skeletal remains within 5-7 days (warm and cold months) when no invertebrate colonization occurred. Morton notes one study site where 27 vultures were observed scavenging on the remains.

[13] Office of the Medical Examiner, Virginia, 2004
[14] Bass, 1997: 182; Mann et al: 106; Morton et al: 475
[15] Morton: 475-479

During the course of our research we observed several issues related to scavenging. We were able to study multiple sites in an area with a high concentration of vultures. Vultures were able to reduce these corpses to skeletal remains in less than 24 hours on a number of occasions. There were several observations with respect to the role of temperature. Scavenging was significantly delayed by extremely cold temperature that effectively froze remains, thereby not allowing any decompositional odors that may have attracted predators. Scavenging commenced only after several days of warming temperatures. The location of remains had a significant impact as well. While one region had several days of 50-60 degree (f) days following a cold spell, the micro-climate surrounding a specific site (elevation, orientation, and exposure) was significantly colder. This had an overall effect of delaying any significant decomposition. Finally, we noted anecdotally that the deposit of remains in seasonal versus year round animal territories may have significant impact upon scavenging patterns.

The role of domestic dogs in scavenging of remains cannot be underestimated.[16] Dogs have been observed carrying bones up to ¼ mile or more from the body, often back to their home or neighborhood. This is an important field consideration. When searching in areas adjacent to domestic dog populations, backyards should be searched for bones. In general, the process of skeletal disarticulation by canines is generally consistent. As suggested by Haglund[17], this is:

| Stage | Condition of Remains | Range of observed Post Mortem Interval |
|---|---|---|
| O | Early scavenging of soft tissue with no removal of body pieces | 4 hours to 14 days |
| 1 | Destruction of the ventral thorax accompanied by evisceration and removal of one of both upper extremities including scapulae and partial or complete clavicles | 22 days to 2.5 months |
| 2 | Lower extremities fully or partially removed | 2 to 4.5 months |
| 3 | All skeletal elements disarticulated except for segments of the vertebral column | 2 to 11 months |
| 4 | Total disarticulation with only cranium and other assorted skeletal elements or fragments recovered | 5 to 52 months |

Haglund notes that the first action of scavenging is the removal of skin and muscle from the face and neck. The canines may or may not puncture the orbital bones in the process, and neck structures tend to be consumed.

This pattern of disarticulation may be modified if the remains are in a more advanced stage of disarticulation. This allows a canine greater access to skeletal elements. The pattern may also be modified when the body is heavily clothed, partially or completely

[16] Jantz L: Class Notes, 2007; Mann et al: 107: Clark: 151
[17] Haglund: 367-68

buried, in water or snow, or wrapped within objects. These will reduce the access points to the remains.

The ability to move human remains is a function of the size and strength of a canine versus the weight and size of the remains.[18] Studies have demonstrated that medium-sized canines can move the remains of children and sub-adults. The remains may also be moved more easily as skeletonization progresses. Factors that may limit overall movement of remains include issues of topography, baseline vegetation, and the accessibility of the remains (covered, partially covered, etc).

In the search for disarticulated remains, the highest potential for recovery is at the original site of deposit. If the remains have been moved in entirety, the original site may be represented by soil discoloration (blackish staining) due to the volatile fatty acids/other body fluids. There may also be a series of soil discolorations if the body, or parts of the body, was moved in stages. Indications that the body, or body parts, has been moved may be evidenced by drag marks or other indications of passage. The range which canines have been observed to transport remains varies, one report indicating several miles.

When skeletal remains are discovered, the association of those elements in a particular location is important. When the remains are found in proximity with those with which they do not articulate (ex. patella near a lumbar vertebrae), one can infer that they were moved away from the original site after decomposition of soft tissue and disarticulation.[19] When articulating elements are found together (hand and arm bones), they may represent transport prior to decomposition of muscle or tissue that held them together. One of the last elements often moved or destroyed is the skull, as it is difficult for most small predators to grasp on to (even with long canine teeth).[20]

Skeletal disarticulation occurs most typically from the head downward and from the central to peripheral portions of the skeleton. Thus the mandible will separate from the skull, and the skull from the vertebral column. Teeth may also disarticulate from the mandible (lower jaw) or maxilla (upper jaw). It is often the single rooted teeth (incisors and canines) that disassociate. Multi-rooted teeth typically only disassociate due to poor rooting or damage/injury.

Cervical vertebrae often follow, with the limbs tending to remain in tact. [21] The process of disarticulation often exposes individual bones to damage from predation, weathering, or other influences.

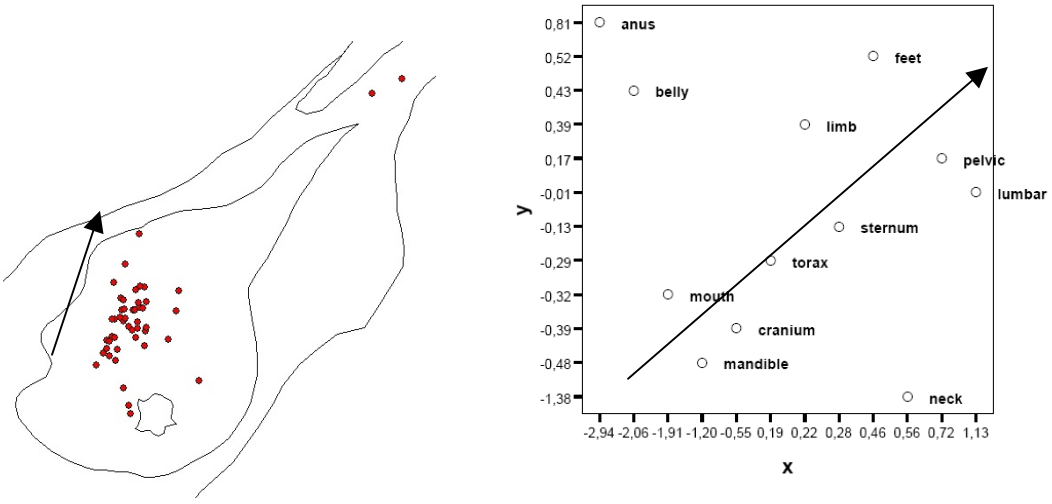
The recovery of skeletal remains is as much influenced by the process of disarticulation as it is by remains going unnoticed in searches. We've observed searchers walk past disarticulated bones, or only realize their presence after having walked upon them. Most

[18] Haglund:377
[19] Haglund: 383
[20] Manheim: 54
[21] Clark 160; Micozzi: 177

often the axial skeletal remains are found by the site of discovery, while skeletal elements of the upper and lower limbs can often be found at great distances. This reflects the ability to move limbs as a single, detachable unit.

**Trajectories of Bone Dispersion:**
When remains are discovered, searchers are often faced with the prospect of identifying the trajectory of bone dispersion. That is, in which direction will the bone field, or other bones, lay? The discovery of a second site will assist in this identification. Additionally nearby animal trails should be a primary place of investigation. Terrain factors should also be considered. For example, animals may stay on the periphery of certain features that pose barriers to travel (ex. Thick vegetation, steep terrain, water features, and swamps).

There are a limited number of studies that indicate a linear trajectory, or scatter pattern, of human remains. This has been noted by Haglund and others.




(Left: Map of scatter on island by Lemasters; Scatter chart on right provided by Eggeman[22])

**Skeletonization and Bone Weathering:**
One question often raised is how human bones will appear in the landscape. Many expect "bleached" bones (white) that will stand out in the baseline environment. This is often not the case in a search event.

Skeletonization is "the removal of soft tissue from bone".[23] Full skeletonization occurs when all soft tissue is removed from the bone. Partial skeletonization occurs when soft tissue remains on the skeleton, and only portions of bone are visible. The process of skeletonization can occur quickly or slowly, depending on many variables.

[22] Eggeman 2007, citing Mameli, Barcelo, Estevez, 2002
[23] Clark: 159

Researchers note that when a body is buried at depths of more than 4 feet, complete skeletonization may take 2-3 years. In shallow graves (less than 12 inches), this process takes between 6-12+ months. This is generally true for most regions of North America.[24]

Behrensmeyer describes five stages of "bone weathering". That is, the changes to bone over time due to environmental influence (sun, soil type, and weather conditions). In stage one, the bone is still greasy, and often has soft tissue and muscle or ligament attached. Within 6 months of most surface deposits of human remains, most of the soft tissue is gone. Much of the bone bleaching of the bone by the sun, surface cracking, and other weathering processes (stages 2-5) take a much longer time to appear (months or years).[25]

There are six recognized and progressive stages of change to bone as a result of weathering. [26]

- Stage 0: The bone surface is typically greasy, and may have skin or tissue connected. The bone surface has no sign of changes due to weathering, such as cracking or flaking.
- Stage 1: The bone surface shows cracking. This is usually parallel to the fiber structure. Skin and tissue may or may not be present.
- Stage 2: The bone is beginning to show flaking. This is often seen along areas of cracking, which often separate and flake before other areas.
- Stage 3: The bone is showing patches of rough, homogenously weathered bone, resulting in a fibrous texture. Weathering does not penetrate deeper than 1.0-1.5 mm, and the bone fibers remain attached to each other.
- Stage 4: The bone surface is coarsely fibrous and rough in texture, large and small splintering is observed, and may be loose enough to fall away from the bone when moved. Weathering has penetrated into the inner cavities.
- Stage 5: Bone is falling apart in situ, with splinters laying around the whole, which is fragile and easily broken by moving.

**Clandestine Graves:**

"Graves are manmade and do not occur as a natural phenomena. In physical terms, a burial is an interference with a given environment; an inhumation of an external object into a pre-existing environment (either natural or developed), thereby disrupting and altering that current ecosystem in content and form".[27]

Most searches for clandestine graves involve teams of professionals or volunteers walking over an area designated as a "high probability area". The determination of high probability is often based upon a specific perpetrator profile, a "confession", or a witness account. In all cases, the determination of high probability becomes a function of the credibility one attributes to, or the general reliability of, the information upon which the search strategy is based.

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[24] Rodriguez: 461
[25] Behrensmyer: 81
[26] Ubelaker: 79
[27] Powell:77

The major difficulty in identifying clandestine graves is that one is often searching for a "small set of objects (a skeleton) in a small area, subject to surface changes that may mask the actual grave zone."[28] Additionally, while a clandestine grave represents a disturbance to the natural baseline of an area, the area of disturbance is rather small compared with the overall landscape

The appearance of a clandestine grave will vary based upon a number of factors. For example, a clandestine grave may not be a "burial" in the traditional sense. It may be contained within a deadfall or beneath a log simply covered by leaves. The grave location may occur in a previously disturbed area (i.e. mulch or manure piles) rather than in undisturbed ground. The burial may have occurred by hand or with machinery. When dug by hand, the ground itself may or may not be receptive to digging. The grave may be in a wooded area or open field.

By their very nature, clandestine graves were created with the intent of being hidden. Privacy is a requirement. The perpetrator must be able to transport the body to the burial site in an undetected manner. Carrying a body is awkward, and often takes a great deal of strength. The burial site must be prepared without attracting a great deal of notice.

By digging a grave, one makes a significant impact in the local environment. For example, the forest floor in often comprised of plants, multiple seasons of fallen leaves, and other debris. These top layers are disturbed in the process of clearing the site or digging the grave. The grave itself requires the displacement of various layers of soil. These layers of soil are mixed together, and cannot be returned to their baseline.

Once the soil is returned to the grave, it goes through a process of resettling or consolidation. This may ultimately leave a depression in the soil as well as other visual indicators. Scavengers and insects may be attracted to the site, resulting in further disturbance. Over time there is a succession of plant life over top of the grave, and the area is recolonized in a manner that may not be consistent with the immediate surroundings.

There is a lack of scientific studies focused on the changes to clandestine graves over time. It is clear, for example, that the digging of a clandestine grave is disruptive to the baseline environment. How those disruptions or "anomalies" change over time and in different environments is not well studied.[29]

There are also no consistently reliable methods identified that assist in the location of these graves, or to validate their absence in a given area. There are some scientific studies that demonstrate the success of certain location techniques under certain conditions, but no evidence that the techniques would have broader applications. There is limited research on the detection of skeletal remains in general. [30]

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[28] Powell: 32
[29] Powell: 79
[30] Powell: 17-23

**Grave Indicators:**

It is clear that, by its very nature, a grave represents a disturbance from the baseline environment. Like any environment, or micro-environment, it is subject to changes over time. There is very little in the way of formal studies that document these changes over time, and no way to predict changes over the many environments in which clandestine graves occur. [31]Despite the lack of literature on the subject, there are key indicators that may at least alert the searcher to the presence of a potential clandestine grave.

**Grave Depth and Size:**

The depth of a given grave is a function of many variables. These must be considered when assessing the nature of the grave being searched for. Consideration should be given to whether or not the soil or environmental conditions lend themselves to digging holes. One must also take into account the size of the person who is suspected to have been murdered. Clearly a hole must be large enough to accommodate the body, in whatever position it is buried.

While information is often limited with respect to suspects or persons of interest, it is important to determine what methods the individual may have used to create a grave. For example, did the individual have access to machinery? Did the individual have time to dig a deep grave? Does he or she have the strength to dig a grave? Does the area lend itself to a daytime or nighttime burial?

A buried body will decay more slowly than one deposited on the soil surface. The depth of burial will also impact decay rates. Shallow graves (+/- 12 inches) allow for greater interaction between the body and the surface than do deeper graves. Mann et all[32] noted that when buried at 1-2 feet, bodies will skeletonize within a few months to a year. A body buried at 3-4 feet may take years to decay to the same condition as one at a shallower depth.

**Disruptions to the Baseline Environment:**

The baseline environment of an area develops over time. Digging a grave necessarily requires a disruption to the baseline environment. The disruption is often the first visual indicator of a clandestine grave. Once disturbed, the environment cannot be returned back to its baseline condition by the gravedigger.

The length of time the disturbance is visible or present is subject to a great deal of variation. This is a function of the type of baseline disturbance, factors related to weathering, and the area in which the grave is located. For example, some studies have shown this to be a period of 1-5 years, while other studies have demonstrated the period to be 50+ years.[33]

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[31] Powell:79
[32] Mann: 106
[33] Powell: 83

**Disturbance to the Leaf Litter**

Many forest floors in Eastern North America could be described as follows:

| lAYER | cHARACTERISTIC |
|---|---|
| Plant Layer | Based upon maturity of plant development |
| Most recent leaf fall | Dried, mostly intact, curled leaves, easily identified as to species mixed with debris due to wind, etc. |
| Earlier Leaf Falls[34] | Moist, flattened, flimsy, abraded, holes in the blade and edges, mixed with aged debris. Older layers of leaves are increasingly skeletonized, darker in color, slimy due to coatings of micro-organisms |
| Deepest Leaf Layer | Leaves broken-up, fragmented, unrecognizable; layer is darker, very moist, and gritty. Represents transition point to soil. |
| Soil Layer | Variable in color and quality/texture, based upon area |
| Sub-soil horizons | Variable in color and quality/texture, based upon area. |

The layers of the forest floor are distinct. A disturbance of the first layer, or plant layer, results in plants being uprooted and cleared from the area. As digging progresses, the various leaf layers are mixed together in a manner where the past years and most recent leaf falls are combined together. One can visualize the disturbance left by an individual simply dragging his or her feet through the leaf litter. The grave digger may or may not attempt to re-distribute the disturbed leaves on top of the grave.

There are no scientific surveys that provide guidance as to how long it takes for this disturbed area to return to baseline. The disturbed area is subject to environmental influences similar to those that impact any sign of human passage, albeit on a slightly larger scale.

**Soil Disturbances and Soil Characteristics of Clandestine Graves:**

Soil type is impacted by regional and local variations, the climate, and vegetation. Soil field types are differentiated by color, texture, and degree of wetness. Soil texture is created by the precise combination of three types of soil particles: sand, silt, and clay (largest to smallest). The different colors and layers of different soil are called soil horizons.[35]

Clandestine graves often dig through multiple soil horizons. These often are different in color or texture. For example some are darker or lighter than others. The textures of soil horizons may also change. The horizons are mixed together before being returned to the grave, or dispersed in areas adjacent to the grave. The result is often a different colored, darker soil in or near the grave. In addition, the mixing may also include rocks or other rubble normally associated with deeper soil horizons.

[34] Kricher et al: 279
[35] Kricher et al: 14-18

There is a clear difference between the "continuity of surface"[36] between the grave and surrounding "baseline" environment. The baseline soil horizon immediately adjacent to the excavated area remains in tact, while the grave itself represents a mixing of horizons. Rodriguez and Bass[37] note that any color changes will lessen over time, ranging from 6 months to a year. This time frame is, however, variable, and will vary in different environments, weather patterns, etc.

A change in the continuity of surface may also be evidenced in things like the general orientation of other objects. For example, surface shale deposits will often orient parallel in one direction. This would create a visual continuity across the entire deposit. The digging will disrupt that orientation, causing a clear visual inconsistency.

It is noted that certain environments do not have distinct soil horizons. This would include the following environments: sand or desert, gardens or tilled areas, and environments similar in nature to landfills.

**Impact to the Surrounding Environment:**
The act of digging also requires that the displaced soil be deposited nearby, albeit for a short term basis. This has an additional impact on the surrounding areas. For example, plants may be compressed by the weight of the soil. If a tarp or some other barrier is used to collect the displaced dirt, this will also compress nearby plant life. One may also observe shreds of the tarp. Small amounts of the displaced soil may not be returned to the hole, resulting in subtle changes in the immediate environment.

**Backfilling the Grave and Mounding:**
The displaced soil is "backfilled" into the grave once the body has been deposited. The result is a mixing of soil layers within, and possibly adjacent to, the grave. As the body has reduced the amount of soil that will fit into the grave, the grave-digger is left with several options. This would include spreading the remaining soil around the environment, or mounding the soil on top of the grave.

Mounding is often cited, and has been observed, as an indicator of a clandestine grave. While this may be true, there are also a number of cases where mounding was not present. This may reflect the grave-digger's attempt to disguise the grave. Additionally, most displaced soil can often be returned to the grave without mounding. When reported as being present, studies have shown it to be a short-lived indicator. Mounds are often eroded due to rain and other weathering phenomena.

**Changes to the Grave over Time:**
There is no real definitive baseline data that describe clandestine graves in varying environments, changes in surface indicators or evidence of changes to vegetation over time, etc. There are a small number of studies that do provide some guidance in this area. For example, Rodriguez and Bass noted that, while surface indicators change over time

[36] Powell: 80
[37] Rodriguez and Bass

due to weathering, the changes themselves are not uniform across gravesites. [38] It is important to note that much available literature discusses grave indicators, and how they may change over time. Most present the indicators as "statements of expectation", rather than as a result of exhaustive studies.[39] That is, one would "expect" that certain of the indicators to be present in various situations. This makes applications of information to specific settings and conditions difficult.

Search and rescue professionals who are tasked with searching for clandestine graves must be trained in detecting and identifying these indicators as separate from the baseline environment. Minimally, inexperienced team members should be briefed about possible indicators for the same purposes. Any disturbances to the environment that fit the parameters of the indicators should be brought to the attention of law enforcement as representing the potential of a clandestine grave.

**Resettling of and Depressions in the Soil:**
Soil is often "backfilled" into graves. This results in the mixing of various soil horizons. Much like when digging a garden, the soil is aerated. This causes a difference in soil density between the baseline and backfilled soils. The soil within the grave is less dense than the surrounding baseline environment. This difference can often be detected by the use of soil probes.

Naturally decomposing buried remains will leave a void in the already aerated soil. The "void" is created by collapsing of certain body cavities, including the abdomen area. The void will be filled naturally through the process of soil resettling. That is, through collapsing into the void. This will result in a primary depression being formed on top of the body. Rodriguez and Bass indicate that the timeframe for the formation of depressions varies, taking anywhere from one week to several months. While not observed by this author, it is reported that secondary depressions may form as a result of further deterioration of the abdominal cavity. [40]

**Soil Crevassing Around Clandestine Graves**: One indicator often reported in the presence of cracking, crevassing or fissuring where the disturbed soil meets the baseline surface. There are a number of reasons why this may occur, including the differences in moisture retention and the differing effects of weathering phenomena on the differences between the disturbed/mixed and baseline areas.

**Halo's**[41] A "halo" is a "barren area" around a gravesite. That is, an area with little or no vegetation. Halos do not result from the presence of a body. Rather, they result from displaced dirt having been left on the surface rather than returned to the grave. They often appear in areas where there is little shade, and that have flat ground that did not allow for water catchment. Shallow rooted plants simply dried out.

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[38] Rodriguez and Bass, 1985
[39] Powell: 79
[40] Hayden and May: 6
[41] Powell, 401

In our own studies we've also noted a halo-like effect resulting from a different mechanism. That is, predator activity around certain surface deposit remains caused plant damage that resulted in woodland halos that were observable from quite a distance.

**Plant Disturbance and Succession in Clandestine Graves:** A clandestine grave represents a significant disturbance to an environment. Plants are uprooted or stepped upon both in an around the grave. This may result in an unnatural clearing in an otherwise plant populated area, significant browning in grave perimeter areas, or plant fragments being mixed with dirt.

The digging of the grave has the effect of destroying the primary root structures of plants. Additionally, non-nutritive soil (deeper layers) is redistributed on the soil surface. Thus the lack of plant life, or a significant disruption of plant life, is often indicative of the presence of a grave.[42] This may be in the form of less dense growth, or growth that is initially smaller or newer than nearby plants.

The act of digging a grave disrupts multiple soil horizons with differing levels of water retention. Displaced soil is often less compact, which also allows for either greater penetration or evaporation of soil moisture. Thus one may observe more lush vegetation in shaded areas over time or, in dryer conditions, browning.

Studies have demonstrated that it is varying levels of moisture that have the greatest impact on vegetation-related visual indicators, rather than the presence of any nutrients related to the decomposing (France, et al). For example, the soil disturbance may increase or decrease the area's capacity to retain moisture. Sub-surface soil is often mixed with topsoil when filling a grave. This may affect moisture retention and, in combination with other environmental conditions, may retard plant growth. The environmental conditions include, but are not limited to, availability of light and access to water. [43]

There is a set pattern of plant succession by which plants re-colonize in an area. In open areas, the primary or initial colonizers are grasses or other local "opportunistic" plants. These are followed by small shrubs, and then trees. The rate of re-colonization is influenced by a variety of factors, including access to light, water, and general soil conditions.[44] Studies have demonstrated that these areas often demonstrate very little species diversity compared to surrounding areas (5 years+).[45]

It has been noted that certain plants have been closely associated with the presence of cadaver decomposition and grave sites. The ammonia fungi and postputrefecation fungi reportedly provide visible markers of decomposition, and also follow a repeated pattern of succession that proved useful in identifying graves.[46]

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[42] Rodriguez: 460
[43] France et al; Powell: 38
[44] Coyle, H, et all: 610
[45] France et al: 504
[46] Tibbet, M. and Carter, D

Disturbed plots, whether they contain a body of not, can remain visually different for up to 5 years. Undisturbed plots have often been found to contain greater plant diversity than disturbed plots. Caution must be given in hastily assuming that changes in vegetation patterns indicate the presence of a body. [47]

**Decomposition of Human Remains in Clandestine Graves**:
Buried human remains generally decompose approximately 8 times more slowly than those that are surface deposits. The exception would be those contained in shallow graves (less than 12 inches), where the body is subject to changing soil temperatures on a daily basis. The body will decompose more quickly than in deeper burials. The combination of shallow depth and decomposition also allow for odors to penetrate the ground surface, thus attracting scavengers. Invertebrates can obtain access due to scavengers uncovering or creating access routes to the remains. Alternately, the decomposing body can cause the rising and falling of the soil, creating cracks or channels by which access can be obtained.

When the grave is deeper than 12 inches, there is also a change in the surrounding soil temperature. The soil temperature will decrease as the grave depth increases. This has the effect of slowing the rate of cooling of the body, and thus slowing the decompositional process. [48]

In general, the bones of children are more highly susceptible to decay than those of adults. The bones of a child and an adult differ in both size and density. Additionally, children's bones are both more porous and have higher collagen[49] contents. Human bones are made more flexible and elastic due to collagen. As individuals age, the collagen is stiffened due to increasing levels of hydroxyapatite (a form of calcium phosphate).[50]. All of these factors increase the potential decay rate of children's bones when buried in soil, particularly when that soil is acidic. [51] Acidic, sandy or gravel soils are generally the worst for bone survival in both children and adults. [52]

**Predation on Clandestine Graves:[53]**
The depth of a grave has an impact on access by scavengers. In shallow graves (less than 1 foot), soft tissue destruction by invertebrates (flies) is often delayed or non-existent. Shallow grave remains are often removed by predators. They are often scattered over greater distances than surface deposits of remains. In warmer months, the scavengers removed the remains as soon as the first week and as late as 74 days. Once the buried remains are brought to the surface, the corpses are reduced to skeletal remains quickly.

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[47] France et al, 1992
[48] Rodriguez: 459; Jantz 2007
[49] White, et al: 420: the "fibrous structural protein constituting about 90% of the bone's organic content"
[50] White, et al: 42
[51] Gordon, C.G. et al
[52] Buckbberry, J.
[53] Morton et all: 475-479

**Human Remains Deposited in Water**

Human remains are often deposited in or near water. For example, the remains may be intentionally placed in the water and weighted down to avoid detection. They may be deposited on a river bank, only to be swept away in a flood. Finally, an individual may simply fall into the water. There are a number of challenges associated with searching for remains in water.

This study included observations of animal remains deposited in or near creeks or rivers. One immediate challenge was the impact of flood waters. One test site was washed away in a flood. The remains were not found. Several sites deposited in or near water sources were recovered much further downstream, often becoming entangled in "strainers". These are downed trees or limbs that "catch" and hold debris, including grass, trash, flotsam such as sticks and twigs, etc.

Another set of remains (on a river point bar) was alternately moved in and out of the water due to predation and flooding, creating a complex bone field. Finally, skeletal remains were often moved great distances, making recovery of all elements very challenging.

In several other sites, the remains were deposited in varying depths of water, which had a significant impact on decomposition rates. When the water level covered body orifices, flies were unable to quickly colonize the remains. This resulted in delays of several days in decomposition stages normally associated with fly activity.

Where the water level permitted some level of entry into the body, flies were able to colonize remains completely surrounded by water. As maggots typically require a terrestrial environment to pupate, they were unable to do so under these conditions. In several cases, flood waters caused the maggots to be disgorged from the remains and directly into the water. This created fairly significant maggot deposits (we termed, "maggot islands") in or near post-flood strainers.

Predation in water environments is common.[54] This caused detached body tissue to move in the direction of water flow. In one case of predation by turtles, body tissue was observed clinging to rocks at the creek bottom up to 75 feet downstream. All evidence of tissue was gone within 24 hours.

Natural decomposition may also cause tissue or skeletal remains to move downstream. It is noted that heavier bones (ex. Pelvis, long bones) are generally not transported as far as lighter bones (ex. hand, foot, ankle, wrist, etc). This is, of course, subject to the nature of the water flow.

The rate of decomposition for submerged bodies is roughly half that of decomposition for surface remains.[55] This is largely a function of lack of invertebrate access and cooler temperatures. It is noted, however, that the process of decomposition does still occur.

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[54] Clark: 156
[55] Rodriguez: 461

Decompositional gas will cause a body to rise the surface, ultimately allowing access by invertebrates. The amount of time it takes for a body to rise to the surface is largely dependent upon temperature. In warm water, this can occur in several days, while in colder water this can take several weeks or months.

Water can move remains great distances. The transport of human remains via water is described as a 4 stage motion that is both vertical and horizontal.[56] These are the sinking of the body to the bottom, the motion along the bottom, the ascent to the surface, and the surface drift with the current. Body density and other factors that decrease buoyancy result in the sinking to the bottom.

Once on the bottom, movement of the body is influenced by both the bottom substrate as well as the forces the water movement places on the body. The movement of the body to the surface is a result of buoyancy from results from decomposition and subsequent developing gas. Surface drift is a combination of multiple factors, including the presence of current, wind, obstructions, etc. It is noted that each body of water presents a specific set of characteristics that affect the movement of remains.

Nawrocki notes that surface flow tends to be directly down the middle of straight channels. At sharp bends objects to move towards the outside bend. The subsurface flow tends to "circulate in a complex spiraling fashion" [57] that lessens nearer to the riverbed.

From a search and rescue standpoint, it is important to establish weather conditions such as rain (flooding) or drought that may impact body movement. For example, bones or remains deposited in a summer drought will not travel far, and are often found in close proximity. Once normal water conditions exist, these same remains will often then be in deeper pools. One phenomenon noted in both existing literature and in our experiments are the high numbers of bones that may be found on river "point bars". Also, skeletal remains have also been recovered within debris that has accumulated in strainers. It is therefore important for searchers to investigate and possibly pull apart strainers for clues or remains.

**Movement of a Body by Human Intervention:**

Human remains are often moved as part of a murder event. There are four critical components in a murder event: the place the victim was last seen, the contact point between the victim and murder, the murder site, and the body recovery site. In most murders, these components occur simultaneously. That is, they occur in the same place at the same time.

When these components are separated by time and place, there are often a number of reasons.[58] For example, a murderer may intentionally abduct a child, transport the child to a remote murder location, and dispose of the body in a third location. The intent is often to reduce the likelihood that the murderer will be connected to the body and related

[56] Nawrocki et al: 531
[57] Nawrocki et al: 531
[58] Brown and Keppel, 138

crime. In the effort to avoid detection, the murderer may transport the child from a high to low visibility location.

The components may also become separated because of events beyond the murder's control. For example, the previously chosen disposal site is occupied by a vehicle, and the individual must change his or her plan. The murderer may also move the victim's body from one place to another. This may be from the site of the murder to a more remote environment, or from a place connected to the murder victim to a place that is unconnected. The murderer may also move a body due to unanticipated decompositional odor.

Depending upon the nature of the murder, the movement of remains may or may not involve a great deal of effort and planning. It has been well documented that most body disposals give the appearance of a certain lack of inertia on the part of the murder, as well as very little planning[59].

The reality is that dead bodies are heavy. They are often deposited in close proximity to easy access or exit points. The disposal is simple, and uses whatever equipment is available. A disposal site is often hastily chosen or, in the case of burial, often very shallow. Alternately, there are instances where the nature of the disposal (under a log, in a ditch covered with leaves) did not offer a great deal of concealment, but the site itself was rural with little perceived risk of discovery. In general, most do not possess a great deal of knowledge or experience in issues of body disposal and recovery techniques.[60]

The geography of a murder's activity often corresponds with the "least effort" principle.[61] That is, individuals usually carry out their routine activities within areas close to their zones of comfort. These are often represented as points (or destinations) linked by a series of routes of travel. These often form the mental or lived map of the individual.

In most cases, the murderer knows the victim. Most often, criminal acts are likely to occur at points where the mental map of the murderer intersects with the map of the victim within a specific time frame. This underscores the importance of understanding the day-to-day routines of the victim and any high-probability suspects. As always, however, there are notable exceptions. For example, the "stalking-type" of murderer may frequent a location simply to see who shows up, follow that person home, and commit a murder.

The criminal event, and subsequent body disposal, often occurs at a point where the "desire for anonymity and the desire to operate in one's comfort zone balance".[62] Often called the "buffer zone", this area may represent the highest probability area to begin searching. However, one must be cautious in determining the location of these zones, as it is often based upon the subjective meaning of the murderer.

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[59] Manhein: 47
[60] Powell, Personal Communications
[61] Shamblin: 4
[62] Rosso, 1998

## The Search for Human Remains:

A search and rescue (SAR) event is always considered a possible criminal event. Many have turned out to be so. There is an increasing trend in using specialized SAR personnel (canines, man-trackers) when searches have included a high probability of human remains. This is generally attributed to training in overall clue awareness and search strategies.

It is important to recognize that not all SAR personnel have adequate knowledge and experience in issues related to the finding of human remains, especially those contained within clandestine graves. Thus the overall success in such a search may be heavily dependent upon having other trained personnel available to assist in the search. Forensic anthropologists are the personnel of choice in such searches. When unavailable, search managers should rely upon search and rescue personnel who have had documented training and experience in performing these searches. Additionally, it is important that all searchers have clear mental images of what they are looking for.

The search for human remains can be divided into two separate stages: (a) the search planning/management stage, and (b) the search, including the preparation and managing of field teams.

## The Search Planning Stage:

### Putting the right resources in the right place

A great deal of planning is required when searching for human remains. Many factors must be considered. The search planner must take into account the training level of available resources, the terrain to be searched, the size of the search area, weather conditions, the time available to search, whether or not the search area will involve private property, etc.

One of the most important considerations is related to working with the local jurisdiction's responsible agent/law enforcement or, in the case of some searches, multiple jurisdictions covered by the search area. It is often law enforcement on scene that have suspect or subject information that can greatly inform search strategy. The release of this sensitive information to search planners is often subject to delicate negotiation. The information to be obtained should include, at a minimum:

1. General investigative findings
2. Witness accounts. It is noted that, with respect to investigations, friends of the victim have been identified as having more correct information about day-to-day routines than either family members or co-workers.[63]
3. Information on suspects or persons of interest
4. Suspected high probability areas, and reasons for having been identified as such
5. Time since suspected death or burial

We must stress that the search for human remains is ultimately an exercise in clue awareness. While surface deposits are not "concealed" in any intentional sense, they are

[63] Shamblin: 29

still difficult to locate. A clandestine grave is, by its very nature, not meant to be found. As such, consideration should be given to the following:

1. The murder may not have been intended and the body disposal not well planned.
2. The body may simply have been placed in a depression and covered with leaves, left under a log, etc.
3. Soil conditions and the local environment may cause the grave to be very shallow.
4. The grave site may have been hastily chosen, with access a primary consideration.
5. The grave will likely be dug at a time, manner, and location that will decrease the possibility that the grave will be observed (secluded). Consider that the burial may have occurred at night, thereby limiting the field of vision of the grave digger to a very small area.

It is critical that an updated map of the area be reviewed for statistically high areas of probability. The combination of topographic maps and aerial photographs should be used in order to give search planners a better sense of landscape, terrain, and vegetation that may or may not facilitate the burying of a body. Consideration should also be given to areas that prevent burial due to obstacles, or may enhance burial by providing secrecy.

Many searches have involved the use of maps that do not designate or identify recent development and roads (unpaved, in particular). It may be important to send out teams with map and GPS to specifically note open areas, road or trails not included on search maps.

With respect to open areas, particular attention should be paid to those near or adjacent to unused structures, waste dumps, or other areas that would not normally be frequented by individuals.

Road access has proven a significant variable in the disposal of murder victims. This cannot be stressed enough.

**Some Statistical Profiles**

Citing FBI statistics, Vass indicates that clandestine graves are typically no deeper than 2.5 feet, are “close” to water or “near” a poorly traveled road, are 10 feet away from the nearest large tree, and contain a clothed or wrapped corpse which will be face down.[64]

A specific subset of statistics[65] related to the abduction and murder of children by sexual predators provides greater guidance in terms of search strategies. The abduction and murder of children by sexual predators are most often crimes of opportunity (57%), rather than related to a prior relationship with the victim (15%). The majority (85%) seek to dispose of the body as quickly as reasonably possible (31% +/- 3 hours; 69% within 24 hours). When the body is held onto longer than necessary for the purposes of disposal, it is most often kept in the offender’s residence. Disposal sites for bodies are deliberately selected (49%), chosen at random (37%), or forced by circumstances. The disposals

[64] Vass, 2007
[65] Eggeman: 2005

themselves involved concealment to prevent discovery (52%), placed without consideration to being found (39%), or placed in a manner to insure discovery (9%). Most often the body is recovered within 200 feet of the murder site (72%).

Recovery sites are largely rural (51%). The geographical profile for the recovery sites includes:

1. Remote areas with vehicle/road access
2. Near or in water
3. Within ½ mile of an intersection
4. Dirt roads are favored over paved roads
5. Body often within 150 feet of access road
6. Body located to downhill side if sloped ground is present.

While this data may represent a statistical norm, it should not eliminate from consideration other possibilities. One may also consider the "radius of the murderer's activity". That is, other areas the individual may be familiar with as a result of his or her normal activity patterns. For example, a parent murdered his two children and placed the remains in an area that was both close to the family home and known to him via his illegal poaching activities. [66]

Thus it is advisable to consider drawing a radius on the map, identifying areas within that radius that are accessible via quick travel by car. Specific attention should be paid to open or disused areas, or areas that may offer secrecy.[67]

Certain times of the year lend themselves to better search conditions for the clandestine grave. Colder months with decreased vegetation are obviously the best, as they allow for less obstructed views of possible grave indicators. However, search managers do not always have a choice as to the timing of the search event. For example, a cold case search for an individual murdered and disposed of in the winter months was called for during the summer. The conditions of the burial event were dramatically different than the search event.

**The Search Method:**

Search and Rescue personnel employ a number of search strategies that translate well to the search for human remains. As the search is, essentially, a search for clues, methods employed by SAR personnel are particularly recommended. In general, the possible search methods include:

1. Grid Search where searchers walk in a tight, closely spaced line with a field of vision overlap. Dirkmaat and Adovasio recommend a 20-30% field of vision overlap.[68] Searchers mark notable findings with flags, which are then followed up by more experienced searchers or experts.
2. Powell suggests variations on commonly used search techniques: (a) having searchers line up at opposite ends of the search area and walk towards each other,

[66] Search for Sam and Lindsey Porter, Kansas City Star, Thomas and Rizzo, 9/11/2007
[67] Powell: Personal Communication
[68] Dirkmaat and Adovasio: 39

continuing past each other, to the other end of the search area. This allows the area to be searched by "two sets of eyes", from two different directions; (b) marking lanes for each searcher, and having the searchers "snake" forward (walking in an "S" pattern) within each laneway; (c) having each searcher responsible for a marked grid. [69] The latter techniques can be employed for very small search areas.

## The Team Briefing: Preparing for Success

All searches involve the consideration of multiple possible scenarios. Is the individual simply overdue? Has the individual become injured and is unable to move? Is the individual in the search area at all? Has the individual become the victim of a criminal event? It is critically important that team leaders use the briefing as a means of preparing the search team for success.

Team leaders need to discuss the most likely scenarios with field teams. In doing so, team members begin to develop a better understanding of the spectrum of clues that may be "out there". That is, on developing accurate mental images of what is being looked for. Many possess expectations that may otherwise negatively impact how much time they spend, and how much value they place, upon following up on any single clue.

It is also important that searchers adjust themselves to the changing baseline environments included in their task areas. Human remain represent disruptions to those environments. By allowing team members to adjust their awareness to each baseline environment they encounter, this may increase the likelihood that clues will be seen.

One illustrative example is when looking for flood victims. A team leader prepares the team by standing them at the water's edge for several minutes with instructions to observe the baseline conditions in and around the flooded areas. This would include how certain objects appear, such as downed limbs, garbage, and other debris. This allows team members to develop an appropriate visual image of baseline conditions, and that which would be considered a disruption (a body, for example) of those conditions.

### Preparing the Search Team[70]

There are two critical components that must be considered when preparing search teams for success. These would be the ability of searchers to (1) detect and (2) recognize potential clues as important.[71] Thus it is important to use a task briefing to assist searchers in developing accurate mental images.

1. **Discuss Human Decomposition**: It is important that field teams understand, in a general way, the possible stages of human decomposition as it relates the time frame of the missing subject. There is a great misunderstanding as to how human remains or bones appear. By explaining likely phases of decomposition given the timing of the search event, team members will better understand what it is they

[69] Powell: 433-4
[70] Powell: 431-44, General acknowledgment to the work of Dr. Powell for this section
[71] Stoffel, 2006

are looking for. For example, many expect bones to appear while (or bleached) against the landscape. However, the reality is that they often blend in to the baseline quite well.

2. **Perform an initial ground survey**: Take the search team to an area closely resembling the ground environment of the search area. Examine the baseline environment, its color and texture, the patterns of vegetation, and other relevant factors. In a woodland setting, for example, team members should accustom themselves to the visual and textural appearance of the topmost layer of leaves, etc. Then disturb the environment by mixing ground layer. This will allow search team members to understand and identify what is normal for the environment and, by extension, what is not normal.
3. **Determining Soil Conditions**: Dig several holes in an area closely resembling the search area. The holes should be deep enough to simulate, minimally, a shallow grave. Have team members accustom themselves to soil texture and color of the top most layer, and those deeper layers which are displaced. This will provide a benchmark for understanding what they may see if the grave is fairly recent. As soil conditions or search environments change, more holes may need to be dug.
4. **Clandestine Graves/Indicator of the Possible Presence of a Body**: Discuss what potential clues or indicators may be present. Underscore that a clandestine grave represents a very small area of disturbance compared with the overall landscape. Thus there is a very small area where grave indicators may be noted. It is important to therefore instruct field teams on the precise search strategy to be employed, including the distance at which searchers should place themselves.[72] The following indicators are discussed in more detail elsewhere in this paper.
    - Changes in the vegetation: plants dying or dead due to being pulled out, crushed, etc; bare patches in an otherwise plant-filled environment; indications of new plant growth that is different from the baseline plant environment, no moss in an otherwise moss filled environment, etc.
    - Changes in the surface or in the “continuity of surface”.
    - Changes in the soil colors or conditions
    - Staining or blackening of soil
    - Changes to the soil texture: hardness versus softness
    - A “Halo” of little or no vegetation;
    - Signs of passage leading to a specific area, including human or tire tracks, signs of dragging.
    - Depressions in the soil indicating a possible clandestine grave. Shallow graves are particularly susceptible to temperature variations. Significant bloating of the body will cause soil to be pushed upwards, and then resettling as the body collapses. This is often referred to as a secondary depression. In older graves, depressions with plant growth.
    - Animal burrowing or signs of digging, especially in relation to depressions, should always be investigated. They map represent

[72] Powell: Personal Communications

attempts at predation. Shallow graves (less than 12 inches) allow for gaseous interchange with the surface, allowing decompositional odors to attract animals.

- Cracking or fissuring of the soil is often present around grave sites. This represents differences in soil water retention, and is often accompanied by differences in color or texture at the site. The soil immediately beneath the area of fissuring is often soft. This underscores the value of soil probing.
- Maggot Trails: The maggot migration occurs when maggots leave the remains in a line of varying width. This leaves leave a wet and dark trail consisting of decompositional fluids. The fluid is transferred from their bodies to the ground and surrounding vegetation. In at least one case parallel maggot trails were incorrectly interpreted as side-by-side drag marks.[73] These trails end where the maggots bury themselves in the ground to pupate. Maggot trails have been observed extending as far as 12 feet from remains, and reported as being up to 100 feet.
- Fly Activity: When maggots emerge as adult flies, they are essentially helpless. They cannot fly anywhere. The flies are usually observed in masses clinging to grass or bushes near the remains "drying out" their wings for a short period of time.

**In the Field:**
Field teams should be instructed on how to mark each possible site using an approved method. These can be ruled in or out later for significance, as the total context of the scene must first be ascertained.

Probing is a useful field tool in identifying the differences in soil density between baseline environment and the displaced soil normally associated with a grave. It can be taught rather quickly, and probing tools are easily obtained.

Properly trained personnel (recommend training by forensic anthropologists first) may consider a preliminary excavation of a site.[74] In order to determine whether or not there has been a soil disturbance (displacement and reburial), the ground surface may be scraped with a flat edged trowel. There is often a clear and distinct demarcation between the more compact baseline area and the disturbed area.

Use of a comparison hole nearby may further demonstrate disturbance. This may reveal a change in the "continuity of surface" referenced earlier. The preliminary excavation may help to reduce the number of possible sites that require later analysis.

Finally, when searching in sites near homes or other residences, field team members should pay particular attention to the presence of domestic dogs. There are well documented instances where domestic dogs have carried human remains back to their

[73] Haskell et all: 415
[74] Jantz, L; Field Lecture; Powell: 434; Dirkmaat et al: 42

homes or neighborhoods. It is well worth the time to seek permission to search nearby yards within a ¼ mile radius.

## Is It Human or Not?

Most landscapes contain some isolated or fragmentary remains (usually bones). This would include deer, dogs, cows, etc. Search and Rescue professionals are not forensic anthropologists or human osteologists. While some do have training specific to this area, most SAR field team members are not qualified to render accurate opinions about whether a specific bone is human or not.

One must therefore exercise both common sense and caution when encountering isolated bones. Sweep the area in close proximity to determine if other nearby fragmentary remains will help answer the question. Don't rush to hasty judgments, as even law enforcement personnel and coroners have been wrong in the past. For example, White notes that pet rabbits caught in trailer home fires have been mistakenly identified as human infants.[75] When in doubt, call in an expert! If instructed to collect the bone, it is important to document the following: Who found and collected the bone, where and when it was collected (location and time), and its general orientation within in the landscape. The bone should be placed within a bag, labeled, and be in the possession of an identified individual until it is handed over to base personnel.

We continue to study training methods by which we can increase SAR Team knowledge in this area.

## The Crime Scene

Any site of human remains is a crime scene (at least initially) where the potential for evidence is significant. It is therefore critically important that the entire scene, and evidence within the scene, remain in context. That is, not be moved or tampered with. As noted by White, "there is only one such bone…which means there is only one chance to extract the remains completely and correctly".[76] The application to other evidence is clear.

While the site is often the primary focus of a search, there may be other nearby areas that are related. For example, a large area of disturbance in a search area may represent where the perpetrator rested or re-adjusted the weight of the body. Alternately, the same disturbance may simply be a result of animal activity. The same consideration must be given to any potential "clues" located within the search area. It is only by preserving the context of all potential scenes that law enforcement can understand whether or not potential evidence within each scene is related.

It is often helpful to ask oneself the following:

1. What was the likely or probable path of entry by the perpetrator? By foot? By car or other motorized vehicle? Dragged or carried to the scene? Searchers

[75] White et al: 8
[76] White et al: 10

should take routes that do not disrupt the area, those that represent the least likely paths to the scene. .

2. What other activities may have occurred while the perpetrator was digging the hole? Look for other evidence of activity, including the presence of cigarettes, food, etc.
3. Consider whether or not the hole may have been pre-dug prior to burying the body.
4. Is there any evidence of the instrument the perpetrator used to dig the hole?

Each of these represents critical evidence considerations. Searchers must therefore be instructed to treat the entire area as a crime scene.[77]

When approaching a crime scene, a searcher also risks leaving evidence of his or her presence. This may include footprints, hairs, or fibers (human, canine). One may also inadvertently take away important evidence on shoes or clothes, or may otherwise damage any evidence that remains at the scene. Thus access to the scene should be severely restricted, and notes should be kept of all who entered the scene. It is not unheard of to be asked by a law enforcement officer to turn over one's shoes in order to eliminate them as being related to the crime.

On Photography: It is important to note all activities related to any potential crime scene. These can be recorded in field notes. Photographs have been taken to document the scene in an unaltered condition. However, searchers should notify law enforcement immediately upon their arrival of any on-scene photography, the intent of said photography, and be willing to turn over their film to law enforcement (you are warned).

**In Summary:**

The search for human remains is an exercise in clue awareness. The searcher is essentially looking for a rather small disturbance in a very large landscape. In order to increase the finding of human remains via organized search efforts, it is important that (1) the right resources are sent to the right places, and (2) those resources have appropriate search (or mental) images of that which they are looking for. In order to assist in developing those images, Field Team Leaders should use the team briefing to discuss possible scenarios, and the range of clues that field team members may encounter. Simple field exercises may assist in this regard. Searchers may then be better able to compare what they encounter with information provided during the briefing, and thus better able to treat potential clues as relevant or not.

[77] Mayo, Kristri: 2

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