Wildlife Decomposition in West Central Montana: A Preliminary Study Conducted to Provide Field Investigation Material and Training for Wildlife Officers

F. Carleen Gonder

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WILDLIFE DECOMPOSITION IN WEST CENTRAL MONTANA:
A PRELIMINARY STUDY CONDUCTED TO PROVIDE FIELD
INVESTIGATION MATERIAL AND TRAINING FOR WILDLIFE OFFICERS

By
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Bachelor of Science Degree from the University of Montana, 1999

Professional Paper

Presented in partial fulfillment of the requirements for the degree of

Master of Interdisciplinary Studies
Criminology and Forensic Anthropology (for wildlife forensics)

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DEDICATION

I dedicate these efforts to my son Don and his family, to Arrow and the memory of Hope—my four legged companions, and to wildlife officers everywhere who are vital to wildlife populations.

ACKNOWLEDGEMENTS

Funding was awarded to the project by the Association of Midwest Fish and Game Law Enforcement Officers. The total award was $10,000 with $5000 disbursed quarterly for 2007 and $5000 for 2008. The Wyoming Game Wardens Association awarded $500 in March 2007, and $750 in 2008. The Missoula, MT chapter of P.E.O. (Philanthropy Educational Organization) awarded $200 in 2008. MT Fish, Wildlife and Parks (FWP), via bear management specialist Jamie Jonkel, loaned the use of an electrified exclosure for site 1, and solar energizer. Grizzly Fence in Missoula, MT loaned the use of twelve 12’x6’ portable chain link panels for the duration of the project for site 2. Monetary value is $864.00 (comparable rent for two years). Quality Supply of Missoula, MT donated $500 in August 2007. MT Department of Natural Resources and Conservation State Forester Bob Harrington, and Ward McCaughey with the US Forest Service Rocky Mountain Research Station loaned the use of various weather instruments. Tim Eicher, US Fish and Wildlife Service (FWS) Special Agent, donated a hanging scale, ropes and pulleys, as well as time, effort and encouragement at the site. Gregory Johnson, PhD, completely outfitted a wet lab at Lubrecht for this project, provided all entomological equipment which included a freezer, refrigerator and microscope, materials for two exclosures at site 3, and gave time, effort and encouragement at the sites. Mike Jimenez, then the FWS Wyoming wolf coordinator and now the Wyoming Game and Fish state coordinator, and Jim Pehringer of US Wildlife Services assisted with procurement of wolves from Wyoming. Steve Nadeau, state carnivore biologist and Jason Husseman, wolf specialist, both with Idaho Fish and Game assisted with procurement of wolves from Idaho. Carolyn Sime, FWP wolf coordinator and Mark Atkinson, DVM/wildlife veterinarian now with NV Dept. of Wildlife, assisted with procurement of wolves and the adult lion from Montana. Jay Kolbe, FWP Blackfoot River area biologist, assisted with procurement of the yearling lions and whitetail deer. Taser International has donated two Taser units to test their suitability for use in providing electrical stimulus to muscles for time of death determinations. Carrie Hunt of Wind River Bear Institute gifted a Karelian Bear Dog to C. Gonder via a scholarship; this dog will be trained for carcass detection/bear conflict work. Frank Maus and his forestry staff, and Janie Howser and facility staff at UM’s Lubrecht Experimental Forest have continually provided invaluable assistance and deserve special acknowledgement.

A number of individuals have helped with material support and other assistance and include: Erica Hutchings, Carol Havlik, The Hager Family, Lucinda Schroeder, Kathy Engstrom, Lilian Evans, Kyriaki Trigonis, Owen Cox, Leila Haack, Bruce Young, and Chris Winter.
Fellow student Laura B. Wagster was able to utilize the carcasses for her own thesis, “Decomposition and the Freeze-Thaw process in Northwestern Montana: A Preliminary Study”. We shared many winter days at the sites. I’m grateful for her help in the more mundane aspects of site maintenance (shoveling snow, exclosure repairs) and simply hanging out with long-dead things.

This project could not have happened without the enthusiasm, support and encouragement of my entire committee:

- Dr. Daniel Doyle, chair – Criminology; University of MT
- Dr. Ashley McKeown – Anthropology (forensics), University of MT
- Dr. Greg Johnson – Entomology, Montana State University
- Mr. Tim Eicher – Special Agent, US Fish and Wildlife Service
- Mr. David Oates – Forensic Specialist and Lab Manager, Nebraska Game and Parks Commission
- Mr. James (Jamie) Jonkel – Bear Management Specialist/Biologist, MT Fish, Wildlife and Parks

I could not have had a better committee for this interdisciplinary project.

And how do I thank the 15 long-dead things who taught me much throughout their earthly process? Being with them day to day for well over a year brought such an intimacy to “dust to dust”.

WILDLIFE DECOMPOSITION IN WEST CENTRAL MONTANA: A PRELIMINARY STUDY CONDUCTED TO PROVIDE FIELD INVESTIGATION MATERIAL AND TRAINING FOR WILDLIFE OFFICERS

F. Carleen Gonder
Interdisciplinary: Criminology and Forensic Anthropology (for wildlife forensics)

Chairperson: Daniel P. Doyle, PhD

An issue with many poaching investigations is the discovery of carcasses in advanced stages of decomposition with little information to indicate time of death (TOD).

To address TOD issues of carcasses found in a state of decomposition, and to provide training materials and field tools for investigating officers, this project was initiated to identify decomposition stages and to monitor decomposition rates for those stages in the west central area of Montana. A total of 15 carcasses were placed in electrified exclosures during various times of the year which provided seasonal variation and include: a pair of gray wolves (8 total) placed on the same day for each of the four seasons; a black bear placed early fall, and another middle fall; three mountain lion kittens and a whitetail deer placed late fall; and an adult mountain lion placed during the winter. Data collection included weather, photography, decomposition characteristics, and insects.

The practical research involved in this study is intended to provide baseline data on long term decomposition in order to develop material for use in the field by federal and state wildlife law enforcement officials. To assure the project’s contribution to wildlife law enforcement, data from this study will be published in a reprint of A Guide to Time of Death in Selected Wildlife Species (Oates et al 1984) and in an update of the Wildlife Forensic Field Manual (Adrian and Walker 2003) produced by the Association of Midwest Fish and Game Law Enforcement Officers, which was the primary sponsor of this project.

It is also important to note that TOD estimates are appropriate for livestock depredation claims. It may be vital to establish the TOD of the predating carnivore to assure it was legally killed by the livestock manager when livestock were in the area.
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CHAPTER 1 – INTRODUCTION

Wildlife law enforcement officers operate under constraints not shared with other fields of law enforcement. An individual officer’s patrol district is vast and remote. Budget shortfalls result in understaffing, lack of sophisticated equipment, and inability to fund specialized crime scene processors or investigators. This means an overworked officer must carry out all facets of an illegal take investigation. While most officers possess a degree in wildlife biology or management, and they are commissioned through their respective state’s law enforcement academies, there is little training available for law enforcement field investigation techniques specific to wildlife.

A major component of illegal take investigations is determining when that animal was killed. Estimating time of death (TOD) during the first 24-48 hours postmortem has long been utilized for traditional game species such as deer and elk. TOD is crucial as court accepted circumstantial evidence with applicability in two situations:

1. determine if that animal was taken by a hunter during legal hunting hours,

2. fix the TOD with a point in time matching the presence of a suspect at an illegal take scene.

TOD is often more readily determined at the scene, rather than in a lab (Oates et al. 1984, Stroud n.d.).

An issue when investigating illegal take of many federally protected species, as well as ungulates killed for their trophy-sized antlers, is the discovery of carcasses in advanced stages of decomposition (Eicher 2005, Kropp 2005). Without an understanding of characteristics of the postmortem interval (PMI) it is difficult to estime TOD. This project was undertaken to develop field applicable TOD material for law enforcement investigators and is based on systematic documentation of postmortem changes during decomposition (p. 43). Using a
controlled setting that allowed for natural decomposition processes to occur, data on changes in the immediate postmortem period, gross changes to the soft tissues related to the passage of time and climatic variation, and the succession of insects that visit and colonize a carcass was documented and analyzed for the purpose of developing a field guide and training material for estimating TOD.

With Montana, Idaho and Wyoming soon to assume management of wolves and states’ statutory management of mountain lions, black bears and big game species, there is a need for more data specific to those species that can assist in law enforcement field investigations, such as estimating TOD of decomposing remains.

To that end, eight gray wolves, four mountain lions, two black bears, and a whitetail deer were utilized as subjects for systematic documentation of decomposition processes. Animals were not euthanized for this project, but were management removals due to preying on livestock or a repeated human conflict situation, vehicle killed or injured with only minimal head trauma and no external or extensive signs of torso damage, or inadvertent snare capture. Upon receipt of already euthanized animals, carcasses were placed in a controlled research site similar to the outdoor Anthropology Research Facility (ARF) developed by the University of Tennessee’s Forensic Anthropology Center for studying examples of human decomposition. Initial research at this ground-breaking facility involved documenting patterns of short term and long term decomposition in an effort to distinguish the overall decomposition rates for human cadavers. The goal of this wildlife project was to duplicate the ARF research setting by establishment of a facility near the University of Montana (UM).

Though numerous decomposition studies have been completed over the years, there has been scant research conducted specific to wildlife. Illegal take of wildlife occurs year
round, though opportunity increases during fall hunting seasons when there are greater
numbers of armed individuals in more remote areas. Therefore, this project was conducted
to ascertain seasonal affects on decomposition processes of various wildlife species. The goal
of this project is twofold: 1. to systematically document wildlife decomposition processes,
and 2. to impart that information to wildlife officers in a practical format.
CHAPTER 2 – BRIEF SURVEY OF RELATED WORK

The inspiration for this project was the University of Tennessee Anthropology Research Facility, and it is based on need. The bulk of decomposition work has been carried out to relate results to the human cadaver, and most of that research has been conducted in biogeoclimatic regions vastly different than west central Montana. While some models from previous research are readily adaptable to more arid regions, research results are not. The common theme gleaned from previous work: Decay rates are temperature dependent with regional and seasonal variations.

Though decomposition studies are conducted with a wide variety of intended goals producing an array of results, each may provide an invaluable and relevant perspective to current and future work.

**General decomposition and associated insects**

The early decomposition studies of H.B. Reed (1958), Jerry A. Payne (1965), and Michael D. Johnson (1975) set the stage for much of the later work and are still relevant today. The focus of Reed’s work was on habitat’s effect on decomposition “seres” or stages with respect to insect succession (1958: 214). Dog carcasses were placed in two different habitats, wooded and pasture, near Knoxville, TN. Since it was conducted over a one year period, Reed’s study also provided seasonal variation for each habitat type. His assessments followed a four stage model: fresh, bloat for the anaerobic period of decomposition, decay for the aerobic period, and dry when only small amounts of tissue remain (1958). Reed concluded that there was a “regular” pattern of species abundance, but an “irregularity” to the appearance of any one particular species (1958: 227).
Payne (1965) conducted his studies during the summers of 1962 and 1963. To define decomposition stages plus identify insects associated with each stage, Payne used two pigs as samples. Insect colonization was allowed on one pig but excluded from the other in order to determine insects’ effects on decomposition. Payne’s (1965) model for decomposition stages are:

1. Fresh – from time of death (or in his case, the thawing out period) to bloat
2. Bloat – when the carcass inflates due to anaerobic processes. Blood may be present at the nose and/or anus, and odor increases
3. Active decay – skin is penetrated by larvae and the carcass deflates at the onset. Liquefaction is caused by larvae enzyme action and odor is strong
4. Advanced decay – little flesh remains on the carcass and odor diminishes. The little remaining tissue dries towards the end of this stage
5. Dry – only small bits of dried skin, cartilage and bone remain
6. Remains – difficult to distinguish the transition from dry to remains stage. Odor is more like soil and litter. Virtually all skin, underlying tissue, and necrophilous insects are gone

Payne found that though decomposition stages are not so succinctly separated into well defined stages, those stages could be fairly easily identified and described with the pig where insect colonizing was allowed. However, where insects were excluded, it was difficult to “divide decomposition” into discrete stages (1965: 598).

Johnson’s (1975) 1968 study utilized small mammals to illustrate the distinction between “microsere” and “sere” and that a decomposing organism is a distinct entity or “microcommunity” (1975: 79). His study illustrates how insect populations “change serially” (succession), as well as seasonally (1975: 79). Groups or orders of insects are associated with
various decomposition stages, such as Diptera (flies, primarily blow flies) with fresh and bloat stages, and Coleoptera (beetles) with decay stage. He noted that the abundance of individuals in any given family such as calliphorids (blow flies) may be affected seasonally. When maggot abundance is greatly diminished or non-existent due to low temperatures, decomposition stages are affected. This is consistent with Payne’s (1965) work utilizing pigs where insects were excluded from the decomposition process. Johnson noted that carcasses protected from insects during decomposition “retain their form” for a longer period than those not protected, and those not protected pass through stages that he modified from Reed’s model (1958, 1975: 81).

Dedicated to the study of human decomposition, the Anthropology Research Facility was established in 1972 by William M. Bass, PhD, through the University of Tennessee in Knoxville (web.utk.edu 2008). The primary purpose was to provide a natural outdoor setting for scientific documentation of decomposition processes utilizing unclaimed bodies and donated human remains. The three acre wooded compound allows for documentation of variables’ effects on decomposition and includes: temperature, humidity, rainfall, soil analysis, trauma to the body, access to the body by insects, burial, limited scavenging, size and weight of the body, type of surface the body rests on, clothing, and embalming (Mann et al. 1990).

**Biogeoclimatic areas for comparison**

To establish decomposition standards in the arid climate of the Sonoran Desert, Alison Galloway (1997) conducted a review of autopsy and forensic anthropological reports. She surveyed 468 cases, with 245 assessed from photos. Galloway’s assessments were based on a five stage decomposition model: 1. fresh, 2. early decomposition, 3. advanced
decomposition, 4. skeletonization, and 5. extreme decomposition (1997). With many cases, she found that early decomposition was followed by desiccation of the body’s surface, which hindered insect activity, lengthening the decay and dry stages. She concluded that the high temperatures of that region accelerate decay.

To determine decay rates in a cold climate, Debra A. Komar (1998) surveyed cases that were on file with the Edmonton, Alberta Office of the Chief Medical Examiner. She studied 20 cases that had reached advanced decomposition with partial to complete skeletonization. Komar concluded that rates for her period of study (1990-1996) spanned six weeks to eight years. During summer months bodies may be skeletonized in less than six weeks, and in winter months skeletonization may occur in less than four months.

**Decomposition and insect colonizing specific to wildlife**

E.J. Watson (2003, 2005) conducted two consecutive studies to assess succession of necrophilous insects on black bears, whitetail deer, alligators, and swine that were control subjects. She utilized Payne’s model for decomposition stages (Payne 1965, 2005). Her first study was conducted spring and early summer of 1999 (2003). The second study spanned fall of 1999 and winter of 2000 (2005). Watson found that for the four species, there were differences “within and between seasons” (2005: 202). She also states that more work is needed that would include greater sample sizes and more field work, and laboratory experiments, specific to wildlife.

To assist in estimating a time of death for two poached black bear cubs in Manitoba, Gail S. Anderson (1999) was approached by a Royal Canadian Mounted Police (RCMP) official who had assisted in recovering evidence at the scene. The bears’ gall bladders had been removed, which is a common practice when poaching for bear bile. Bear bile is an
ingredient used in some Asian medicines. Adult flies and fly eggs were recovered from the carcasses and processed by the RCMP officer and by Dr. Anderson. Based on results of the fly egg analysis, Dr. Anderson was able to determine time of death and the case was successfully prosecuted. This case illustrates the usefulness of postmortem insect colonizing analysis for poached wildlife. During a telephone conversation, Anderson stated that more wildlife officers need to be made aware of the importance of forensic entomology and trained in collection protocols (Anderson 2008).

Decomposition studies conducted in west central Montana

Starting in spring of 1996, T.T. Terneney (1997) conducted a pig decomposition study to determine decay rates for the west central area of Montana. She chose Payne’s model for decomposition stages: fresh, bloat, active decay, advanced decay, dry, and remains. One pig was left on the surface and the other was buried. The research area was open pastureland in Missoula. Terneney concluded that though decomposition stage progression in Missoula, MT is consistent with work done in other areas of the US, rates in Montana were slower due to climate differences and seasonal weather variations. Compared with rates of studies conducted in other regions of the US, rate differences can be a matter of weeks or months (Reed 1958, Payne 1965, 1997).

In June 1999, Seth Barnes (2000) began a pig decomposition study on Lubrecht Forest, a University of Montana forestry research station 30 miles from Missoula. Two pigs were placed in bear proof cages. One was left intact and the other was burned using gasoline as an accelerant. Barnes’ study concentrated on insect succession of both pigs and provided an exhaustive survey of carrion associated fauna. He also noted that the succession pattern of insects for the burned pig was similar to the unburned pig.
CHAPTER 3 – METHODS

The carcass decomposition sites were established in a remote rural research area. Though illegally taken wildlife left to rot are usually scavenged, the study carcasses were placed in large-mammal and avian proof exclosures in order to provide ample baseline data on basic decomposition processes with minimal disturbance. The entire project, from site establishment to procurement of carcasses, required careful coordination with campus university officials, research area administrators, and several officials with various government agencies.

Study area

The study area was located on Lubrecht Experimental Forest which is owned and operated by the UM Department of Forestry. Lubrecht is a 28,000 acre rural, coniferous forest tract approximately 30 miles east of Missoula, MT. With a concern for the security of the sites, the location chosen was in an area not visible from an unimproved forest access road with entry to that road from the paved highway, through a locked gate. Three sites were in two separate areas, approximately 1.5 miles from the paved highway via the forest road. Sites one and two were approximately 400 yards cross country from the forest road, on top of a small knoll (p. 83). Site three was approximately 100 yards from that same road, but on the opposite side and approximately 0.5 mile from sites one and two (p. 83). Sites one and two were at 4,424 feet elevation (UTM: 12312531 E and 5197975 N). Site three was at 4,296 feet (UTM: 12312818 E and 5197638 N). All sites were flat to gently sloping with slight south-east aspect. Tree canopy for all sites was 30-40%. Habitat type for the entire area is second growth Ponderosa Pine (Pinus ponderosa) with Douglas Fir (Pseudotsuga menzieii) and mixed shrub understory, primarily ninebark (Physocarpus maxim) and snowberry.
Symphoricarpos alba). The areas within and immediately adjacent the exclosures contained a mix of pine grass and elk sedge (Calamagrostis rubescens and Carex geyeri) and was interspersed with small shrubs and forbs, primarily lupine (Lupinus spp.), arrow-leaf balsam root (Balsamorhiza sagittata), and snowberry (Symphoricarpos alba). A research site plan was filed with Lubrecht management per their protocols (p. 81).

Site details

Site one exclosure consisted of four 16’x4’4” rigid heavy gauge livestock panels (6”x4” mesh) arranged to form a 16’ square pen attached to fiberglass posts that were driven into the ground (p. 84, 85). Site two exclosure consisted of twelve 12’x6’ chain link panels arranged to form a 60’x12’x6’ pen (p. 84, 87). T-posts were driven into the ground at each corner to both anchor the exclosure, and to attach insulators to keep the electrified wire strands from grounding against the exclosure corners. Ten foot posts were utilized for additional side support and anchors. The northwest end of the site two exclosure was approximately 3’ 11” from the southeast end of the site one exclosure. Both exclosures were topped initially with 0.5” hardware cloth. The hardware cloth was replaced with wire strands spaced roughly 6” apart to allow for normal snowfall within the exclosures, yet deter large avian scavengers. Site three exclosures consisted of two chain link dog kennels, each measuring 8’x6’x4’ and topped with rigid heavy gauge livestock panels (6”x4” mesh) secured to the sides with wire. As with the site two exclosure, t-posts were driven into the ground at each corner, with wire securing the exclosures to the t-posts. Since carcasses are a prime bear attractant, site one and two exclosures were electrified with a 12 volt system powered by a solar energizer (p. 84). The site three exclosures were powered by a portable 12 volt/energizer system (p. 84, 88). A small weather station consisting of minimum and
maximum thermometers, and a rain gauge for summer and snow gauges for winter, was erected at sites one and two (p. 84). Warning signs were placed full perimeter out to 100 yards at both site locations, as well as on the exclosures themselves (p. 105, 106).

Routine site maintenance consisted of keeping vegetation and debris, plus snow in the winter, cleared from the electrified wires to prevent grounding. A volt meter was used to test the electrified wires after securing each exclosure prior to leaving the sites after each visit. Though bears usually hibernate during the winter months, electric power was left on to deter other carnivores. A wolf pack frequented the general area and mountain lion sign was often seen near sites one and two.

**Carcass procurement, assessment and placement at the sites**

Subjects utilized in this study included eight gray wolves (*Canis lupus*), four mountain lions (*Felis concolor*), two black bears (*Ursus americanus*), and one whitetail deer (*Odocoileus virginianus*). Though the focus of this project was carnivores, procurement of the deer set the stage for future ungulate decomposition research.

Availability of subjects was dependent upon an individual’s removal due to livestock predation or other management action by government agencies, or other causes such as vehicle killed (p. 2). Possession permits are required by state and federal wildlife agencies for species under their respective management (p. 89). Since as wide a pool as possible was necessary for subject procurement, permits for possession were obtained from Idaho Fish and Game, Montana Fish, Wildlife and Parks, and Wyoming Game and Fish for mountain lions and black bears. Letters of approval were obtained from the FWS national grizzly bear coordinator, and from the FWS national wolf coordinator. Carcass protocols detailing the condition of carcasses that could be accepted for the decomposition study were sent to state
and federal biologists (p. 90). Carcass protocols stipulated that there should not be significant external wounding, and requested known environmental factors that would affect the overall condition of the animal. Due to safety concerns of carcasses attracting black and grizzly bears, a bear management plan was written and filed with Lubrecht management officials, and the area bear management specialist with MT Fish, Wildlife and Parks (p. 91). UM’s Institutional Animal Care and Use Committee reviewed the project proposal and passed approval with conditions: 1. to place warning signs full perimeter of the sites and on the exclosures (p. 105, 106), 2. to have a press release on file with UM administration officials in case of a wildlife-human conflict incident at the sites, and 3. to include a wildlife biologist as a graduate committee member.

Most of the carcasses obtained for the study were frozen and stored at agency facilities, protected by polyethylene while being transported to Lubrecht, and thawed near the site area. To deter premature insect colonizing, frozen carcasses were placed in large concrete mixing tubs and tented with mosquito netting until they thawed. Each carcass was thoroughly examined, weighed and measured before being placed on the ground in the exclosures (p. 86, 87, 88, 93). Wounds detected during the carcass examinations were noted. During placement at the sites, carcasses were positioned with known wounds next to the ground to prohibit fly oviposition in the wounds. All carcasses were left intact and minimally disturbed throughout the decomposition process for this project. Carcasses were placed at various times of the year to document seasonal effects on decomposition stages. Carcass spacing was at a six foot minimum. The two summer carcasses were placed in the site one exclosure, and 11 carcasses (fall and winter) were placed in two rows roughly staggered in the site two exclosure. In site two, early fall carcasses were placed at the head of the rows and descending to the middle, and late fall carcasses towards the bottom and ascending towards
the middle. Winter carcasses were placed in the middle which was easily accessed by the mid-span entrance gate, in order to minimize snow compaction when placing carcasses after snowfall. Spring carcasses were placed one each in the electrified dog kennels at site three.

**General data collection**

Upon placement in an exclosure, each carcass was assessed daily for decomposition characteristics that included stage of decomposition for that particular site visit, degree of odor, degree of desiccation both in general and for particular areas of the carcass such as ears, nose pads and foot pads, and other characteristics such as tooth cracking, hair loss, and location of exposed bone (p. 100). Simple line drawings were copied on the back of each carcass assessment sheet to locate notable decomposition and insect features for that particular carcass. Weather data were collected daily both from the small weather station erected near sites one and two consisting of a minimum/maximum thermometer and rain gauge, and with instruments contained in a portable belt weather kit (p. 84, 98). Photographs were taken of each carcass during every site visit (p. 84, 101). Insects were collected and processed for a separate but concurrent forensic entomological study (p. 84, 99).

Long term decomposition was monitored until carcasses reached the dry stage, with data collection occurring twice daily at the onset of each carcass placement, and decreased to once daily through July 2007. Frequency of visits was determined by the level of insect and other notable activity.

To refrain from compacting snow during the winter months when carcasses were well snow covered, the exclosures were not entered, and site visits were conducted every other day (p. 102). During periodic thaws, visits were resumed daily.
Data details and characteristics

Six stage decomposition model. Since the fundamental purpose of this project was to provide documentation in a field applicable format for wildlife officers, decomposition stages identified by Payne (1965) in a pig decomposition study were used due to their easily recognizable characteristics at the gross level of observation. Payne’s model was also utilized by Terneny (1997) for a pig decomposition study conducted in Missoula, MT, approximately 30 miles from this project’s Lubrecht site area. Stages identified by Payne:

1. **Fresh stage** begins at death and ends when the carcass inflates during the bloat stage. Odor is normal at the start. Insects can begin arriving at the carcass within minutes of death.

2. **Bloat stage** begins when anaerobic internal chemical reactions cause the carcass to inflate. Odor of putrefaction becomes strong and insect activity increases.

3. **Active decay stage** commences when the carcass deflates from bloat. There is significant insect activity during this stage, primarily fly larvae. Odor is strongest at this stage due to both putrefaction and fly larvae excreted enzyme. Much of the carcass will appear wet from liquefaction of tissue due to larvae enzyme action. Most of the tissue is removed by the end of this stage.

4. **Advanced decay stage** is marked by a decrease in odor and most of the carcass tissue is removed. Fly larvae diminishes and beetle activity increases.

5. **Dry stage** carcasses have only small bits of tissue remaining and odor becomes faint. Predominant insects include beetles, centipedes, ants, and mites, and bones begin to bleach.
6. **Remains stage** carcasses are largely skeletonized. According to Payne (1965) it is difficult to distinguish a transition from dry to remains stage. Odor is of “litter and soil” (1965:598). Insect activity is greatly diminished and virtually all the tissue has been removed from the skeleton.

**Odor.** Degree of odor is highly subjective. To simplify recording odor characteristics, the following were marked on the data sheet to denote strength, along with type such as “sour” or “musty”: normal or none, faint, mild, moderate, and strong.

**Desiccation.** The degree of desiccation was noted as fresh, intermediate, dry, or mummified.

**Disarticulation.** If disarticulation of joints was observed, it was noted.

**General observations.** General observations were noted and include: disturbance on carcasses due to small mammal or bird scavenging, small bird or mammal sign such as tracks, birds carrying hair from carcasses to be used as nesting material, etc.

**Photo documentation.** Photographs of each carcass were taken during every site visit, starting north and moving clockwise for ventral, posterior, dorsal, and anterior views. Photos were also taken of notable features including head and muzzle profiles, teeth, footpads, areas of exposed bone, and insects.

**Teeth.** Coloration and condition of the teeth were noted, especially the degree and sequence of cracking.

**Weather.** General weather plus micro-climate at the sites were noted during every visit and included: minimum and maximum temperatures for a 24 hour period, temperature at the time of the site visit, relative humidity, wind direction and speed at the time of visit, percent of cloud cover at the time of visit, precipitation or snow cover amount, and if known, the duration of rain or snow fall.
**General site conditions including exclosures and sign of scavengers.** While hiking to the site areas, any and all disturbances were noted and include animal and human tracks, or other signs that would warrant caution or security concerns. Maintenance needs were noted and corrected, such as 12 volt battery replacement at site three, where the batteries were rotated frequently to maintain full power.

**Insect collections and processing.** Extensive insect collections were conducted during each site visit via sweep net, pitfall traps and by hand. Insects were processed at Lubrecht’s wet lab after each site visit, and stored. Insect samples were periodically sent to Gregory D. Johnson, PhD at Montana State University in Bozeman, MT, for a separate but concurrent study of forensic entomology specific to wildlife (Johnson 2007).

**Carcass details**

**Summer carcasses.** On 19 June 2006, two female yearling wolves (W 1 and W 2) were placed for decomposition in site one (p. 93). Weights, lengths and girth were recorded, and a coin was tossed to determine site placement. MSU entomology lab assistants were on hand to install pitfall traps for crawling insects, and review insect collection protocols.

**Early fall carcasses.** On 15 September 2006, two adult female wolves (W 3 and W 4) and a three year old female black bear (BB 1) were placed for decomposition in site two (p. 93). Protocols were followed per the summer carcasses.

**Middle fall carcass.** A male black bear (BB 2) cub of the year was placed in site two on 25 October, 2006 (p. 93). Since that carcass was still frozen at that time, it remained wrapped in polyethylene plastic to prohibit insect colonizing until it thawed. It was unwrapped on 28 Oct for decomposition.
**Late fall carcasses.** Three mountain lion kittens (two males and a female, L 1, L 2, and L 3) and one spike buck whitetail deer (WT 1) were placed in site two on 22 November 2006 (p. 93). Snow gauges were installed in both sites one and two, and three feet long steel rods were placed 2-3” from the anterior and posterior ends of each carcass to mark their positions once they became snow covered.

**Winter carcasses.** Two adult male wolves (W 5 and W 6) were placed for decomposition in site two on 1 December 2006 (p. 93). An adult male mountain lion (L 4) was placed in site two on 11 January 2007 (p. 93). All three carcasses were left on top of the snow to mimic winter poaching conditions.

**Spring carcasses.** Two wolves, one adult male (W 7) and one adult female (W 8), were placed in site three on 4 April 2007 (p. 93).

**Placement summary by species**

**Wolves.** A pair of wolves were placed each season: 19 June 2006 for summer, 15 September 2006 for fall, 1 December 2006 for winter, and 4 April 2007 for spring.

**Black bears.** A black bear was placed 15 September 2006 for early fall, and 28 October 2006 for middle fall.

**Mountain lion.** Three mountain lion kittens were placed 22 November 2006 for late fall, and an adult was placed 11 January 2007 for winter.

**Whitetail deer.** A whitetail deer was placed 22 November 2006 for late fall.
CHAPTER 4 – RESULTS

Though a total of fifteen carcasses were used for this project, results will be provided for representative samples, rather than the entire assemblage. A pair of wolves was placed on the same date for each season. But despite a carcass protocol stipulation that there be minimal external wounding, one each of the winter and spring wolves (W 5 and W 7) had deep posterior wounds that may have affected decomposition rates. The decomposition rates for the summer and fall pair were comparable. Therefore, one representative wolf for each placement season will be detailed for results (W 2, W 3, W 6, and W 8). The choice for summer and fall subjects was based on their orientation in the exclosure: north chosen over south (from site one, summer wolves), and left chosen over right when facing north (from site two, fall wolves). This is consistent with the order that data were collected throughout the entire project. Since the three mountain lion kittens (L 1 – L 3) were considerably smaller than the other carcasses, their results will not be detailed here. However, carcass assessments are provided for all fifteen in Appendix H, page 93 and decomposition data for all carcasses is available upon request.

To aid in stage descriptions, photographic documentation of each decomposition stage for W 2, W 6, BB 1, BB 2, L 4, and WT 1, is provided in Appendix A-1, pages 51-57. A weather table is provided in Appendix A-1, page 60 for the four representative wolves and their respective seasons. Bar graphs depicting stage durations out to 300 days of placement for each representative subject is provided in Appendix A-1, pages 58 and 59. Decomposition duration tables for each representative subject are provided in Appendix A-1, pages 59 and 60. A table of predominant insects collected during each stage from W 2, is provided in Appendix A-1, page 66. Blow fly larvae information and photographs are
provided in Appendix A-1, page 65. Photographs of other predominant insects collected from W 2 are provided in Appendix A-1, page 66.

There was consistent snow cover at the sites from 24 November 2006 to early March 2007. Maximum depth throughout that period was 9 inches.

**Other observations**

There were two obvious bear visits to sites one and two. A well formed rear foot track of a small sized black bear was observed two feet adjacent site one, and a large black bear front foot track seven feet adjacent site two. Both sets of tracks indicate the bears likely received a shock from the electrified wires. A thrush-type bird was observed pecking on the side of W 1 at the time beetle larvae were in greater numbers. The bird, plus sign (droppings, pulled hair and tracks) were observed for approximately a week middle summer 2006, usually on or near W 1. Occasionally rodent and small carnivore (possibly a shorttail weasel) tracks were observed in the snow, both in sites one and two. There was also indication in the snow that a small rodent inhabited the posterior area immediately adjacent W 5. During spring nesting season, a pair of robins, plus a nut hatch, were observed collecting hair from W 6 and the kitten carcasses.

**Carcass summary by season**

Day one counts as one for all decomposition stage durations noted below.

Precipitation amounts (rain and snow) are in inches. Though processes are continuing since most of the carcasses are still at dry stage, duration data ends 19 June 2008.
**Summer – 2006**

**W 2.** Wolf 2 was a yearling female that weighed 88 pounds at the time of placement.

Total days on the ground as of 19 June 2008 – 732

**FRESH** – 19-21 June 2006; 3 day duration

Temperature averages: overall 60° F; minimum 43° F; maximum 77° F

Precipitation amount – 0

**BLOAT** – 22-26 June; 5 day duration

Temperature averages: overall 66° F; minimum 48° F; maximum 83° F

Precipitation amount - 0

**ACTIVE DECAY** – 27 June-7 July; 11 day duration

Temperature averages: overall 73° F; minimum 56° F; maximum 90° F

Precipitation amount – 0.57

**ADVANCED DECAY** – 8 July-17 September; 72 day duration

Temperature averages: overall 69° F; minimum 52° F; maximum 86° F

Precipitation amount – 1.84

**DRY** – 18 September 2006-19 June 2008; 641 days

**Early fall – 2006**

**W 3.** Wolf 3 was an adult female that weighed 86 pounds at the time of placement.

She appeared to be in good physical condition at the time of her death, and was a management removal due to livestock depredation.

Total days on the ground as of 19 June 2008 – 644

**FRESH** – 15-17 September 2006; 3 day duration

Temperature averages: overall 47° F; minimum 37° F; maximum 57° F
Precipitation amount – 0.94

**BLOAT** – 18 September-1 October; 14 day duration

Temperature averages: overall 53° F; minimum 40° F; maximum 65° F

Precipitation amount – 0.2

**ACTIVE DECAY** – 2-23 October; 22 day duration

Temperature averages: overall 45° F; minimum 33° F; maximum 56° F

Precipitation amount – 1.53

**ADVANCED DECAY** – 24 October 2006-5 March 2007; 133 day duration

Temperatures averages: overall 33° F; minimum 25° F; maximum 40° F

Precipitation amount – 1.68 plus snow

**DRY** – 6 March 2007-19 June 2008; 472 days

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**BB 1.** Black bear 1 was a three year old female that weighed 84 pounds at the time of placement. She was in fair condition at the time of her death and was a management removal due to continually procuring human food.

Total days on the ground as of 19 June 2008 – 644

**FRESH** – 15-24 September 2006; 10 day duration

Temperature averages: overall 48° F; minimum 37° F; maximum 58° F

Precipitation amount – 1.14

**BLOAT** – 25 Sept-2 October; 8 day duration

Temperature averages: overall 58° F; minimum 43° F; maximum 73° F

Precipitation amount - 0

**ACTIVE DECAY** – 3-16 October; 14 day duration

Temperature averages: overall 48° F; minimum 35° F; maximum 61° F
Precipitation amount – 0.74

**ADVANCED DECAY** – 17 October-23 November, snow free; 24 November 2006-5 March 2007, under snow; 140 day duration advanced decay and static

Temperature averages: overall 28° F; minimum 19° F; maximum 37° F

Precipitation amounts – 2.47 plus snow

**DRY** – 6 March 2007-19 June 2008; 472 days

*Middle fall – 2006*

**BB 2.** Black bear 2 was a male cub of the year that weighed 62 pounds at the time of placement. He was in excellent condition at the time of his death, and was killed by a vehicle. Trauma was confined to his head, with wounding of his muzzle. Though this bear is small compared to other subjects, it provides a good example of middle fall decomposition processes.

Total days on the ground as of 19 June 2008 – 601

**FRESH** – 28 October-6 November 2006; 10 day duration fresh, frozen, and static

Temperature averages: overall 35° F; minimum 24° F; maximum 46° F

Precipitation amount – 0.19 plus snow

**BLOAT** – Fall: 7-23 November 2006 snow free, bloat and static; spring: 6 March 2007-7 April, bloat and static; 152 day duration bloat, frozen, and static

Temperature averages: overall 31° F; minimum 21° F; maximum 40° F

Precipitation amount – 1.56 plus snow

**ACTIVE DECAY** – 8 April-15 May; 38 day duration

Temperature averages: overall 50° F; minimum 35° F; maximum 64° F

Precipitation amount – 1.31 plus snow
**ADVANCED DECAY** – 16 May-14 July; 60 day duration

Temperature averages: overall 62° F; minimum 44° F; maximum 80° F

Precipitation amount – 2.4 plus snow

**DRY** – 15 July 2007-19 June 2008; 341 days

**Late fall – 2006**

**WT 1.** Whitetail 1 was a spike buck that weighed 82 pounds at the time of placement. He appeared to have been in good condition at the time of his death. He was hit by a car causing injury to his jaw making it impossible to forage. He was euthanized by gunshot.

Placed on bare ground and snow covered within one week

Total days on the ground as of 19 June 2008 – 576

**FRESH** – 22 November 2006-9 March 2007; 108 day duration fresh, frozen, and static

Temperature averages: overall 26° F; minimum 16° F; maximum 35° F

Precipitation amount – 0.07 plus snow

**BLOAT** – 10 March-23 April; 45 day duration bloat and static

Temperature averages: overall 41° F; minimum 29° F; maximum 53° F

Precipitation amount – 0.19 plus snow

**ACTIVE DECAY** – 24 April-8 May; 15 day duration

Temperature averages: overall 52° F; minimum 37° F; maximum 67° F

Precipitation amount – 1.19

**ADVANCED DECAY** – 9 May-20 July; 73 day duration

Temperature averages: overall 62° F; minimum 44° F; maximum 80° F
Precipitation amount – 2.45 plus snow

**DRY** – 21 July 2007-19 June 2008; 335 days

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**Winter – 2006 for W 6 and 2007 for L 4**

**W 6.** Wolf 6 was an adult male that weighed 110 pounds at the time of placement. He was in excellent condition at the time of his death and was a management removal due to livestock depredation

Placed on top of snow

Total time on the ground as of 19 June 2008 – 567

**FRESH** – 1 December 2006-13 March 2007; 103 day duration fresh, frozen, and static

Temperature averages: overall 27° F; minimum 17° F; maximum 37° F

Precipitation amount – 0.14 plus snow

**BLOAT** – 14 March-6 April; 24 day duration

Temperature averages: overall 41° F; minimum 29° F; maximum 52° F

Precipitation amount – 0.52

**ACTIVE DECAY** – 7 April-3 May; 27 day duration

Temperature averages: overall 46° F; minimum 32° F; maximum 60° F

Precipitation amount – 0.46 plus snow

**ADVANCED DECAY** – 4 May-21 June; 49 day duration

Temperature averages: overall 57° F; minimum 41° F; maximum 73° F

Precipitation amount – 2.2 plus snow

**DRY** – 22 June 2007-19 June 2008; 364 days
**L 4.** Lion 4 was a young male that weighed 130 pounds at the time of placement. He appeared to be in excellent condition at the time of his death and was a management removal due to livestock depredation.

Placed on top of snow

Total days on the ground as of 19 June 2008 – 526

**FRESH** – 11 January 2007-17 March; 66 day duration fresh, frozen, and static

Temperature averages: overall 31° F; minimum 20° F; maximum 41° F

Precipitation amount – 0 rain plus snow

**BLOAT** – 18 March-20 April; 34 day duration bloat and static

Temperature averages: overall 41° F; minimum 29° F; maximum 53° F

Precipitation amount – 0.18 plus snow

**ACTIVE DECAY** – 21 April-6 May; 16 day duration

Temperature averages: overall 50° F; minimum 35° F; maximum 65° F

Precipitation amount – 1.2

**ADVANCED DECAY** – 7 May-30 June; 55 day duration

Temperature averages: overall 59° F; minimum 42° F; maximum 76° F

Precipitation amount – 2.45

**DRY** – 1 July 2007-19 June 2008; 355 days

**Spring – 2007**

**W 8.** Wolf 8 was an adult female that weighed 79 pounds at the time of placement. She appeared to be in excellent condition at the time of her death and was a management removal due to livestock depredation.

Total days on the ground as of 19 June 2008 – 443
FRESH – 4-25 April 2007; 22 day duration fresh and static

Temperature averages: overall 43° F; minimum 30° F; maximum 55° F

Precipitation amount – 1.3 plus snow

BLOAT – 26-30 April; 5 day duration

Temperature averages: overall 55° F; minimum 39° F; maximum 70° F

Precipitation amount - 0

ACTIVE DECAY – 1-6 May; 6 day duration

Temperature averages: overall 50° F; minimum 34° F; maximum 65° F

Precipitation amount – 0.99 plus snow

ADVANCED DECAY – 7 May-6 July; 61 day duration

Temperature averages: overall 60° F; minimum 43° F; maximum 77° F

Precipitation amount – 3.47

DRY – 7 July 2007-31 March 2008; 269 day duration

No weather data available

REMAINS – 1 April 2008; total days to reach remains – 363
CHAPTER 5 – DISCUSSION

When Reed (1958) and Johnson (1975) refer to carcasses as microcommunities with microsere, their assertion dovetails nicely with the following statement, “Insects don’t control the decay process; they respond to it” (Higley 2008: Lecture 17). Upon spending countless hours with a carcass as it passes through its organic processes of nutrient recycling, one is struck at how complete a microenvironment the little community is. The process of decomposition, the carcass itself, and the attendant fauna seem a complete unit. As the carcass passes through its phases the insects respond in a successional wave. One is reminded of forest communities that have undergone successions from grassland, to shrub, to forest, with the mega fauna that responded to each stage: elk and grizzly bears’ adaptation to and preference for open areas; deer adaptation to browse shrubs; and black bears’ adaptation to forest communities. And while mega fauna do not wholly control forest succession, they respond to it and to some degree exert an influence.

The overriding influence on carcass microenvironments and resultant decomposition stage durations observed with this project appears to be temperature. This is consistent with findings from previous studies of decomposition processes (Watson 2005, Barnes 2000, Terneney 1997, Payne 1965). Comparison of seasonal decomposition characteristics with weather data, indicates that moisture in the form of rainfall or relative humidity is also a strong factor. The west central area of Montana is generally more arid than the northwest area of the state, providing an opportunity to observe seasonal variation specific to this region.
**Seasonal variation for one carnivore species**

Due to their availability, wolves provided seasonal variation for one species. Two yearling females were placed middle June (W 1 and W 2, summer). The weather remained hot and dry for most of the summer. Within two weeks of placement their hides were nearly mummified, with little underlying tissue. Two adult female wolves were placed mid September (W 3 and W 4, fall). While temperatures remained warm, there was slightly more precipitation. This resulted in delayed carcass drying. As of 19 June 2008, the summer and fall wolves were still well preserved due to early mummification of external tissue. Two adult male wolves were placed early December (W 5 and W 6, winter), and remained static for several months. Two wolves were placed in April (W 7 and W 8, spring) with increased amounts of available moisture in the form of rainfall and higher relative humidity, compared to the other three seasons. They exhibited decomposition characteristics not observed in the wolves placed in the three previous seasons, such as significant amounts of skeleton exposed during the active decay stage. This is likely due to higher overall moisture resulting in delayed carcass drying which promoted an increase in insect activity. Tissue remained pliant and therefore was easily consumed by blow fly larvae during the active decay stage, followed by beetle larvae during the advanced decay stage. It was noted by Mann et al. (1990: 106) in an article detailing variables effecting decomposition rates, that most “soft tissue destruction” is caused by insect larvae. By the time they were snow free March 2008, the spring wolves were at remains stage.

**Notable general observations**

It was found that odor, though somewhat subjective with regards to the degree, may be a definable characteristic for determining a particular stage: active decay – pungent or
sour; advanced decay – similar to rancid cooking grease; dry – musty or earthy (p. 63). Teeth changes appeared to follow a sequence. All of the wolves plus L 4 exhibited a “pink” coloration, as if bleeding was occurring within the tooth itself, during the fresh and early bloat stages. This seemed to follow a sequence of fading beginning with the incisors, followed by premolars, canines, and lastly the molars. At times the incisors and canines would retain faint color at the tips for extended periods. Tooth cracking also seemed to follow a sequence beginning with enamel flaking from the canines, followed by cracking of the premolars, and finally the molars (p. 64). No studies have been found for teeth coloration or cracking sequence. Hair “curling” or texture change was noted on the adult lion and whitetail deer, but not on the bears and wolves while in late advanced decay stage. It did occur on the wolves in late dry stage.

**Potential issues using decomposition stages for TOD determinations**

According to Payne (1965) and Terneney (1997), decomposition stages are readily identifiable and can be useful in determining TOD. However during periods of high temperature fluctuations or consistently cool (not freezing) temperatures, carcasses in this project remained static for extended periods during fresh and particularly bloat stages. In fact, when bloat finally occurred in the late fall, winter and spring carcasses, it was barely detectable. At times it was only detectable due to daily site visits rendering familiarity with the carcasses, the ability to notice subtle changes, and noting a blood colored discharge from nostrils and mouths. Active decay was the only clearly definable stage for those carcasses. The presence of high numbers of blow fly larvae helped define the onset, and then their mass migration helped define the transition to advanced decay.
There were indicators that decomposition processes were occurring internally with carcasses that appeared to be static during the fresh stage. Primary clues were high numbers of carrion beetles which were observed in carcass mouths or anuses, and warmth detected on the abdomens of carcasses contrasting with cool ambient temperatures. It is believed that the abdominal warmth detected was caused by fly larvae masses and/or chemical reaction of the putrefaction process. This raises the question of insects’ influence on their environment: Can that heated mass affect decomposition rates during seasonally cool or cold periods, as well as the insects’ (larvae) own development rates?

Based on initial appearances, carcasses that could be particularly deceiving in terms of actual length of the PMI were BB 2, W 6, and L 4. Though they each were placed either late fall or during the winter, they remained static or unchanging for sustained periods. At first glance they appeared to be “fresh” carcasses, although they had each been on the ground for six, 4.5 and three months respectively. Closer inspection revealed desiccated nose and footpads, slight to moderate odor, small bits of hair being pushed from underneath the carcasses probably by fly larvae, and in the case of BB 2, grass growing up through his fur. (p. 61, 62, 63).

The only two sets of carcasses with easily definable stages were the summer and early fall wolves (W 1 – W 4), and early fall black bear (BB 1). With all carcasses, the transition from advanced decay to dry stage was detectable only due to daily site visits providing the ability to note subtle characteristics such as consistent dryness and odor changes: in other words, looking at a combination of factors and really noting the subtle characteristics day to day. This would be problematic when trying to generate a TOD estimate on a discovered carcass, without having previous days’ documentation up to that point.
A note on decomposition stage names and identifiers

Since the overriding purpose of this project is to provide practical material to field investigators, Payne’s (1965) stage classification model proved a good fit. While there are fundamental differences of aerobic and anaerobic (Reed 1958) processes of decomposition, there is a need to be able to identify stage characteristics at a more gross level. Additionally, insects, particularly blow fly larvae and beetle larvae, were invaluable markers for indicating active and advanced decay stages.

Additional concurrent studies

A concurrent forensic entomology study was conducted by Montana State University (MSU) wildlife entomologist, Greg Johnson, PhD, who established insect collection protocols and supplied insect collection and processing equipment to the Lubrecht site. The Lubrecht wet lab was utilized as a processing and storage facility for insects later transported to MSU for detailed analysis. An additional forensic anthropology graduate study utilized summer and fall wolf carcasses, which was conducted by Laura Wagster to monitor and document over-winter and freeze-thaw cycle effects on decomposition.
Comparison of four decomposition studies, Tables 1-4

<table>
<thead>
<tr>
<th>Study</th>
<th>Start date</th>
<th>Location</th>
<th>Fresh</th>
<th>Bloat</th>
<th>Active decay</th>
<th>Advanced decay</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payne - pigs</td>
<td>August 1962</td>
<td>S. Carolina</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>13 to remains</td>
</tr>
<tr>
<td>Barnes - pigs</td>
<td>17 June 1999</td>
<td>Missoula, MT</td>
<td>1</td>
<td>6</td>
<td>Decay 4</td>
<td>Post decay/dry</td>
<td>23</td>
</tr>
<tr>
<td>Terneney - pigs</td>
<td>5 April 1996</td>
<td>Lubrecht Forest, MT</td>
<td>3</td>
<td>7</td>
<td>68</td>
<td>27</td>
<td>105 to remains</td>
</tr>
</tbody>
</table>

TABLE 1
THREE PIG STUDIES
STAGE DURATIONS – DAYS

<table>
<thead>
<tr>
<th>Study</th>
<th>Start date</th>
<th>Location</th>
<th>Fresh</th>
<th>Bloat</th>
<th>Active decay</th>
<th>Advanced decay</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonder – spring wolf</td>
<td>4 April 2007</td>
<td>Lubrecht Forest, MT</td>
<td>22</td>
<td>5</td>
<td>6</td>
<td>61</td>
<td>269 to remains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-40% forest canopy</td>
<td>T-43</td>
<td>T-55</td>
<td>T-50</td>
<td>T-60</td>
<td>No temp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,300' avg. elevation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terneney – pig</td>
<td>5 April 1996</td>
<td>Missoula, MT</td>
<td>3</td>
<td>7</td>
<td>68</td>
<td>27</td>
<td>105 to remains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open pasture</td>
<td>T-69.5</td>
<td>T-57.8</td>
<td>T-63.3</td>
<td>T-75.9</td>
<td>No temp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,200' avg. elevation</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

TABLE 2
TWO SPRING STUDIES IN WEST CENTRAL MONTANA*
DAYS AND AVERAGE TEMPERATURES IN FAHRENHEIT
*Climate differences for the years of each study, open pastureland vs. forested area, and urban vs. rural setting of each may have contributed to duration differences with each stage. Complete weather data for Terneney’s study is not available.
<table>
<thead>
<tr>
<th>Individual and Date of placement</th>
<th>Season of Placement</th>
<th>Placement Weight</th>
<th>Fresh</th>
<th>Bloat</th>
<th>Active</th>
<th>Advanced</th>
<th>Dry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>W2 06/19/06</td>
<td>Summer</td>
<td>88</td>
<td>3</td>
<td>5</td>
<td>11</td>
<td>72</td>
<td>641</td>
<td>732</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(209 at day 300)</td>
<td></td>
</tr>
<tr>
<td>W3 09/15/06</td>
<td>Fall</td>
<td>86</td>
<td>3</td>
<td>14</td>
<td>22</td>
<td>40 plus 93 under snow 133 total</td>
<td>472</td>
<td>644</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(128 at day 300)</td>
<td></td>
</tr>
<tr>
<td>W6 12/01/06</td>
<td>Winter</td>
<td>110</td>
<td>95 frozen 8 thawed static 103 total 21 static 3 bloat 24 total</td>
<td>27</td>
<td>49</td>
<td>364</td>
<td>567</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(97 at day 300)</td>
<td></td>
</tr>
<tr>
<td>W8* 04/04/07</td>
<td>Spring</td>
<td>79</td>
<td>22; larvae Observed day 20</td>
<td>5</td>
<td>6</td>
<td>61</td>
<td>363</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(206 at day 300)</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 3
WOLVES BY SEASON IN MONTANA
STAGE DURATIONS – DAYS
Totals as of 19 June 2008
*W8 at Remains as of 1 April 2008

<table>
<thead>
<tr>
<th>Season</th>
<th>Habitat</th>
<th>Fresh</th>
<th>Bloat</th>
<th>Decay</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>Woods</td>
<td>0.9</td>
<td>3.5</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>0.9</td>
<td>2.5</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Fall</td>
<td>Woods</td>
<td>7</td>
<td>9</td>
<td>34</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>2.5</td>
<td>11.5</td>
<td>21</td>
<td>80</td>
</tr>
<tr>
<td>Winter</td>
<td>Woods</td>
<td>25</td>
<td>20</td>
<td>95</td>
<td>unknown</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>8</td>
<td>32</td>
<td>85</td>
<td>unknown</td>
</tr>
<tr>
<td>Spring</td>
<td>Woods</td>
<td>4</td>
<td>7</td>
<td>26</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>2.5</td>
<td>4.5</td>
<td>13</td>
<td>75</td>
</tr>
</tbody>
</table>

TABLE 4
DOGS BY SEASON IN TENNESSEE (REED 1958:219)
STAGE DURATIONS – DAYS
**Decomposition stage characteristics observed with this study**

The following characteristics are general and there may be overlap during stage transitions.

<table>
<thead>
<tr>
<th>Decomposition Stage</th>
<th>Characteristics</th>
<th>Insect activity</th>
</tr>
</thead>
</table>
| **Fresh**           | First stage after death  
Odor – not of decomposition  
Lasts until bloat begins  
Small areas of hair mat might start forming towards the end as maggots work underneath and push hair out | Blow flies primarily first insects and may arrive within minutes of death  
Possibly house and flesh flies  
Predatory beetles may be feeding on fly eggs and maggots |
| **Bloat**           | Begins with first visible signs and ends when deflates  
Odor - strong of putrefaction  
Blood may leaking from the nose and/or mouth  
Bloat may be barely detectable if cool temperature periods  
Hair mat starting or increasing | Substantial fly activity  
Maggot activity increases  
Predatory beetles may be feeding on maggots |
| **Active decay**    | Begins when carcass deflates  
Odor – extremely strong of putrefaction and maggot enzyme (sour, pungent odor)  
Carcass appears wet from maggot enzyme action (liquefaction of tissue)  
Torso/flank area appears sunken  
Wet weather conditions – pliant hide easily consumed by maggots exposing large amounts of skeleton  
Dry weather conditions – hide will mummify and be preserved  
Hair slippage; hair mat greatly increase | Maggot activity substantial  
Predatory beetles may still be present  
Cheese skipper flies may be present in large numbers (predate on maggots) |
| **Advanced decay**  | Odor – moderate at start and mild at end; more sweet than pungently sour, like old or rancid grease  
Wet weather conditions – pliant hide easily consumed by beetle larvae; substantial skeleton may then be exposed  
Dry weather conditions – mummification preserving hide | Marked by increase of beetle larva activity and greatly diminished maggot activity as they migrate off carcass  
Ends with diminished beetle larva activity  
Pupae may be under, against, near or out several feet from carcass; cases may be open in later advanced as flies emerge |
| **Dry**             | Odor – faint and musty  
Wet weather conditions – substantial skeleton exposed  
Dry weather conditions – dried/mummified hide covers skeleton | Greatly diminished beetle larva activity  
Dermestid beetles present (though they may occasionally be present in earlier stages, they are predominant in dry stage)  
Pupae present as above; cases may be open |
| **Remains**         | Odor – little to none  
Skeleton with remnants of tissue | Little to no carcass related insect activity |

**TABLE 5**
CHAPTER 6 – CONCLUSION

Though there are limitations using decomposition stages to generate TOD estimates in our climate, it can nevertheless be an invaluable tool for wildlife investigators conducting illegal take investigations. It should be obvious that a combination of characteristics must be utilized: the greater the PMI, the greater the number of characteristics. Most wildlife officers are well experienced in “reading” a poached carcass and its environment. With additional training, they will readily grasp the significance of the numerous subtle clues.

Practical field format to distribute results

To achieve the goal of providing decomposition data in a practical version for field use by wildlife investigators, a manual was created and is now available in coil-bound color hardcopy. It may also be available in CD format (p. 43).

A PowerPoint program has been created and presented at a number of venues, including several hundred federal, state and provincial wildlife officers at their annual conference hosted by the North American Wildlife Enforcement Officers Association (p. 69).

A Wildlife Field Forensics training seminar for wildlife officers was organized and held spring 2007 and 2008 (p. 72). Attendance both years was capped at 58, with several instructors teaching a variety of techniques. This forum is now recognized by several state and federal agencies as an annual event.

A core group of instructors have formed to expand the Wildlife Field Forensics program by being available to travel to various agency venues, in addition to providing contract services and consulting (p. 79).

**The current project site**

It was unknown at the beginning of this project the length of time it would take for a carcass in this relatively arid environment to reach remains stage. Of the fifteen subjects, only two are clearly at remains. As a footnote, W 1 and W 2 will be left at the site for another year. W 7 and W 8 were removed from their site since they have clearly progressed to remains stage. A decision will be made September 2008, regarding leaving additional carcasses to allow progression from dry to remains stage. Heads of all wolves that will be left at the sites will be removed due to security concerns. All eight wolf heads will be sent to the FWS National Fish and Wildlife Forensics Lab located in Ashland, OR where they will be further analyzed for notable microscopic characteristics that may relate to the PMI. Viewed through a microscope, teeth may provide valuable clues to TOD.

**The future**

This project presented just a glimpse into wildlife decomposition as it relates to its use for generating TOD estimates in west-central Montana. It was conducted in a controlled setting in order to gather baseline data on decomposition stage characteristics and durations. As a committee member stated in the beginning (Eicher 2006), it will generate more questions than answers. Indeed. As any wildlife investigator knows, there is no end to the
variations of conditions for poached wildlife. Likewise, as this project has demonstrated, there is no end to the variables that need to be introduced and their effects documented. Baseline data is needed for more species, particularly ungulates such as both species of deer, elk, and antelope. Introduced variables include: heads and/or antlers removed; carcasses skinned and/or field dressed; large ungulates quartered; buried and unburied; north and south slope differences; and carcasses in wet, riparian areas compared to open, dry meadows. Predetermined carcasses can be opened sequentially to observe internal characteristics. Winter work would include examining conditions under an insulating blanket of snow, and devising a means for observing possible internal larvae activity. More attention can be given to documenting changes in teeth over time. Is there a definable sequence to tooth cracking and coloration related to passage of time? Changes in looseness of skin over connective tissue, fascia and bone may hold clues to TOD. With most decomposition research focused on mammals, birds, particularly raptors, are prime research subjects. And since most poached wildlife is scavenged before it might be discovered, bone weathering and scavenging patterns as it relates to the PMI needs further study. It is easy to note the sun’s effect on exposed bone, but the degree of bleaching and weathering provides important clues, as is well known by forensic anthropologists. And bones provide food (marrow), fat, minerals, and a chewing medium to a host of small mammals. Knowing gnawing and feeding patterns of small mammals may provide important clues to TOD simply by looking at scavenged, scattered, and gnawed bones.

Though results were not detailed for the three mountain lion kittens that were placed at site two, they presented an intriguing question: What does happen when a carcass remains fully snow covered throughout the winter? They were placed on bare ground the afternoon of a snow storm, and were fully covered by at least three inches the following day. As with
all the subjects, three feet long slender rods were placed in the ground near the anterior and posterior ends of each kitten to mark their positions once they became snow covered. During their first week of placement, high ambient temperatures remained in the twenties (Fahrenheit), well below freezing, and by the end of that week they were fully covered by four inches of snow. A biologist was informed that he was required to gather tissue samples from each kitten for the state wildlife lab, which we proceeded to do after their first week of placement. Snow was carefully removed over their muzzle areas. It was a surprise discovery that none of the three kittens’ muzzles or tongues were frozen, apparently having been well insulated by snow. As snow melted off the kittens that following spring, it appears they had not frozen the entire winter, and they exhibited different decomposition characteristics from overwinter carcasses that were placed on top of snow and remained frozen throughout the winter. It is known that the subnivian space has characteristics that differ from above snow surface conditions (temperature, etc), and that snow acts as an insulating layer.

Yes, more work needs to be done to address the many questions generated by this project.
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APPENDIX A-1

WILDLIFE DECOMPOSITION ANALYSIS FOR TIME OF DEATH ESTIMATES

Plus Forensic Entomology Basics

F. Carleen Gonder

Photo: C. Gonder
WILDLIFE DECOMPOSITION ANALYSIS FOR TIME OF DEATH ESTIMATES

Plus Forensic Entomology Basics

by
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Wildlife Field Forensics
Self-Published
2008

Training, consulting and PowerPoint presentations are available

DEDICATION

I dedicate these efforts to my son Don and his family, to Arrow and the memory of Hope – my four legged companions, and to wildlife officers everywhere who are vital to wildlife populations.
ACKNOWLEDGEMENTS

Funding was awarded to the project by the Association of Midwest Fish and Game Law Enforcement Officers. The total award was $10,000 with $5000 disbursed quarterly for 2007 and $5000 for 2008. The Wyoming Game Wardens Association awarded $500 in March 2007, and $750 in 2008. The Missoula, MT chapter of P.E.O. (Philanthropy Educational Organization) awarded $200 in 2008. MT Fish, Wildlife and Parks (FWP), via bear management specialist Jamie Jonkel, loaned the use of an electrified exclosure for site 1, and solar energizer. Grizzly Fence in Missoula, MT loaned the use of twelve 12’x6’ portable chain link panels for the duration of the project for site 2. Monetary value is $864.00 (comparable rent for two years). Quality Supply of Missoula, MT donated $500 in August 2007. MT Department of Natural Resources and Conservation State Forester Bob Harrington, and Ward McCaughey with the US Forest Service Rocky Mountain Research Station loaned the use of various weather instruments. Tim Eicher, US Fish and Wildlife Service (FWS) Special Agent, donated a hanging scale, ropes and pulleys, as well as time, effort and encouragement at the sites. Gregory Johnson, PhD, completely outfitted a wet lab at Lubrecht for this project, provided all entomological equipment which included a freezer, refrigerator and microscope, materials for two exclosures at site 3, and gave time, effort and encouragement at the sites. Mike Jimenez, then the FWS Wyoming wolf coordinator and now the Wyoming Game and Fish state coordinator, and Jim Pehringer of US Wildlife Services assisted with procurement of wolves from Wyoming. Steve Nadeau, state carnivore biologist and Jason Hueseman, wolf specialist, both with Idaho Fish and Game assisted with procurement of wolves from Idaho. Carolyn Sime, FWP wolf coordinator and Mark Atkinson, DVM/wildlife veterinarian now with NV Dept. of Wildlife, assisted with procurement of wolves and the adult lion from Montana. Jay Kolbe, FWP Blackfoot River area biologist, assisted with procurement of the lion kittens and whitetail deer. Taser International has donated two Taser units to test their suitability for use in providing electrical stimulus to muscles for time of death determinations. Carrie Hunt of Wind River Bear Institute gifted a Karelian Bear Dog to C. Gonder via a scholarship; this dog will be trained for carcass detection/bear conflict work. Frank Maus and his staff at UM’s Lubrecht Experimental Forest have continually provided invaluable assistance and deserve special acknowledgement.

A number of individuals have helped with material support and other assistance:
Erica Hutchings, Carol Havlik, The Hager Family, Lucinda Schroeder, Kathy Engstrom, Lilian Evans, Kyriaki Trigonis, Owen Cox, Leila Haack, Bruce Young, and Chris Winter.

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Ashley H. McKeown, PhD; Forensic Anthropology
Gregory D. Johnson, PhD; Wildlife/Livestock Entomology, Montana State University
Tim Eicher, Special Agent; US Fish and Wildlife Service
David Oates, Forensic Specialist and Lab Manager; NE Game and Parks Commission
James (Jamie) Jonkel, Bear Management Specialist; MT Fish, Wildlife and Parks
ABSTRACT

To address time of death (TOD) issues of carcasses found in a state of decomposition, and to provide training materials and field tools for investigating officers, a project was initiated to identify decomposition stages for a variety of carnivore species, and to document decomposition rates for those stages in the west central area of Montana. The practical research involved in this study will provide baseline data on long term decomposition in order to develop standards for use in the field by wildlife law enforcement officials.

TOD estimates are also appropriate for livestock depredation claim investigations. It may be vital to establish the TOD of the predating carnivore to assure it was legally killed by the livestock manager at the time when livestock were in the area.

FUTURE WORK

Decomposition/time of death project efforts now include strategies to keep it going long into the future. Proposals are being submitted to interested agencies and funding entities. The objective is to provide a permanent location for decomposition which will allow for an expanded site area, and introduction of the numerous variables and species encountered in natural settings and poaching situations.
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INTRODUCTION

An issue when investigating poaching of many wildlife species is the discovery of carcasses in advanced stages of decomposition with little information about time of death (TOD). Documenting decomposition changes over time can provide markers for wildlife law enforcement officers to utilize for TOD estimates. For this study, decomposition data has been collected from eight gray wolves, four mountain lions, two black bears, and one whitetail deer.

University of Montana’s Lubrecht Experimental Forest
Carcass sites were established in a secure area of Lubrecht Forest, and were protected by four electrified exclosures. The sites were on nearly level knolls at approximately 4,300 feet elevation. Tree canopy for that area is 30-40%. Habitat type is second growth Ponderosa Pine with Douglas Fir understory. The area within the exclosures was covered primarily with pine grass and interspersed with small shrubs and forbs.

Seasonal variation for one carnivore species (data available for each subject)
Due to their availability, wolves provided seasonal variation for one species. Two yearling females were placed 19 June 2006 (summer). The weather remained hot and dry for most of that summer. Within two weeks of placement their hides were nearly mummified, with little underlying tissue. Two adult females were placed 15 September 2006 (fall). While temperatures remained warm, there was slightly more precipitation. This resulted in delayed carcass drying. The summer and fall wolves were well preserved during early decomposition due to mummification. Two adult males were placed 1 December 2006 (winter), and remained static for several months, with hide drying occurring during the static periods. An adult male and female were placed 4 April 2007 (spring) with increased amounts of moisture in the form of rainfall and higher relative humidity, compared to the other seasons. Those spring wolves reached remains stage by April 2008, and were the only subjects in this study to reach that stage as of 19 June 2008. They exhibited decomposition characteristics not observed in the wolves placed during the three previous seasons, such as significant amounts of exposed skeleton starting in the active decay stage. Higher overall moisture resulted in delayed carcass drying which promoted an increase in insect activity while the hide was pliant. As of June 2008, all wolves placed summer, fall and winter seasons were at dry stage with significant amounts of mummified hide remaining. (A three year old black bear was placed the same date as the fall wolves and was also at dry stage as of June 2008.)

Multiple species to illustrate freeze/thaw cycles (data available for each subject)
One cub-of-the-year black bear was placed on bare ground on 28 October 2006. The carcass had been frozen but was fully thawed at the time of placement. That fall the bear had undergone numerous freeze/thaw cycles, and remained static after snowmelt the following spring for well over one month. Three lion kittens and one whitetail deer were placed on bare ground 22 November 2006 during an active snow storm and were well covered the following day. They remained snow-covered until the following spring. The small lions were possibly insulated from freezing until after early spring snowmelt. Two adult male wolves were placed on top of the snow 1 December 2006 and remained frozen until the following spring. One adult male lion was placed 11 January 2007 on snow and it, too, remained frozen until spring.
### DECOMPOSITION CHARACTERISTICS AND TIME OF DEATH FIELD ESTIMATES

<table>
<thead>
<tr>
<th>Decomposition stage</th>
<th>Characteristics</th>
<th>Insect activity</th>
<th>Time estimate*</th>
</tr>
</thead>
</table>
| Fresh               | First stage after death  
Odor – not of decomposition  
Lasts until bloat begins  
Small areas of hair mat might start forming towards the end as maggots work underneath and push hair out | Blow flies primarily first insects and may arrive within minutes of death  
Possibly house and flesh flies  
Predatory beetles may be feeding on fly eggs and maggots  
Ticks may be present (not an insect) | Fall: 1-3 days (longer if late fall)  
Winter: 1-100 days (if frozen)  
Spring: 1-25 days  
Summer: 1-3 days |
| Bloat               | Begins with first visible signs and ends when deflates  
Odor - strong of putrefaction  
Blood may leaking from the nose and/or mouth  
Bloat may be barely detectable if cool temperature periods  
Hair mat starting or increasing | Substantial fly activity  
Maggot activity increases  
Predatory beetles may be feeding on maggots  
Ticks may be present in early bloat | Fall: 3-20 days  
Winter: unlikely stage during winter  
(see below active stage/winter for on snow/under snow)  
Spring: 20-30 days  
Summer: 3-10 days |
| Active decay        | Begins when carcass deflates  
Odor – extremely strong of putrefaction and maggot enzyme (sour, pungent odor)  
Carcass appears wet from maggot enzyme action (liquefaction of tissue)  
Torso/flank area appears sunken  
Wet weather conditions – pliant hide easily consumed by maggots  
Exposing large amounts of skeleton  
Dry weather conditions – hide will mummify and be preserved  
Hair slippage; hair mat greatly increase | Maggot activity substantial  
Predatory beetles may still be present  
Cheese skipper flies may be present in large numbers (predate on maggots) | Fall: 15-40 days  
Winter: unlikely stage during winter  
Carcasses on snow probably frozen  
Carcasses under snow may have internal maggot activity  
Spring: 25-35 days (a winter carcass can be at active stage in spring, but would possibly have dried foot/nose pads, and hard, stiff ears)  
Summer: 10-20 days |
| Advanced decay      | Odor – moderate at start and mild at end; more sweet than pungently sour, like old or rancid grease  
Wet weather conditions – pliant hide easily consumed by beetle larvae; substantial skeleton may then be exposed  
Dry weather conditions – mummification preserving hide | Marked by increase of beetle larvae activity and greatly diminished maggot activity as they migrate off carcass  
Ends with diminished beetle larvae activity  
Pupae may be under, against, near or out several feet from carcass; cases may be open in later advanced as flies emerge | Fall: 40-90 days  
Winter: 155-205 days (possibly unfrozen/insulated under snow)  
Spring: 35-95 days  
Summer: 20-90 days |
| Dry                 | Odor – faint and musty  
Wet weather conditions – substantial skeleton exposed  
Dry weather conditions – dried/mummified hide covers skeleton | Greatly diminished beetle larvae activity  
Dermestid beetles present (a few may be present in earlier stages)  
Pupae as above with cases open | Dry carcasses found in any season may be at 90 days to a year or more.  
Other clues: insect remains (pupae cases, etc), crushed vegetation (plant phenology) |
| Remains             | Odor – little to none  
Skeleton with remnants of tissue | Little to no carcass related insect activity | Bone weathering data not available with this study. Other clues as above |

*Based on Lubrecht wolf carcass decomposition durations. Fresh, bloat and active can have considerably shorter durations with warmer temperatures and more moisture, and longer durations with cool/cold temperatures. In Montana's winter climate, carcasses on top of snow will freeze, or possibly remain unfrozen if snow covered. Winter: possibly determine stage at the time it became frozen (check weather history to estimate time frozen)

**Teeth:** They may be pink colored during fresh and early bloat, progressively fading through active decay stage. The tips of the incisors and canines, and the body of the molars may retain faint color as decomposition transitions to advanced decay. As conditions dry, enamel may start to flake off the canines as the carcass progresses through advanced decay stage. Cracks and full splits may appear starting with the premolars and then carnassials and molars as the carcass progresses through dry stage.

**Scavenged carcasses:** Insects can provide clues, such as presence of maggots and pupae. They can be collected and analyzed for TOD estimate.
DECOMPOSITION STAGE SUMMARY

Decomposition stages: Fresh, Bloat, Active Decay, Advanced Decay, Dry, and Remains

Durations are temperature dependent, with characteristic insect succession for each stage. Stage descriptions accompany photographs for wolf 2 (W 2).

NOTE: Animals were not euthanized for this project, but were management removals, road killed with minimal head trauma, and inadvertent snare capture. Placement condition information is available.

The following were stages reached as of 19 June 2008, with placement dates noted. Winter carcasses were placed on top of snow. A few carcasses will remain in place for another year.

Wolves (photos for W 2 and W 8 are included; photos for remainder are available)

W 1 and W 2 – 19 June 2006; dry stage/mummified. Progressed through predictable stages (summer: hot/dry)

W 3 and W 4 – 15 September 2006; dry stage/mummified. Progressed through predictable stages (fall: warm to cool)

W 5 and W 6 – 1 December 2006; dry stage/mummified. Placed on top of snow and remained frozen throughout winter. Did not progress through predictable stages due to extended static periods (winter: predominantly freezing with snow cover on ground November to March)

W 7 and W 8 – 4 April 2007; Remains stage. Remained fresh until 24 April with signs of early bloat. Did not progress through predictable stages due to extended static periods (spring: mix of freezing day/night temps; warm or cool days/freezing night temps; warm days/cool nights)

Significant amount of hide and fur remain; hide mummified: W 1 – W 6

Significant amount of skeleton exposed; remaining hide mummified: W 7 and W 8

Black bears (photos included)

BB 1 – 15 September 2006; dry stage/mummified. Progressed through predictable stages

BB 2 – 28 October 2006; dry stage/mummified. Placed on bare ground, and freeze/thaw temps until snowfall. Snow covered and at times partially exposed during winter. Carcass possibly remained frozen until snow-free. Did not progress through predictable stages due to static periods

Mountain lions (photos for L 4 included; photos for remainder available)

L 1, L 2 and L 3 – 22 November 2006; dry stage/mummified. Placed on bare ground but snowed that same day and were covered by the next day. Remained under at least 4 inches of snow the entire winter and it is believed they did not freeze, but were insulated by snow cover and subnivian space. Did not progress through predictable stages due to static periods

L 4 – 11 January 2007; dry stage/mummified. Placed on top of snow and remained frozen throughout winter. Did not progress through predictable stages due to static periods

Whitetail deer (photos included)

WT 1 – 22 November 2006; dry stage/mummified. Placed on bare ground. Did not become immediately snow covered due to carcass size and froze shortly after placement. Possibly remained frozen throughout winter due to partial exposure at times. Did not progress through predictable stages due to static periods

Decomposition stages for W 2

Summer

DURATIONS: Day one counts as one
Placed 19 June 2006
19 - 21 June; 3 days fresh
1. Fresh. First stage after death; lasts until bloat begins. Blow flies are usually the first insects and may be present within minutes of death. House and flesh flies may be present. Predatory beetles may be feeding on fly eggs and maggots

All decomposition photos: C. Gonder
2. Bloat 06/26/06
22 - 26 June, 5 days bloat
Begins with first visible signs; ends
when body deflates. Strong odor of putrefaction
and substantial fly activity. Bloat may be barely
detectable if strong day/night temperature
fluctuations, or cooler overall temps (fall/spring).
Maggot activity increases. Predatory beetles may be
feeding on maggots

3. Active decay 06/27/06
27 June – 7 July, 11 days active
Begins when body deflates from bloat; maggot
activity is substantial. End is marked by maggot
numbers diminishing and migrating off carcass,
and torso/flank area appears sunken. Very strong
odor of putrefaction and wet with maggot enzyme
action/liquefaction. (W 2: By 2 July hide extremely
dry, almost mummified; maggots unable to
consume. Moist, pliant hides will be consumed)

4. Advanced decay 07/19/06
8 July – 17 September, 72 days advanced
Marked by increase in beetle and beetle larvae
activity and end marked by beetle activity
diminishing and carcass has the appearance of hide
stretched over bone. Odor moderate at the start
and mild to faint when ends and becoming more
sweet or rancid than pungently sour

5. Dry 05/13/07
18 September 06 – 19 June 08, 641 days dry
Marked by beetle activity greatly diminishing, and
it appears there is little tissue under the hide. Odor
mild to faint and is musty rather than that of
putrefaction. Predominant insects are dermestid
beetles. With more moist conditions, there may be
significant amount of skeleton exposed. Ends
when little tissue remains

6. Dry 05/02/2008

7. Dry 06/19/08
Total days on the ground as of
19 June 2008 – 732
Decomposition stages for BB 1
Early fall

Placed 15 September 2006
Progressed through predictable stages
with possible static conditions while snow covered

1. Fresh
09/24/06
15 - 24 Sept, 10 days fresh

2. Bloat
09/29/06
25 Sept – 2 Oct, 8 days bloat

3. Active decay
10/02/06
3 -16 Oct, 14 days active

4. Advanced decay
11/09/06
17 Oct – 23 Nov, snow free
24 Nov – 5 March, under snow
140 days advanced/static

5. Dry
05/01/07
6 March 2007 – 19 June 2008, 472 days dry

6. Dry
05/02/2008

7. Dry
06/19/08
Total days on the ground as of
19 June 2008 – 644
Decomposition stages for BB 2
Mid fall

Placed 28 October 2006
Temperature fluctuations caused several static periods. Bloat started prior snow fall. Parts of the carcass were frequently exposed during the winter, possibly prompting freezing. After becoming snow free in March bloat resumed interspersed with static periods. Bloat barely detectable fall and spring

1. Fresh 10/29/06
28 Oct – 6 Nov, 10 days fresh/frozen/static

2. Bloat/fall 11/13/06
7 - 24 Nov, snow free

3. Bloat/spring 03/16/07
6 Mar snow free, 152 days bloat/static

4. Active decay 05/12/07
8 April – 15 May, 38 days active

5. Advanced decay 05/20/07
16 May – 14 July, 60 days advanced

6. Dry 07/24/07
15 July 2007 – 19 June 2008
341 days dry

7. Dry 05/02/08

8. Dry 06/19/08
Total days on the ground as of 19 June 2008 – 601
Decomposition stages for WT 1
Late fall

Placed 22 November 2006
Placed on bare ground. Became snow covered by 24 Nov until 4 March. Experienced static conditions during bloat stage. Bloat barely detectable

1. Fresh 11/22/06
22 Nov – 9 March, 108 days fresh/frozen/static

2. Bloat 04/22/07
10 March – 23 April, 45 days bloat/static

3. Active decay 05/02/07
24 April – 8 May, 15 days active

4. Advanced decay 05/09/07
9 May – 20 July, 73 days advanced

5. Dry 07/24/07
21 July 2007 – 19 June 2008, 335 days dry

6. Dry 05/02/2008

7. Dry 06/19/08
Total days on the ground as of 19 June 2008 – 576
Decomposition stages for L 4
Winter

Placed 11 January 2007
Placed on top of snow and remained frozen until 5 March. Experienced static conditions during fresh/thawed and bloat stages. Bloat barely detectable

1. Fresh 01/11/07
11 Jan – 17 March, 66 days fresh/frozen/static

2. Bloat 04/14/07
18 March – 20 April, 34 days bloat/static

3. Active decay 05/02/07
21 April – 6 May, 16 days active

4. Advanced decay 05/24/07
7 May – 30 June, 55 days advanced

5. Dry 07/24/07
1 July 2007 – 19 June 2008, 355 days dry

6. Dry 05/02/2008

7. Dry 06/19/08
Total days on the ground ad of 19 June 2008 – 526
**Decomposition stages for W 8**

**Spring**

Placed 4 April 2007
Remained fresh/static for an extended period due to cool, fluctuating temperatures. Warm abdomen, and carrion beetles in mouth and anus, indicated maggots internal. Spring moisture kept hide pliant for easy consumption by maggots and beetle larvae, resulting in well exposed skeleton. Bloat barely detectable

1. Fresh 04/04/07
4 - 25 April, 22 days fresh/static

2. Bloat 04/29/07
26 - 30 April, 5 days bloat

3. Active decay 05/01/07
1 - 6 May, 6 days active

4. Advanced decay 05/07/07
7 May – 6 July, 61 days advanced

5. Dry 07/07/07
7 July 2007 – 31 March 2008, 269 days dry

6. Remains 05/02/08
1 April 2008

7. Remains 06/19/08
Total days on the ground as of 19 June 2008 – 443
Total days to end of dry - 363
Above illustrates seasonal variation of wolves (one representative subject from each of the four pairs)

Above illustrates seasonal variation of mixed species plus extended stages due to static conditions
### DECOMPOSITION STAGES TO 300 DAYS

Above illustrates all species and all months of placement.

<table>
<thead>
<tr>
<th>Individual and Date of Placement</th>
<th>Season of Placement</th>
<th>Placement Weight</th>
<th>Fresh</th>
<th>Bloat</th>
<th>Active</th>
<th>Advanced</th>
<th>Dry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>W2 06/19/06</td>
<td>Summer</td>
<td>88</td>
<td>3</td>
<td>5</td>
<td>11</td>
<td>72</td>
<td></td>
<td>732</td>
</tr>
<tr>
<td>W3 09/15/06</td>
<td>Fall</td>
<td>86</td>
<td>3</td>
<td>14</td>
<td>22</td>
<td>40 plus 93 under snow 133 total</td>
<td>472</td>
<td>(128 at day 300)</td>
</tr>
<tr>
<td>BB1 09/15/06</td>
<td>Early fall</td>
<td>84</td>
<td>10</td>
<td>8</td>
<td>14</td>
<td>47 plus 93 under snow 140 total</td>
<td>472</td>
<td>(128 at day 300)</td>
</tr>
<tr>
<td>BB2 10/28/06</td>
<td>Late fall</td>
<td>62</td>
<td>10 frozen days 4-6</td>
<td>17 static 102 snow 3 static 9 bloat 21 static 152 total</td>
<td>17 static 21 active 38 total</td>
<td>60</td>
<td>341 (40 at day 300)</td>
<td>601</td>
</tr>
<tr>
<td>WT1 11/22/06</td>
<td>Late fall</td>
<td>82</td>
<td>2 Fresh 10 frozen now 5 thawed 108 total</td>
<td>8 bloat 26 static 11 bloat 45 total</td>
<td>15</td>
<td>73</td>
<td>335 (59 at day 300)</td>
<td>576</td>
</tr>
<tr>
<td>W6 Winter 12/01/06</td>
<td>Winter</td>
<td>110</td>
<td>95 frozen 8 thawed 9 static 103 total</td>
<td>21 static 3 bloat 24 total</td>
<td>27</td>
<td>49</td>
<td>364 (97 at day 300)</td>
<td>567</td>
</tr>
<tr>
<td>L4 01/11/07</td>
<td>Winter</td>
<td>130</td>
<td>53 frozen 13 thawed 11 static 66 total</td>
<td>4 bloat 14 static 16 bloat 34 total</td>
<td>16</td>
<td>55</td>
<td>355 (129 at day 300)</td>
<td>526</td>
</tr>
<tr>
<td>W8 * 04/04/07</td>
<td>Spring</td>
<td>79</td>
<td>22 larvae observed day 20</td>
<td>5</td>
<td>6</td>
<td>61</td>
<td>269 (206 at day 300)</td>
<td>363 To Rem Stage</td>
</tr>
</tbody>
</table>

**STAGE DURATIONS – DAYS**

**Totals as of 19 June 2008**

*W8 at Remains as of 1 April 2008*

**Note:** Shorter active decay durations for W2, W8 and BB1.

**Possibly due to:**

- W2 – rapid mummification of hide occurring at approx 2 weeks from placement
- W8 – greatly increased moisture keeping hide pliant for rapid maggot and beetle larvae consumption
- BB1 – higher body fat content
Weather averages for decomposition stages for wolves as of 19 June 2008 (Snow depth 7”)

### W-2 Summer - 19 June 2006
<table>
<thead>
<tr>
<th></th>
<th>Fresh</th>
<th>Bloat</th>
<th>Active</th>
<th>Adv</th>
<th>Dry</th>
<th>Total pc</th>
<th>pcp</th>
</tr>
</thead>
<tbody>
<tr>
<td>TempMn</td>
<td>43</td>
<td>48</td>
<td>56</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TempMx</td>
<td>77</td>
<td>83</td>
<td>90</td>
<td>86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precip</td>
<td>0</td>
<td>0</td>
<td>0.57</td>
<td>1.84</td>
<td></td>
<td></td>
<td>2.41</td>
</tr>
<tr>
<td>Days</td>
<td>3</td>
<td>5</td>
<td>11</td>
<td>72</td>
<td></td>
<td></td>
<td>641-6/19/08</td>
</tr>
<tr>
<td>Total days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>732</td>
</tr>
</tbody>
</table>

### W-3 Fall - 15 September 2006
<table>
<thead>
<tr>
<th></th>
<th>Fresh</th>
<th>Bloat</th>
<th>Active</th>
<th>Adv</th>
<th>Dry</th>
<th>Total pc</th>
<th>pcp</th>
</tr>
</thead>
<tbody>
<tr>
<td>TempMn</td>
<td>37</td>
<td>40</td>
<td>33</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TempMx</td>
<td>57</td>
<td>65</td>
<td>56</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precip</td>
<td>0.94</td>
<td>0.2</td>
<td>1.53</td>
<td>1.68*</td>
<td></td>
<td></td>
<td>4.35</td>
</tr>
<tr>
<td>Days</td>
<td>3</td>
<td>14</td>
<td>22</td>
<td>133</td>
<td></td>
<td></td>
<td>472-6/19/08</td>
</tr>
<tr>
<td>Total days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>644</td>
</tr>
</tbody>
</table>

**Placed on top of snow**

### W-6 Winter - 1 December 2006
<table>
<thead>
<tr>
<th></th>
<th>Fresh/frz</th>
<th>StaticBlot</th>
<th>Active</th>
<th>Adv</th>
<th>Dry</th>
<th>Total pc</th>
<th>pcp</th>
</tr>
</thead>
<tbody>
<tr>
<td>TempMn</td>
<td>17</td>
<td>29</td>
<td>32</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TempMx</td>
<td>37</td>
<td>52</td>
<td>60</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precip</td>
<td>0.14*</td>
<td>0.52</td>
<td>0.46*</td>
<td>2.2*</td>
<td></td>
<td></td>
<td>3.32</td>
</tr>
<tr>
<td>Days</td>
<td>103</td>
<td>24</td>
<td>27</td>
<td>49</td>
<td></td>
<td></td>
<td>364-6/19/08</td>
</tr>
<tr>
<td>Total days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>567</td>
</tr>
</tbody>
</table>

*Plus snow

**Placed on top of snow**

### W-8 Spring - 4 April 2007
<table>
<thead>
<tr>
<th></th>
<th>Fresh</th>
<th>StaticBlot</th>
<th>Active</th>
<th>Adv</th>
<th>Dry</th>
<th>Total pc</th>
<th>pcp</th>
</tr>
</thead>
<tbody>
<tr>
<td>TempMn</td>
<td>30</td>
<td>39</td>
<td>34</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TempMx</td>
<td>55</td>
<td>70</td>
<td>65</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precip</td>
<td>1.3*</td>
<td>0.99*</td>
<td>6.0</td>
<td>6.0</td>
<td></td>
<td></td>
<td>5.76</td>
</tr>
<tr>
<td>Days</td>
<td>22</td>
<td>5</td>
<td>6</td>
<td>61</td>
<td></td>
<td></td>
<td>269/remains</td>
</tr>
<tr>
<td>Total days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>363</td>
</tr>
</tbody>
</table>

**Precipitation and humidity can be significant factors in the earlier stages of decomposition, which keeps the hide pliable. Beetle larvae were far more numerous on W-8 and were observed consuming large amounts of flesh. Consequently, W-8 has a significant amount of skeleton exposed, whereas the other wolves are relatively intact. Beetle larvae numbers dropped substantially as the hide dried.**

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<thead>
<tr>
<th>Individual and Date of placement</th>
<th>Season of Placement</th>
<th>Placement Weight</th>
<th>Fresh</th>
<th>Bloat</th>
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<th>Dry</th>
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<td>732</td>
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<td>86</td>
<td>3</td>
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<td>22</td>
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<td>27</td>
<td>49</td>
<td>364 (97 at day 300) 567</td>
<td></td>
</tr>
<tr>
<td>W8* 04/04/07</td>
<td>Spring</td>
<td>79</td>
<td>22; larvae Observed day 20</td>
<td>5</td>
<td>6</td>
<td>61</td>
<td>269 (206 at day 300) 363 To Rem Stage</td>
<td></td>
</tr>
</tbody>
</table>

**STAGE DURATIONS – DAYS**

Totals as of 19 June 2008 *W8 at Remains as of 1 April 2008*
**WHEN WAS THIS ANIMAL KILLED?**

Look at the whole scene and combinations of clues…

W 6 – Winter wolf

*1 December 2006 – Placed on the ground for decomposition*

*Photo – 15 April 2007*

*15 April 2007 – Carcass appears “fresh”* though placed on the ground 1 December 2006; thawed from overwinter by 6 March

*Characteristics to indicate this is not a fresh carcass:*

- nose pad – dried; hard
- foot pads – dried; hard
- ears – hard; not flexible
- eyes - gone
- odor – moderate
- maggots – large; between front and rear legs
- hair mat – starting to form dorsal and ventral/chest area (hair pushed out from underneath carcass by maggots)
- predatory carrion beetles – in mouth and at anus eating maggots
- belly – warm compared to ambient temp (from maggot mass within abdominal cavity and/or decomposition chemical reaction)
BB 2 – Mid fall black bear

28 October 2006 – Placed on the ground for decomposition

Photo – 29 April 2007

29 April 2007 – Carcass appears “fresh” though placed on the ground 28 October 2006; thawed from overwinter by 6 March

Characteristics to indicate this is not a fresh carcass:

- nose pad – dried; hard
- foot pads – dried; hard
- ears – hard; not flexible
- eyes – gone
- hide – dried; belly felt like “cardboard” when depressed
- odor – moderate
- predatory carrion beetles in mouth and at anus eating maggots
- belly – warm compared to ambient temp (from maggot mass within abdominal cavity and/or decomposition chemical reaction)
- vegetation – growing up through hair; note posterior near left leg in photo
L 4 – Winter mountain lion

11 January 2007 – Placed on the ground for decomposition

11 April 2007 – Carcass appears “fresh” though placed on the ground 11 January 2007; thawed from overwinter by 6 March

Characteristics to indicate this is not a fresh carcass:
• nose pad – dried; hard
• foot pads – dried; moderately hard
• ears – hard; not flexible
• eyes – gone
• odor – mild
• predatory carrion beetles in mouth eating maggots
• hair mat – small, forming dorsal/posterior (hair pushed out from underneath carcass by maggots)
• belly – hard

Notes on decomposition stages and other characteristics observed
• **ODOR**: During *active decay*, carcasses will be wet from maggot enzyme secretion and odor is “sour” or pungent. In *advanced decay stage* the odor gradually changes from pungent or “sour” to rancid, like old or bad cooking grease. As the carcass reaches *dry stage*, the odor gradually changes to musty and greatly diminishes.
• In arid climates, summer and fall carcasses at the dry decomposition stage, may have significant amounts of hide with attached fur remaining due to mumification (preservation), but there may be little underlying tissue. They can remain in this state for a year or more.
• With more moist conditions in the spring, corresponding carcasses may have significant amounts of skeleton exposed within a few weeks of time of death (TOD) due to the more pliant hide being consumed by masses of maggots and beetle larvae.
• An extremely thick hair mat could mean the animal had a fall or winter coat at the TOD (as with W 6/TOD 2 Nov; W 8/TOD 11 Dec). A thin hair mat could mean summer coat at the TOD (as is possible with W 2; unknown TOD).

• Carcasses that remain well snow covered may not freeze but may be well insulated the entire winter if snow is not compacted.

• Cracked teeth may indicate TOD of a few months to a year or more.

• Bloat may be barely detectable with ambient temperature fluctuations such as fall and spring changes day to day, and day/night fluctuations.

• The belly area may be warm compared to ambient temperatures and other areas of the carcass, which would indicate decomposition chemical reactions at the cellular level and/or a maggot mass within the abdominal cavity.

• Insects can be clues to TOD of even heavily scavenged carcasses (presence of maggots indicate shorter postmortem interval or PMI; pupae indicate longer PMI; types of beetles, etc)

Seasonal density of hair mat

1. W 2 – Summer coat

2. W 6 – Winter coat

Carcass teeth changes over time

1. W 2 – 06/20/06, 'pink' (placed 06/19)
   Fresh stage

2. 06/24/06 – insect debris/fly specks*
   Bloat stage

3. 07/20/06 – canine enamel flake
   Advanced decay stage

4. 10/20/06 – split premolar, cracked molars
   Dry stage

5. 06/19/07 – increased split, bleached gums
   Dry stage

6. 06/19/08 – increased gum bleaching
   Dry stage
   *photo was shot from above and accidentally inverted
FORENSIC ENTOMOLOGY PRIMER (THE BARE BONES BASIC)

Insects collected from carcasses and processed by C. Gonder were analyzed at Montana State University in a separate but concurrent study conducted by Gregory Johnson, PhD. Dr. Johnson is compiling a forensic entomology data base specific to wildlife.

NOTE: 1. Maggots are fly larvae. 2. This easy to use web site is a good reference for color photos: http://bugguide.net
3. Carcasses were not disturbed (moved or lifted) for insect collections.

Blow fly development – temperature dependent; temperature history is crucial for analysis
- Eggs at and in body openings can be laid within minutes of death (mouth, ears, nasal passages, anus, wounds; eggs/maggots are good indicators for bullet entrance/exit if observed on torso).
- Three stages of larval development: First, second and third instar
- Blow fly larvae: Tiny maggots – first instar; large maggots – third instar
- Maggots cease feeding towards end of third instar and will migrate to pupate*
- Pupae location examples: Summer wolves, a few to several feet from carcasses. Fall carcasses, massed against, near or under carcasses. Some clusters above ground, some under soil surface, or under duff/leaves/carcass. Temperature example of pupae cluster next to carcass on 10/07/06: pupae cluster 93.8 F; ambient 53.3 F
- Pupae: Large rat dropping sized, dark reddish/burgundy color, brown to tan. Adult flies emerge from pupae cases. Look for both closed and open cases.
  *Presence of blood in crop indicates feeding; no blood indicates pre-pupal phase

Fly life cycle
Length of durations is determined by temperature.

Durations noted below for the black blow fly were lab generated at 71.6 degrees F. *Maggots pass through three stages of development before pupating.

Starting above adult fly, clockwise:
- Eggs – 20 hours
- First instar – 25 hours
- Second instar – 25 hours
- Third instar – 150 hours
- Pupae – 116.5 hours


Maggots cease feeding towards end of third instar and will migrate to pupate*

Pupae location examples: Summer wolves, a few to several feet from carcasses. Fall carcasses, massed against, near or under carcasses. Some clusters above ground, some under soil surface, or under duff/leaves/carcass. Temperature example of pupae cluster next to carcass on 10/07/06: pupae cluster 93.8 F; ambient 53.3 F

Pupae: Large rat dropping sized, dark reddish/burgundy color, brown to tan. Adult flies emerge from pupae cases. Look for both closed and open cases.

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Maggots cease feeding towards end of third instar and will migrate to pupate*

Pupae location examples: Summer wolves, a few to several feet from carcasses. Fall carcasses, massed against, near or under carcasses. Some clusters above ground, some under soil surface, or under duff/leaves/carcass. Temperature example of pupae cluster next to carcass on 10/07/06: pupae cluster 93.8 F; ambient 53.3 F

Pupae: Large rat dropping sized, dark reddish/burgundy color, brown to tan. Adult flies emerge from pupae cases. Look for both closed and open cases.

*Maggots pass through three stages of development before pupating.

Maggot masses generate metabolic heat and can raise carcass internal temperature well above 50 degrees F even with below-freezing ambient temperatures (observed by C. Gonder).
OTHER INSECTS OBSERVED AT SITES ASSOCIATED WITH CARCASSES

Predatory and scavenger beetles

Carrion and other predatory beetles can be found during early stages feeding on fly eggs, maggots, and possibly the carcass itself. Carrion beetles were found in the mouths and at the anus of most carcasses, even at the fresh stage. Scavenger beetles are generally found during the more dry stages, but a few were observed even in the early stages. The more common beetles that were found on carcasses (P – predator; S – scavenger):

*Carrion beetles – P
Hister beetles – P
Rove beetles – P
Dermestid beetles – S*

All measurements are approximate.

Hister beetle – 4-6 mm
Carrion beetle on wolf carcass
Carrion beetle – 12-20 mm
Rove beetle – 16-18 mm
Dermestid beetle – 5-8 mm

Flesh and cheese skipper flies: Flesh flies may arrive shortly after death. They lay larvae, not eggs. Therefore, observing larvae on a carcass does not necessarily mean it is at a later stage – 10-12 mm
Cheese skipper flies far right, feed on maggots – 3-5 mm

<table>
<thead>
<tr>
<th>W2 Decomposition stages with days duration for each</th>
<th>Predominant insects collected from W2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh – placed 06/19/06 Three days (day one counts as one for all stages)</td>
<td>Adult blow flies observed on carcass within minutes. Eggs observed within an hour. Flesh and house flies Rove beetles; carrion beetles observed</td>
</tr>
<tr>
<td>Bloat Five days</td>
<td>Adult blow flies – eggs, small maggots towards end of bloat. Rove beetles peak at end of bloat Carrion beetles peak at end of bloat</td>
</tr>
<tr>
<td>Active decay Eleven days</td>
<td>Blow flies – maggots and adults collected; maggot migration at end of active decay Blow fly maggots peaked during the first third of active decay Cheese skipper flies peak midway</td>
</tr>
<tr>
<td>Advanced decay 72 days</td>
<td>Few blow fly maggots Great increase in beetle larvae Rove beetle peak midway Hister beetle peak early advanced</td>
</tr>
<tr>
<td>Dry As of 19 June 2008 – 732 days</td>
<td>Few beetle larvae observed Beetles continue to be predominant, especially dermestids</td>
</tr>
</tbody>
</table>

Above table information compiled from PowerPoint material presented by Gregory Johnson, PhD, 30 May 2007

“Insects don’t control the decay process; they respond to it.”
Leon Higley, PhD. UN/Lincoln – forensic entomologist
WILDLIFE FORENSIC ENTOMOLOGY BASIC PROTOCOLS
Johnson, Greg, Ph.D. – (406) 994-3875
Dept of Animal and Range Sciences, Marsh Lab Rm 70, Montana State University,
Bozeman, MT 59717
Carleen Gonder – (406) 244-0007; carleen_montana@yahoo.com
38689 Highway 200 East, Box 6; Greenough, MT 59823 (snail-mail address and phone change in September 08)

EVIDENCE COLLECTION: Samples/insect evidence collected from poached carcasses may be sent to Dr. Johnson or C. Gonder. Please call C. Gonder for protocol/processing details, and Dr. Johnson before sending.

Materials:
- Containers for live maggots with moist paper towel and good lid, and plastic spoon for scooping maggots
- Sweep net for adult fly capture (adult flies are a must!)
- Soft forceps and moistened No. 2 paintbrush
- Rearing containers for live eggs, maggots, pupae (mesh-vented plastic soup/salad containers with secure lids are suitable)
- Vermiculite, non-asbestos from Africa available at nurseries, for rearing containers; sawdust can work
- Beef liver for rearing containers – migrating maggots and pupae don’t need liver; use it if in doubt
- Petri dish for liver placed on small amount of vermiculite; dish placed on top of vermiculite in container
- Vials for processed (blanched) maggots; and for adult flies killed in “killing jar or baggie”
- Vials for others: beetles, etc, each individual in its own vial since some are predacious
- 70% Ethyl Alcohol for maggots after they have been “blanched”
- Container to boil water to blanch the maggots (some coffee pots plug into vehicle cigarette lighters)
- Meat thermometer for ambient air, on top of carcass, on top of soil, maggot mass, etc
- Killing jar or zip lock baggie for adult flies with 100% acetone (nail polish remover) on cotton ball
- Cotton balls for killing jar
- Bottle of 100% acetone (nail polish remover) for killing jar for flying insects caught in sweep net
- Hand trowel for looking for pupae

Collections from carcasses and surrounding area:
- Sweep net capture for adult flies; adult fly collections are a must when collecting maggots
- At least 50 eggs/maggots/pupae. Ideally, collect each 50 from a couple locations, keep each location separate, and label location collected from carcass. For at least one collection, get largest maggots (50 or so). Keep in containers with moist paper towel. Blanching: bring water to boil; unplug, drop in maggots; then place maggots in alcohol/vial (soft forceps, paintbrush, plastic spoon for collecting from carcass; soft forceps to place in vials)
- Collect pupae preserving half and placing the other half in rearing containers (in vermiculite only; no liver)
- Place vials with adult flies that were gassed in the kill jar/baggie, in freezer
- Hand collect beetles, and other insects; place each in its own vial, and freeze
- Label everything: date; temp; location on carcass/near site; other weather data
- Get temp/weather history (several days/month previous and subsequent) for area: nearest weather station; data logger left at site for several days post carcass discovery for comparison with weather station
- Temps/weather at site: soil surface, animal surface, maggot mass, under carcass, 4” in soil under carcass, ambient, cloud cover, shade/sun*

* Taylor meat thermometers have a 2” sensor on the end of the probe. It must therefore be inserted a minimum of 2” so ambient temperature does not corrupt what is being measured. Check with other manufacturers for sensor length.

Collections: 1. Over carcass – flying insects; 2. From carcass – eggs, maggots, beetles, ants, anything*; 3. Under carcass – beetles, maggots, anything*; 4. 20’ or more from carcass – migrating maggots, opened and unopened pupae, anything*. Look under and near carcass for beetles, maggots and pupae. Pupae may be on, against, or even massed under the carcass, or several feet away (especially to the west), and/or buried. Look for maggots migrating away from carcass; they like to burrow, so dig with a trowel. Note whether pupae cases are opened on one end, which indicates fly emergence. Collect open pupae cases and note location; place in a vial and freeze. Unopened pupae should be preserved in alcohol.

Adult flies, maggots, pupae, beetles and beetle larvae are the most crucial to collect for TOD analysis. It is also important to note and collect other insects on the carcasses and nearby. Example: Ants can heavily predate maggots and eggs, affecting volume of masses and development. Collect ants and note location; note mounds if seen.

Other notes and information sources: 1. Since flesh flies don’t lay eggs but larva, larva presence does not necessarily mean it’s later in the process. 2. Predatory beetles may feed on eggs even before larvae are present. Therefore, beetles could potentially arrive close to TOD. 3. Blow flies generally don’t lay eggs at night.

Manual: Data from C. Gonder’s decomposition project will be reproduced in the Wildlife Forensic Field Manual produced by Association of Midwest Fish and Game Law Enforcement Officers. This will include a brief summary of associated forensic entomology.
EQUIPMENT LIST BY FUNCTION

General
- Labels, Sharpee pen for labeling
- Disposable gloves
- Meat thermometer
- Data logger to leave at poaching site for temperature history and comparison with weather station data

For collecting
- Plastic spoon
- Soft forceps
- Moistened No. 2 camel hair paint brush
- Sweep net
- Hand trowel

For field storage
- Vials
- Small mason jars with lids and/or…
- Wide mouth 8 oz pharmacy bottles with screw on lids
- Paper towels, moistened

For preserving
- Vials
- 70% Ethyl Alcohol
- Pot for boiling water
- Killing jar or large zip lock bag to kill flying insects
- Cotton balls for killing jar/baggie
- 100% Acetone (nail polish remover) to saturate cotton balls for killing jar/baggie

For live rearing
- Vermiculite or sawdust
- Petri dishes
- Beef liver
- Clear plastic containers with vented lids (with fine mesh taped to the inside of vented lid)

Web sites for equipment
http://www.bioquip.com
General equipment
www.onsetcomp.com
Hobo data loggers
http://store.gardensare.com/forceps.html
Soft forceps
www.texasento.net/equip.htm
General equipment

Web sites for weather data
www.usbr.gov/pn/agrimet/webarcread.html
Locate station, choose period
www.wrnp.noaa.gov
Click on ‘town’, then ‘local’; or
www.nde.noaa.gov
Click on ‘free data’, follow prompts
www.wcc.nrcs.usda.gov/snow
Click on state, follow prompt

Complete equipment list
Entomology and Death: A Procedural Guide by E. Paul Catts and Neal Haskell
Joyce’s Print Shop, Inc, Clemson, South Carolina
APPENDIX A-2

WILDLIFE DECOMPOSITION ANALYSIS FOR TIME OF DEATH ESTIMATES

Plus Forensic Entomology Basics

POWERPOINT PRESENTATION TO ILLUSTRATE DECOMPOSITION STAGES FOR USE IN TIME OF DEATH DETERMINATIONS

F. Carleen Gonder

Photo: C. Gonder
WILDLIFE DECOMPOSITION ANALYSIS FOR TIME OF DEATH ESTIMATES
Plus Forensic Entomology Basics

Contact: F. Carleen Gonder
38689 Highway 200 East, Stop 6, Greenough, MT 59823
(406) 244-0007; carleen_montana@yahoo.com

PURPOSE OF THE DECOMPOSITION PROJECT
Estimating time of death (TOD) during the first 24 hours postmortem has been long used for traditional game species such as deer and elk. In poaching investigations TOD is crucial as court accepted evidence with applicability in two situations:

3. Determine if that animal was taken by a hunter during legal hunting hours
4. Fix the TOD with a point in time matching the presence of a suspect at an illegal take scene

And TOD is often more readily determined at the scene, rather than in a lab.

An issue with many poaching situations is the discovery of carcasses that are in advanced stages of decomposition with little information to indicate TOD.

Investigators have long understood the importance of TOD estimates, both short term or during the initial hours postmortem, and long term by understanding the various stages of decomposition. The practical research involved in this project provides baseline data on long term decomposition in order to develop markers for use in the field by federal and state wildlife law enforcement officials.

SIGNIFICANCE
As a law enforcement officer with the US Fish and Wildlife Service (FWS)/Division of National Wildlife Refuges, C. Gonder was a field investigator of several poached deer and elk with antlers or heads removed and the remainder of the carcasses found in advanced stages of decomposition. Those investigations helped to demonstrate a need to Gonder for this type research. Project endorsement further attests to the project’s worthiness and includes:

• Tim Eicher, FWS Special Agent: Carleen’s project represents “cutting edge research in wildlife enforcement, with direct applications to field investigations and is supported by US FWS Office of Law Enforcement.”
• Bonnie Yates, FWS National Fish and Wildlife Forensics Lab’s senior mammalogist/osteologist: “I am busting with pride at your progress…Your project is top notch. I am keenly interested in your progress.”
• Karen Rudolph, Idaho Fish and Game forensic lab specialist: “What a treat to have a Master’s project that will truly provide immediate and hands on (applied) benefits.”

Data from this project will be published in A Guide to Time of Death in Selected Wildlife Species (D. Oates, 1984) and Wildlife Forensic Field Manual produced by the Association of Midwest Fish and Game Law Enforcement Officers, which was the primary sponsor of the project. This assures its contribution to wildlife law enforcement.

A POWERPOINT PRESENTATION IS NOW AVAILABLE THAT ILLUSTRATES DECOMPOSITION STAGES OF CARNIVORES WITH EMPHASIS ON SEASONAL VARIATION. IT INCLUDES FORENSIC ENTOMOLOGICAL ANALYSIS AND COLLECTION PROTOCOLS.

LENGTH: 1.5 HOURS PLUS TIME FOR QUESTIONS AND DISCUSSION
POWERPOINT PRESENTATION TO ILLUSTRATE DECOMPOSITION STAGES FOR USE IN TIME OF DEATH ESTIMATES

Program length: Approximately 1.5 hours plus time for discussion
Outline: 82 slides total

I. How long has that animal been dead – illustrates that length of time can be deceiving; major factor: arid climate
   A. Wolf
   B. Black bear
   C. Mountain lion

II. Time of death determinations in two phases
    A. Initial postmortem/first 24 hours
    B. Decomposition

III. Project site description
     A. Lubrecht Forest
     B. Exclosures

IV. Decomposition stage descriptions using summer gray wolf as an example
    A. Bloat
    B. Active decay
    C. Advanced decay
    D. Dry
    E. Remains

V. Seasonal variations of stages
   A. Summer – gray wolf
   B. Early fall – black bear
   C. Mid fall – black bear
   D. Late fall – whitetail deer
   E. Winter – mountain lion
   F. Spring – gray wolf

VI. Decomposition characteristics including
    A. Odor
    B. Teeth
    C. Arid climate seasonal differences

VII. Forensic entomology
     A. Blowfly lifecycle
     B. Maggots for time of death estimates
     C. Other insects associated with decomposition
     D. Collection equipment and protocols

A COMPANION MANUAL IS AVAILABLE IN COLOR HARDCOPY COIL-BOUND FORMAT, OR CD

*Sponsored by the Association of Midwest Fish and Game Law Enforcement Officers*

*Contact: Carleen Gonder (406) 244-0007; carleen_montana@yahoo.com*

Three day seminar at Lubrecht Experimental Forest, University of Montana.
24 hours of POST credit available for participants

*Lubrecht, a university forestry field station approximately 30 miles east of Missoula, MT, is a full conference facility with overnight accommodations and staffed kitchen.*

**Participants**

Montana Fish, Wildlife and Parks wardens, Wyoming Game and Fish wardens, Idaho Fish and Game conservation officers, other state and provincial wildlife officers, US Fish and Wildlife Service Refuge Officers and Special Agents, National Park Service law enforcement rangers

**Topics and presenters**

*Field necropsy protocols, and recognition and handling of hazardous materials*

  Richard Stroud, DVM, wildlife medical examiner; US Fish and Wildlife Service National Fish and Wildlife Forensics Lab

*Firearms evidence field analysis*

  Tony Latham, Regional Investigator, Idaho Fish and Game

*Backcountry wildlife investigation techniques: When batteries go dead and cell phones don’t work*

  Tim Eicher, Special Agent, US Fish and Wildlife Service

*Time of Death and decomposition, plus basic forensic entomology*

  Carleen Gonder, Interdisciplinary graduate student in Criminology and Forensic Anthropology for wildlife forensics at the University of Montana, Missoula, MT

*The basics of field forensics, materials and practicum*

  Karen Rudolph, PhD, Forensic Specialist, Idaho Fish and Game

*Utah protocols for carnivore attacks*

  Jodi Becker, Training Sgt., Utah Division of Wildlife

*Montana case histories: Field investigations of large scale operations*

  JD Douglas, regional Investigator, Montana Fish, Wildlife and Parks

*Footwear and tire track collection*

  Deborah H. Lougee, CLPE, (Certified Latent Print Examiner) Forensic Scientist, Montana DOJ, Missoula, MT

*Wildlife Service Dogs: their versatility and use in evidence recovery*

  Kirk Olchowy, Fish and Wildlife Officer, Alberta Fish and Wildlife Enforcement Field Service

*Forensic botany: Basics of plant biology for forensic applications*

  Kevin Murray, PhD, University of Montana biologist

*Idaho wolf poisoning case*

  Richard Stroud, DVM, US Fish and Wildlife Service and Tony Latham, Idaho Fish and Game

  (Tentative: Scott Bragonier, Special Agent, US Forest Service; previously with US FWS)
Field necropsy protocols for poaching investigations
**Richard K. Stroud, DVM, US FWS National Fish and Wildlife Forensics Lab, Ashland, OR**
Dr. Stroud received an undergraduate degree in fisheries biology and graduated from Washington State University as a Doctor of Veterinary Medicine. He completed further graduate work in Veterinary Science Pathology at Oregon State University. Since 1990 Dr. Stroud has been the Veterinary Medical Examiner with US Fish and Wildlife Service, Division of Law Enforcement National Fish and Wildlife Forensics Lab where he conducts pathological evaluations and evidence gathering of law enforcement submissions to the lab, conducts field investigations with FWS special agents and serves as expert court witness in highly complex wildlife cases. He has numerous publications to his credit and has led and participated in several seminars and conferences internationally.

Firearms evidence field analysis
**Tony Latham, Idaho Fish and Game Regional Investigator, Salmon, ID**
The firearms course instructs field techniques to conduct detailed examinations of spent bullets, cartridge cases and suspected firearms. It includes both lecture and practical exercises. This in-depth course has been given to: North American Wildlife Enforcement Officers Assoc. conference, Idaho Fish and Game in-service and new officer training, Montana Fish, Wildlife and Parks in-service, Ontario Ministry of Natural Resources in-service, and National Tribal Game Warden training. Tony has a degree from the University of Idaho and was a uniformed Conservation Officer with Idaho Fish and Game for 15 years. His experience includes backcountry patrols via boat and horseback. In 2003 he was selected as Idaho Fish and Game’s first Regional Investigator. He has been the recipient of multiple officer of the year awards.

Backcountry wildlife investigation techniques
**Tim Eicher, US FWS Special Agent, Cody, WY**
This presentation will detail recovery of ballistic evidence, field necropsies and crime scene reconstruction with a focus on backcountry techniques. With a degree in Forestry, a Master’s in Wildlife Biology and experience as a guide and outfitter in the Gila Wilderness, Tim Eicher began his wildlife law enforcement career as a Conservation Officer with the New Mexico Dept of Game and Fish in 1978. He joined US FWS as a Special Agent in 1988. In addition to conducting criminal investigations, he instructs interview and interrogation, crime scene techniques, handling of evidence, and wildlife field forensic techniques throughout the US, and in Canada, Ukraine, Botswana and Tanzania.

Time of Death and decomposition; includes basic forensic entomology (recognition of relevant insects and collection protocols; MSU data base contact – Gregory Johnson, PhD)
**Carleen Gonder, Interdisciplinary graduate student in Criminology and Forensic Anthropology for wildlife forensics at the University of Montana, Missoula, MT**
Several carcasses are in advanced and dry stages of decomposition in a secure site at Lubrecht Forest and include: mountain lions, black bears, wolves and a whitetail deer. The purpose of this project is to develop time of death markers to be used in field investigations by wildlife officers. Carleen was a law enforcement officer with US Fish and Wildlife Service, Wyoming Game and Fish and National Park Service, and has received numerous awards for investigations.

The basics of field forensics, materials and practicum
**Karen Rudolph, Ph.D., Idaho Fish and Game Forensic Specialist**
Karen’s presentation will focus on field techniques for evidence collection and determination, and will include a practical with a “mock” crime scene. Karen has an undergraduate degree in molecular, cellular and developmental biology from the University of Colorado, and a doctorate in molecular biology from
Dartmouth College. She has been with Idaho Fish and Game since 1995, initially participating in bighorn sheep disease research and in 1997 assumed duties of Idaho’s wildlife forensics program.

Utah protocols for carnivore attacks
Jodi Becker, Utah Division of Wildlife Training Sergeant
Jodi’s presentation will focus on basic scene investigations of predator attacks. This field based training is designed as a working outline for field personnel. After receiving a Bachelor of Science degree in Michigan, Jodi joined the National Park Service and worked in law enforcement at Crater Lake National Park and Apostle Islands National Lakeshore. Jodi began her work with Utah Division of Wildlife in 1992 and is currently the statewide training coordinator. Additionally, she instructs K-9 drug and wildlife detection at the Utah State Police Academy.

Montana case histories: Field investigations of large scale operations
J.D. Douglas, MT Fish, Wildlife and Parks, R-2 Regional Investigator
This presentation will detail a large scale investigation in Seeley Lake, MT which included covert operations, video/photo analysis and numerous hours of typical warden investigative duties. There will also be a presentation of a smaller case involving the taking of a trophy mule deer and the photo evidence used in that prosecution. J.D. has a degree in wildlife biology from the University of Montana and began his law enforcement career as a Sheriff's Deputy in 1997. J.D. joined FWP in 2001 and has been a FWP warden for 6 years. He is currently the Region 2 Regional Investigator. He is a training officer, and recipient of multiple wildlife officer awards including the Shikar Safari Officer of the Year in 2005.

Footwear and tire track collection
Deborah H. Lougee, CLPE, (Certified Latent Print Examiner) Forensic Scientist, Montana DOJ, Missoula, MT
Bring your Camera Equipment! Debbie has 28 years experience in the collection and comparison of latent prints, footwear impressions and tire tracks. Specific to outdoor crime scenes, the non-destructive preservation method for footwear and tire track evidence is photography. Techniques for proper capture and lighting will be discussed with hands-on practice. Various casting methods using dental stone will be demonstrated and include more hands-on practical exercises. Explanation on how the comparison process is conducted and the types of conclusions the lab would report to you will be given. The various resources available for database searches to identify a particular vehicle, tire or shoe are provided to assist you in your investigation for suspects.

Wildlife Service Dogs: Their versatility and use in evidence recovery
Kirk Olchowy, Alberta Fish and Wildlife Officer, and Jodi Becker, Utah Training Sgt.
Kirk will present details of Alberta’s Wildlife Service Dog program using Wind River Bear Institute (WRBI) Karelian Bear Dogs (KBDs), and will highlight their versatility and agency image enhancement. Use of Wildlife Service Dogs provides a canine adjunct to tracking and carcass detection, can push back carnivores and provides safety during chance encounters or conflict situations, and provides potential for evidence recovery at poaching investigations (spent casings and other material). Jodi Becker will also give a presentation of Utah Division of Wildlife’s K-9 program. Kirk Began service with the Alberta Government as a Provincial Park ranger in 1974 and was hired as an Alberta Fish & Wildlife Officer in 1976. He has been certified as a Bear Response Team Leader since 1989, and became involved with KBDs in 1998. He was selected by Alberta Fish & Wildlife and WRBI in 2000 as one of two officers to receive a KBD from WRBI. These were the first service dogs of any description taken on by the Alberta Fish & Wildlife Division of the Department of Sustainable Resource Development. He subsequently coordinated the acquisition and training of both dogs and handlers, as well as drafting a Standard and Procedure
Document for the Fish & Wildlife Division for the Alberta KBD Program. He continues to act as both a handler and a coordinator for the KBD Program.

Forensic botany: Basics of plant biology for forensic application
Kevin Murray, PhD, University of Montana, Missoula biologist
Focus of this presentation will be on time dependent plant phenology (plant development stage at the time plant was crushed under a carcass, foot tracks at a poaching scene, etc). It will include information on the transfer of seeds, pollen, moss, and lichens that are region specific (plant parts found on a suspect, the carcass, the suspect’s vehicle, etc). Dr. Murray is currently a Lecturer in Biology. Primary activities center on teaching Introductory Biology/Botany courses as well as more advanced courses in Plant Evolution and Phylogenetics, Geology/Biology and Diversity of Life. Prior to coming to the University of Montana in 1995, Dr. Murray held a similar position at the University of Nevada, Las Vegas. Dr. Murray’s research interests have centered on plant physiological ecology, community structure, conservation biology and exotic plant invasiveness. These studies have involved work with lichens, bryophytes (mosses), perennial herbaceous, woody invasive and timberline coniferous species at sites ranging from Arctic Alaska, the Sierra Nevada, central Montana and desert systems of the Great Basin region. Dr. Murray holds degrees in Biology (B.S.), Ecology & Systematics (M.A.) from San Francisco State University and a PhD in Ecology, Evolution and Conservation Biology from the University of Nevada, Reno.

Idaho wolf poisoning case
Richard Stroud, DVM, US FWS and Tony Latham, ID Fish and Game
(Tentative, Scott Bragonier, USFS; previously with US FWS)
Coordination between US Fish and Wildlife Service and Idaho Fish and Game resulted in successful conviction of an individual attempting to poison wolves in Idaho. Scott and Tony will present details of the field investigation, and Dr. Stroud will highlight the work conducted by the federal wildlife forensics lab for this case.

Recognition of hazardous materials and safe handling techniques
Richard K. Stroud, DVM, US FWS
Dr. Stroud will discuss recognition of hazardous materials that may be present in and around carcasses, and safe handling techniques for evidence recovery.
APPENDIX A-3, continued

Wildlife Crime Scene Field Investigation Seminar – 30-31 May, 1 June 2007

Sponsored by the Association of Midwest Fish and Game Law Enforcement Officers

Contact: Carleen Gonder (406) 244-0007; carleen_montana@yahoo.com

Three day seminar at Lubrecht Experimental Forest, University of Montana.
24 hours of POST credit available for participants

Fifty-eight participants including Wardens, conservation officers, criminal investigators, refuge officers, special agents and law enforcement rangers from: MT Fish Wildlife and Parks, WY Game and Fish, ID Fish and Game, ND Game and Fish, CO Division of Wildlife, SD Game Fish and Parks, NM Game and Fish, US Fish and Wildlife Service, and Yellowstone National Park

Topics

Forensic entomology: Insect collection protocols at a scene investigation plus highlights of decomposition/forensic entomology study at Lubrecht
Greg Johnson, PhD, Montana State University wildlife/veterinarian entomologist

Time of Death: Initial postmortem and decomposition. Ungulate initial postmortem plus site tour and lecture detailing a carnivore time of death/decomposition pilot research project currently underway
David Oates, Nebraska Game and Parks Commission Forensic and Analytical Specialist, and Lab Program Manager
Carleen Gonder, Interdisciplinary graduate student in Criminology and Forensic Anthropology for wildlife forensics at the University of Montana, Missoula, MT

The role of the wildlife medical examiner
Richard Stroud, DVM, US Fish and Wildlife Service National Fish and Wildlife Forensics Lab Wildlife Medical Examiner

Firearms evidence field analysis and GPS for evidentiary use
Tony Latham, Idaho Fish and Game Regional Investigator

Forensic geology: Case histories and collection protocols
Raymond Murray, PhD, Vice President of American Association of Forensic Geologists; member Montana POST commission; author and professor of forensic geology

Sawtell Mountain grizzly bears: A poaching case in Idaho
Scott Bragonier, US Fish and Wildlife Service Special Agent and Richard Stroud, DVM

Tooth cementum aging for law enforcement purposes and case histories
Gary Matson, MS, Matson’s Lab

Technology in solving wildlife crimes
Jeff Scott, Montana Fish, Wildlife and Parks Regional Investigator

Montana case histories: Field investigations of large scale operations
Chad Murphy, Montana Fish, Wildlife and Parks Regional Investigator

The basics of field forensics, materials and practicum
Karen Rudolph, Idaho Fish and Game Forensic Specialist

Backcountry wildlife investigation techniques: When batteries go dead and cell phones don’t work; tentative (if cancellation)
Tim Eicher, US Fish and Wildlife Service Special Agent
Forensic entomology: Highlights of the wildlife decomposition project insect analysis
Includes protocols for collection at a scene investigation
Greg Johnson, Ph.D., Montana State University, Bozeman, MT
Dr. Johnson is conducting forensic entomology research in conjunction with a wildlife decomposition project which is focusing on establishing time of death standards for carnivores. His research will establish baseline forensic entomology data specific to wildlife in the intermountain west. Dr. Johnson is Professor of Veterinary Entomology at Montana State University. His research focus is on insects and other arthropods that affect livestock and wildlife. In addition to wildlife forensic entomology research, his current projects include the spatial and temporal distribution of the biting midge which is the vector of bluetongue in cattle and epizootic hemorrhagic disease in white tail deer; epidemiology of West Nile virus in sage grouse and the American white pelican; and the prevalence and potential vectors of vesicular stomatitis in equines. He teaches a course in Veterinary Entomology.

Time of death and decomposition: Site tour and lecture detailing a carnivore time of death/decomposition pilot research project currently underway
Carleen Gonder, Interdisciplinary graduate student in Criminology and Forensic Anthropology for wildlife forensics at the University of Montana, Missoula, MT
Several carcasses are in various stages of decomposition in a secure site at Lubrecht Forest and include: mountain lions, black bears, wolves and a whitetail deer. The purpose of this project is to develop time of death markers to be used in field investigations by wildlife officers. Carleen was a law enforcement officer with US Fish and Wildlife Service, Wyoming Game and Fish and National Park Service/Yellowstone NP, and has received several awards for investigations of archeological, poaching and motor vehicle accident cases. She is currently enrolled at the University of Montana and has a UM certificate in forensic studies.

Time of death determinations during the first 24 hours postmortem for ungulates
David Oates, Forensic and Analytical Specialist/Lab Program Manager, Nebraska Game and Parks Commission, Lincoln, NE
Dave has been with Nebraska Game and Parks Commission since 1970 and is best known for his research and analysis of time of death determinations for deer. He published A Guide to Time of Death in Selected Wildlife Species and was involved in the production of the Association of Midwest Fish and Game Law Enforcement Officers’ (AMFGLEO) Wildlife Forensic Field Manual. He is currently chairman of forensics and research for AMFGLEO and has received a number of awards for his research and wildlife conservation efforts.

The role of the wildlife medical examiner
Richard K. Stroud, DVM, US FWS National Fish and Wildlife Forensics Lab, Ashland, OR
Dr. Stroud received an undergraduate degree in fisheries biology and graduated from Washington State University as a Doctor of Veterinary Medicine. He completed further graduate work in Veterinary Science Pathology at Oregon State University. Since 1990 Dr. Stroud has been the Veterinary Medical Examiner with US Fish and Wildlife Service, Division of Law Enforcement National Fish and Wildlife Forensics Lab where he conducts pathological evaluations and evidence gathering of law enforcement submissions to the lab, conducts field investigations with FWS special agents and serves as expert court witness in highly complex wildlife cases. He has numerous publications to his credit and has led and participated in several seminars and conferences internationally.

Firearms evidence field analysis and GPS for evidentiary use
Tony Latham, Idaho Fish and Game Regional Investigator, Salmon, ID
The firearms course instructs field techniques to conduct detailed examinations of spent bullets, cartridge cases and suspected firearms. It includes both lecture and practical exercises. This in-depth course has been given to: North American Wildlife Enforcement Officers Assoc. conference, Idaho Fish and Game in-service and new officer training, Montana Fish, Wildlife and Parks in-service, Ontario Ministry of Natural Resources in-service, and National Tribal Game Warden training. The GPS course instructs how to use a GPS in evidence collection to assist in building a strong court case. This is not “how to” beginners GPS instruction, and will be offered as a short evening class. Tony has a degree from the University of Idaho and was a uniformed Conservation Officer with Idaho Fish and Game for 15 years. His experience includes backcountry patrols via boat and horseback. In 2003 he was selected as Idaho Fish and Game’s first Regional Investigator. He has been the recipient of multiple officer of the year awards.

Forensic geology: Case histories and collection protocols
Raymond Murray, Ph.D., Missoula, MT
As a forensic geologist, Dr. Murray has extensive experience with law enforcement cases, and has published a book that includes case histories. Extremely small amounts of soil (found on “cleaned” footwear, undercarriage/wheels/tires of a vehicle, etc) can be matched to a specific location. Like forensic entomology, certain protocols must be followed in collection. Dr. Murray is a member of the Montana Peace Officer Standards and Training Council and is chair of the Missoula, MT Police Commission. He has instructed numerous courses and workshops in forensic geology world wide.
Evidence from the Earth: Forensic Geology and Criminal Investigation – Raymond C. Murray
Sawtell Mountain grizzly bears: A poaching case in Idaho
Scott Bragonier, US FWS Special Agent, Idaho Falls, ID
Richard Stroud, DVM, US FWS National Fish and Wildlife Forensics Lab, Ashland, OR
A female grizzly was shot with an arrow and the carcass opened. Her cub was shot with a rifle and its carcass was left intact. This case is an excellent example illustrating the difference in decomposition rates when one carcass is opened and the other relatively intact. Scott Bragonier is the son of a retired Wyoming game warden with over 34 years experience. After receiving a degree in Criminal Justice from Montana State University, Bragonier was hired as a Wyoming warden in 1995. In 2001 he was selected to be a special agent with US FWS and is the SE Idaho agent.

Tooth cementum aging for law enforcement purposes and case histories
Gary Matson, MS, Matson’s Lab, Milltown, MT
Matson’s Lab has been operating since 1969 and is the only commercial lab offering cementum age analysis. They have processed well over 807,980 teeth from over 25 species, predominantly grizzly and black bear, bobcat and white tail deer. They routinely process specimens from legal cases for state and provincial wildlife law enforcement agencies, and have served as expert witnesses. Gary Matson studied histology as a graduate student at the University of Nebraska College of Medicine and the University of Montana. He and his wife have standardized the cementum method for wildlife aging.

Technology in solving wildlife crimes
Jeff Scott, MT Fish, Wildlife and Parks, R-5 Regional Investigator
This presentation will detail 3 case histories: Seismic video surveillance for a felony bobcat case, a transceiver/pit tag implanted in an illegally taken bull elk, and a multiple felony wildlife case known as the Huntley Poaching Project. Jeff has a degree in wildlife biology from the University of Montana and was a FWP warden for 28 years. He is currently the Region 5 Regional Investigator. He is a firearms instructor and field training officer, and recipient of multiple wildlife officer of the year awards.

Montana case histories: Field investigations of large scale operations
Chad Murphy, MT Fish, Wildlife and Parks, R-3 Regional Investigator
Several large scale operation poaching cases will be detailed and include multi-agency cooperation and a landowner case involving commercial hunters. With a degree in Range Science from Montana State University, Chad was a FWP warden for over 17 years. During that time he was involved in several large scale poaching investigations. He is now the Region 3 Regional Investigator and has received several awards.

The basics of field forensics, materials and practicum
Karen Rudolph, Ph.D., Idaho Fish and Game Forensic Specialist
Karen’s presentation will focus on field techniques for evidence collection and determination, and will include a practical with a “mock” crime scene. Karen has an undergraduate degree in molecular, cellular and developmental biology from the University of Colorado, and a doctorate in molecular biology from Dartmouth College. She has been with Idaho Fish and Game since 1995, initially participating in bighorn sheep disease research and in 1997 assumed duties of Idaho’s wildlife forensics program.

Backcountry wildlife investigation techniques; tentative (if cancellation)
Tim Eicher, US FWS Special Agent, Cody, WY
This possible presentation will detail recovery of ballistic evidence, field necropsies and crime scene reconstruction with a focus on backcountry techniques. With a degree in Forestry, a Master’s in Wildlife Biology and experience as a guide and outfitter in the Gila Wilderness, Tim Eicher began his wildlife law enforcement career as a Conservation Officer with the New Mexico Dept of Game and Fish in 1978. He joined US FWS as a Special Agent in 1988. In addition to conducting criminal investigations, he instructs interview and interrogation, crime scene techniques, handling of evidence, and wildlife field forensic techniques throughout the US, and in Canada, Ukraine, Botswana and Tanzania.
WILDLIFE FORENSICS FOR FIELD INVESTIGATORS

Advanced training for the wildlife conservation officer is provided in accordance with state or federal conservation agency law enforcement needs. Customized programs are now available for in-service training of officers on a contract fee basis.

Core Program: 2 days • 16 hours • 4 instructors
Length of program can be adjusted to agency needs
Certificates provided for POST credit

Training now available or in development includes:

- Biological considerations in wildlife crime scene processing
- Recognition and documentation of cause of death
- Gunshot wound evaluation
- Investigational techniques of suspected poisoning cases
- Gun shot and arrow wound differentiation
- Finding and using laboratory expertise in forensic cases
- DNA collection protocols, collection kits and practicum
- How DNA is analyzed and used in forensic cases
- Practical field firearms evidence analysis
- GPS for evidentiary use at crime scenes
- Decomposition analysis and other time of death determinations
- Basic forensic entomology including insect evidence collection protocols and preservation
- Discussion of the role of forensics in past wildlife cases
- Additional offerings available relevant to scene processing

Other Consultant Services Available

On site crime scene processing, forensic necropsy,
Insect evidence processing/forensic entomological analysis/forensic case consultation/expert witness in wildlife forensics

All or part available

In-service training for agencies may be developed in accordance to need and time constrains.
Instructors can travel to venues on a cost plus basis
Future offerings: Forensic botany, forensic geology, etc.

A three day Wildlife Field Forensics Investigation Seminar is held annually at Lubrecht Forest near Missoula, MT. Call (406) 244-0007 for schedule, availability and other details.
CORE MEMBERS LISTED ALPHABETICALLY WITH EXAMPLES OF PRESENTATIONS:

Carleen Gonder - - Interdisciplinary graduate student in Criminology and Forensic Anthropology for wildlife forensics at the University of Montana, Missoula, MT

Time of Death and decomposition analysis; includes basic forensic entomology (recognition of relevant insects and collection protocols). Other relevant topics are available. Carleen has been conducting decomposition research since 2006 to aid in time of death determinations. Currently, several carcasses are in advanced and dry stages of decomposition in a secure site at Lubrecht Forest near the University of Montana. They include: mountain lions, black bears, wolves and a whitetail deer. The purpose of this project is to develop time of death markers to be used in field investigations by wildlife officers. Efforts are now underway to establish a permanent site to add species such as ungulates and raptors, and research variables that affect decomposition rates. Carleen was a law enforcement officer with US Fish and Wildlife Service, Wyoming Game and Fish and National Park Service, and has received numerous awards for investigations.

Tony Latham - - Idaho Fish and Game Regional Investigator, Salmon, ID

Field analysis of firearms evidence, GPS for evidentiary use, crime scene investigation and case histories. Other relevant topics are available. The firearms course instructs field techniques to conduct detailed examinations of spent bullets, cartridge cases and suspected firearms. It includes both lecture and practical exercises. This in-depth course has been given to: North American Wildlife Enforcement Officers Assoc. conference, Idaho Fish and Game in-service and new officer training, Montana Fish, Wildlife and Parks in-service, Ontario Ministry of Natural Resources in-service, and National Tribal Game Warden training. Tony has a degree from the University of Idaho and was a uniformed Conservation Officer with Idaho Fish and Game for 15 years. His experience includes backcountry patrols via boat and horseback. In 2003 he was selected as Idaho Fish and Game’s first Regional Investigator. He has been the recipient of multiple officer of the year awards.

Karen Rudolph, Ph.D - - Idaho Fish and Game Forensic Specialist, Boise ID

The basics of DNA field forensics, materials, and practicum. Other relevant topics are available. Karen’s presentation will focus on field techniques for evidence collection and determination, and will include a practical with a “mock” crime scene. Karen has an undergraduate degree in molecular, cellular and developmental biology from the University of Colorado, and a doctorate in molecular biology from Dartmouth College. She has been with Idaho Fish and Game since 1995, initially participating in bighorn sheep disease research and in 1997 assumed duties of Idaho’s wildlife forensics program. Karen was 2008 recipient of the prestigious Guy Bradley Award. She is the first non-law enforcement recipient and woman to have received this award.

Richard K. Stroud, DVM, MS - - US FWS National Fish and Wildlife Forensics Lab, Ashland, OR

Biological considerations in crime scene investigations, recognition and investigation techniques for poisoning cases, evaluating gunshot wounds, gunshot vs arrow wounds, and case histories. Other relevant topics are available. Dr. Stroud received an undergraduate degree from Oregon State University in fisheries and wildlife biology and worked as a marine mammal biologist. He returned to Washington State University and obtained a Doctor of Veterinary Medicine. He completed further graduate work in Veterinary Pathology at Oregon State University. He worked as a diagnostic veterinary pathologist at Oregon State University and the National Wildlife Health Lab in Madison, WI. Since 1990 Dr. Stroud has been the Veterinary Medical Examiner with US Fish and Wildlife Service, Division of Law Enforcement National Fish and Wildlife Forensics Lab where he conducts pathological evaluations and evidence gathering of law enforcement submissions to the lab, conducts field investigations with FWS special agents and serves as expert court witness in highly complex wildlife cases. He has numerous publications to his credit and has led and participated in many seminars and conferences both nationally and internationally.
APPENDIX B
LUBRECHT EXPERIMENTAL FOREST ACTIVITY FORM – AMMENDED
11 July 2007

NAME OF PROJECT: Development of Time of Death Standards for Bears, Wolves and Mountain Lions
University of Montana: Masters of Interdisciplinary Studies: Criminology and Forensic Anthropology (wildlife forensics)

Persons Responsible for Activity:
- Student: Carleen Gonder, 38689 Hwy 200 East, Box 6, Greenough, MT 59823; 244-0007
- Dr. Dan Doyle – Criminology; graduate committee chair – 243-5912
- Dr. Ashley Mckeown – Forensic Anthropologist graduate committee member – 243-2145

Cooperators: US Fish and Wildlife Service; Montana Fish, Wildlife and Parks; Idaho Fish and Game; Wyoming Game and Fish

Sponsor/Source of Funding: Association of Midwest Fish and Game Law Enforcement Officers (AMFGLEO) is primary sponsor. Wyoming Game Warden’s Association is secondary sponsor. Various equipment loan: MT Fish, Wildlife and Parks, MT Dept. of Natural Resources, US Forest Service, Grizzly Fence, MSU/Greg Johnson, Marsh Lab for lab equipment and site material. (Additional sponsors pending)

Location: 1 - SW,NW,NW,SE Sec 2, T 13 N, R 15 W

Narrative description: Site 1 – Level area SW of Midway Rd. Open with approx 30% canopy cover. Predominately Ponderosa Pine with D. Fir.

Size area: Approx. 2,500 sq feet.

A Second site established April 2007: SE,NW,SW,SE Sec 2, T 13 N, Range 15 W

ACTIVITY: Research; graduate

Purpose and intent:
To monitor carcass decomposition during four (4) seasons, researcher placed 15 carcasses (8 wolves, 4 lions, 2 black bears and a whitetail deer) in four electrified exclosures. The purpose is to develop time of death standards for use in wildlife crime scene field investigations. Carcasses were placed during various times of the year. Animals were not euthanized for this project, but were result from government agency management action, such as livestock depredation issues, and roadkill.

NOTE: Electrified exclosures will deter scavenging by large mammals and raptors, such as eagles, vultures and ravens. Scavenging by small mammals and birds will not be deterred. The exclosures are locked for security reasons.

A Bear Management Plan is attached and will address bear/human conflict issues. Included in the plan is a contact sequence with telephone numbers.
If the activity is permanent, how will the boundary be marked?
The activity will not be permanent, but last approximately 2-3 years.

Identify persons responsible for site maintenance and cleanup:
Carleen Gonder

Activity schedule:
Field work – Beginning date: Spring 2006  Ending date: spring 2009 at the latest

Date on which site will be available for other research studies, operational activities and so forth:
Other research projects may still be done in the site area. Please discuss with researcher, Carleen Gonder.

Timetable: spring 2006 – begin placing carcasses as they become available. Monitoring and data collection will by 1-2 times daily at the start, once daily through summer 2007, weekly starting fall 2007, and daily during hunting seasons for security reasons. *There is a possibility it could continue through spring 2009 depending on carcass decomposition stages (when reach skeletonized stage)*

Published Results of Activity:
- Thesis
- Wildlife Forensic Field Manual produced by AMFGLEO
- A Guide to Time of Death in Selected Wildlife Species, Nebraska Game and Parks Commission publication
- International Game Warden, quarterly trade publication
- Various journals and popular literature

Location of Detailed Activity Records:
With Carleen Gonder and her committee

Comments:
- Proposal/project details on file at Lubrecht with Frank Maus
- Bear Management Plan attached to earlier activity form.
- C. Gonder conducted a seminar on wildlife crime scene investigation/wildlife field forensics (30 May – 1 June 2007) which could possibly be an annual event.
- C. Gonder will live at Lubrecht during most of the research period.

Signature of Responsible Party: (Carleen Gonder)

Date: 11 July 2007, amended/updated
APPENDIX C
EQUIPMENT USED and SPECS

General
Nikon D50 digital SLR camera; Nikkor 18-55 mm lens; personal
Laminated site signs duct taped to trees at start; personal
Polyethylene to wrap carcasses for transport; personal
Non-Latex gloves by the box; personal
Knife; personal
Duct tape; personal
Electricians tape; personal
Assorted batteries; personal
Galvanized utility wire for general use; personal
Trowel, shovel, post hole digger; personal and Lubrecht
T-post pounder; personal
Two Brunton macro-scopes – 7x, plus 5x, 10x, 15x loop/magnifier; personal
Mossquito net tent and concrete mixing tubs to protect thawing carcasses from premature insect colonization

Containment
Four 16’x4’4” livestock mesh panels; FWP via Jamie Jonkel
Parmak Solar Pak 12v energizer system for electrification; FWP via Jamie Jonkel
12 chain link panels, 12’x6’, donated by Grizzly Fence for duration of project
9’ larch posts/10-12 posts for 12 chain link panels; personal
½” hardware cloth for top; personal from metal recycling center; personal
Wire for electrification plus fittings, t-posts and fence tester; personal
Portable Gallagher 60 electric fence energizer, two motorcycle 12v batteries, and charger for site 3; personal

Weather
Firefighter belt weather kit; MT DNRC via Bob Harrington, State Forester
Relative humidity: firefighter’s swing psychrometer
Wind speed: Dwyer hand held indicator
USFS precipitation gauge and Taylor minimum/maximum thermometers; USFS via Ward McCaughey
Wind direction: Silva Type 15T compass set at East declination 15 degrees; personal

Soil and carcass temperatures
Hobo probes/data loggers from Greg Johnson (with computer program to launch)/MSU
Data loggers: Hobo, H08-006-04 (Onset Computer Corp); 4-channel external with “wet” and “dry” probes
Suture kits, to seal around probes; personal;
Vaseline to seal around probes; personal
Ace No-run Super Glue Gel to seal around probes; personal

Entomology equipment from Greg Johnson/Montana State University
Sweep net, rearing chambers, pitfall traps
Vermiculite
Liver
70% alcohol
Tri-ethylamine
Microscope/dissecting scope
Scale; small capacity
Refrigerator/freezer combo; standard size set up at Lubrecht lab
15 cu ft chest freezer
Vials, tubes and whirl-packs for storing samples
Various size zip-lock bags for storing sample bags
Two 8’x6’x4’ dog kennels for exclosures/site 3

Carcass measurements
Plastic Vernier calipers, CaliMax 41103; Scales: .1mm and 1/64”; personal
Rules; personal
25” measuring tape; personal
Taylor 200 pound capacity hanging scale; donated by Tim Eicher

Site markers
Pin flags to mark areas in site; personal
3’ slender steel rods to mark anterior/posterior while snow covered; personal
Site 2 consists of twelve 6'x12" chain link panels

Minimum 6' spacing of all carcasses

Not to scale

Diagram 3, Site 2 carcass layout
APPENDIX E
Species and their respective agencies – June 2006
Coordination required with each

Mountain lions and black bears – state game animals
Montana Fish, Wildlife and Parks, research permits for all species; authorization for lions and black bears.
  • Keith Aune (biology) and Mike Mehn (law enforcement)
  • Rich DeSimone, researcher in Garnets
  • James Jonkel, bear conflict specialist/biologist

Grizzlies – federally protected
US Fish and Wildlife Service – Chris Servheen, National Coordinator, UM, Missoula, MT; supplied letter to authorize temporary possession. States heavily involved in management
Montana; research permit obtained
Montana Fish, Wildlife and Parks
  • Above biologist and law enforcement
  • James Jonkel, conflict specialist
Wyoming; research permit obtained
Wyoming Game and Fish
  • Mark Bruscino, conflict specialist
  • Carol Havlik – Chapter 33 research permit
Idaho; research permit obtained
Idaho Fish and Game
  Steve Nadeau, state carnivore biologist – research permit

Wolves – federally protected
Wyoming – has no state management/involvement
US Fish and Wildlife Service, Ed Bangs, National Coordinator; Helena, MT; supplied letter to authorize temporary possession.
  • Tim Eicher, SA in Cody, WY and on my committee
  • Mike Jimenez, state coordinator, Lander, WY
Wildlife Services/APHIS; Jim Pehringer, Cody WY
Montana – has limited management/involvement; research permit obtained
Montana Fish, Wildlife and Parks
  • Caroline Sime, state coordinator, Helena, MT
  • Mark Atkinson, DVM, state wildlife vet, Bozeman, MT
Wildlife Services/APHIS, Larry Handegard, Billings, MT
Idaho – has limited management/involvement; research permit obtained
Idaho Fish and Game
  • Steve Nadeau, state carnivore biologist
  • Clay Cummins, deputy chief for Conservation Officers
  • Karen Rudolph, state wildlife lab
Wildlife Services/APHIS
APPENDIX F
University of Montana Masters of Interdisciplinary Studies
Criminology and Forensic Anthropology (wildlife forensics)
Development of Time of Death Standards for Grizzly Bears, Wolves and Mountain Lions

Carleen Gonder (406) 244-0007

Carcass protocols (amended 25 May 2006)
- Must have a known time of death plus date. If frozen, check with researcher.
- If euthanized with drugs, may not be suitable. Check with researcher.
- Not field dressed, skinned or gutted.
- Preferably, intact with no wounds other than bullet holes. Possibly can be accepted if road killed, if external wounding is slight. Check with researcher.
- Wrapped in polyethylene to prohibit insects from colonizing, when taken out of refrigeration.
- Stored in agency walk-in refrigeration if sent within a day or two; record temp of cooler.
- Frozen if stored longer than a few days; record temp of freezer.
- Transported/shipped on ice and wrapped in polyethylene.
- Document cause or mechanism of death (include caliber and type weapon), document known entrance and exit wounds or any other wounds, conditions just prior to and at time of death (weather and other environmental), and condition of animal just prior to and at time of death (if aerial, how far run, etc).
- Animal weight at time of death.
- Location animal taken including GPS (ideally) or Section/Town/Range, habitat type, slope, etc.
- Condition of local habitat at time of death.
- Reason for lethal removal of animal from population.

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<tr>
<th>Species</th>
<th>Date of Death</th>
<th>Time of Death</th>
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Conditions before refrigeration/freezing, storage, transport

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<th>Date/time placed in refrigeration</th>
<th>Date/time placed in freezer</th>
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Time interval from killed to refrigeration and/or freezer

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Sex | Age | Weight | Location animal taken
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Location description (slope, elev, vegetation, etc)

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Location/habitat condition at time of death

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Reason for lethal removal of animal

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Cause or mechanism of death (caliber and type of weapon, vehicle/road kill, chemical used for euthanasia, etc)

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Location and condition of all wounds

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Other factors at time of death (if aerial, how far run, if other animals/pack members present, how long in culvert trap etc)

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Animal condition at time of death

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NOTES (use reverse if needed)

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APPENDIX G

BEAR MANAGEMENT PLAN FOR THE MIS DECOMPOSITION STUDY TO BE CONDUCTED AT LUBRECHT FOREST

SITE
Site location is above and out of site from a dirt road accessed from Highway 200. That access road is gated and locked at the highway to prohibit public vehicular access at all times.

SIGNAGE
Signs prohibiting public access will be placed around the site perimeter approximately 100 yards around the site. The signs will read: “Research Area – Please Do Not Enter. Audio and visual surveillance. For information contact 244-0007”. Next to the containment area signs will read: “High Voltage Electrified Fencing. Please stay back”.

PATROL/MONITORING
The area around the site will be patrolled at least twice daily and closely monitored for any sign of bear activity (scat, scavenging, tracks).

CONTACT WITH BEAR SPECIALIST
For the entire duration of the project, Carleen Gonder* will remain in frequent contact with James Jonkel, Montana Fish, Wildlife and Parks (FWP) area bear management specialist/biologist, who will notify her if there have been any bear sightings in the greater area (from Clearwater Junction to Potomac Valley). They will have ability to contact one another or designated assistants at all times.

SEASONAL CONSIDERATIONS INCLUDING HUNTING ACTIVITY
Seasonal movements of grizzlies will be taken into consideration. During spring and fall periods when the bears are most hyperphagic, and potentially could be moving through the Lubrecht area, monitoring and site assessment for bear activity will be increased to at least 3 times each day during those seasons. Fall hunting season will also warrant the increase in patrols (at least 3 times each day). C. Gonder will coordinate with FWP Block Management personnel and area wardens.

BEAR ACTIVITY OR SIGN OBSERVED
If any sign of bear activity is observed, or if there is a sighting of a grizzly bear or black bear, J. Jonkel will be notified and all activity described to him in full. Any additional instructions from him will be written in a log and followed. The site area will be intensely monitored and patrolled at least 3 times a day, until it has remained clear of any sign of bear activity for 3 consecutive days, and C. Gonder will not leave the Lubrecht area during this period.

BEAR/HUMAN INCIDENT
If there is a bear/human incident, J. Jonkel, and Dr. Chris Servheen, US Fish and Wildlife Service National Grizzly Bear Coordinator will be immediately notified and protocols per the Endangered Species Act will be followed. Additionally, Dr. Dan Doyle will be notified as the UM public relations contact.

LUBRECHT PERSONNEL OBSERVING BEAR ACTIVITY OR SIGN
All Lubrecht personnel will be instructed to immediately contact C. Gonder if any bear activity is observed. She will then investigate and take appropriate action as stated above. If C. Gonder is out of the area, J. Jonkel or his assistant will be immediately notified.

A contact sequence is attached to this Plan.

* C. Gonder has been a commissioned law enforcement officer for wildlife and land management government agencies for 5 years. While she does not have law enforcement authority during this project, she will rely on her training to be an astute observer with sound judgment in noting and documenting unusual activity, and notifying area law enforcement personnel. She also was a full time bear management specialist in Glacier National Park for 2 seasons and is highly trained in recognizing potential bear/human conflict concerns and mitigating issues in both front and back country settings.
ORDER OF CONTACT IN CASE OF BEAR INCIDENT

1. Lubrecht employees observe bear or bear sign (grizzly or black bear) in the greater Lubrecht area
   A. Contact C. Gonder immediately. If she is out of the area…
   B. Contact J. Jonkel. If no response…
   C. Contact B. Wiesner.
   AND contact Frank Maus

2. Bear/human conflict; no injury
   *Detain individuals for interview by C. Gonder and J. Jonkel or other FWP personnel*
   A. Contact C. Gonder immediately. If no response…
   B. Contact J. Jonkel. If no response…
   C. Contact B. Wiesner. If no response…
   D. Contact Capt. Darrah
   AND contact Frank Maus AND Dr. Dan Doyle if unable to contact C. Gonder

3. Bear/human conflict; injury
   A. Call 911
   B. Then contact J. Jonkel. If no response…
   C. Contact B. Wiesner. If no response…
   D. Contact Capt. Darrah
   AND contact Frank Maus AND C. Gonder. If unable to contact C. Gonder, contact Dr. Doyle.

CONTACTS

Carleen Gonder
   Home – 244-0007
   Cell – (I will be getting a cell phone for the duration of the project)

James (Jamie) Jonkel – Area FWP bear management specialist
   FWP/office – 542-5508
   Cell – 544-1447
   Home – 728-3275

Bob Wiesner – Assistant bear management specialist
   Cell – 240-3296
   Home – 543-6358

Game Wardens
Captain Jeff Darrah – Missoula Region warden Captain
   FWP/office – 542-5512
   Cell – 240-0982
   Home – 777-4257

Sgt. Dan Curtin – Missoula
   Cell – 240-0932
   Home – 273-0868

Derek Schott – Missoula
   Cell – 240-2579
   Home – 273-7968

Bill Koppen – Seeley Lake
   Cell – 210-1299
   Home – 677-3628

Frank Maus – Lubrecht Manager
   244-5524, ext. 1

Dan Doyle, PhD. – Committee chair and public relations contact
   243-5912
APPENDIX H

Carcass assessments

1. Carcass BB 1
   - 12 September 2006 received carcass from Jamie Jonkel, MT FWP bear biologist/Missoula
   - 12 September 2006 set out to thaw under mosquito net
   - 15 September 2006 set out in carcass pen

Female black bear, adult (2 ½ years)
Flies attracted to in shed as thawing; protected w/mosquito net.
Management action via Superior area FWP warden summer 2006. Taken to Missoula and frozen that same day.
Cinnamon phase. Shot in right ear probably with 40 cal duty weapon. Green ear tag, left ear from previous
conflict situation (food scavenging/dumpster diver). No other marks found. Low weight, small girth and
course, shaggy coat indicate poor condition at time of death.

Weight: 84 pounds
Total body length: 43"
Body length: 40"
Girth: 25 ½"

2. Carcass BB 2
   - 20 September 2006 discovered by FWP employee; roadkill near Seeley lake and picked up by C.
     Lorentz, head of parks (677-6804)
   - 21 September 2006 taken by Lorentz to FWP/Missoula freezer
   - 25 September 2006 received carcass from MT FWP (Jonkel put on hold for the project; picked up
     from Mike Thompson, MT FWP Missoula biologist
   - 25 September 2006 set out in pen to thaw in black plastic to draw heat
   - 28 September 2006 remove plastic for decomposition

Male black bear, cub of the year
Roadkill early AM of 20 Sept; frozen the next day. Mouth/teeth damage; bleeding from mouth. Remainder of
external carcass in good condition with no marks.

Weight: 62 pounds
Total body length: 35.0"
Body length: 33.0"
Girth: 30"

3. Carcass L 1
   - 22 November 2006 carcass brought to site by Jay Kolbe, FWP Clearwater biologist; fresh/unfrozen

Mountain lion, yearling male/one of three litter mates brought this day
Trapping incident with TOD w/in 36 hours; incidental trapping. Snare trap around neck. Mark but no wound
of snare around neck. Tongue extended out from teeth which bit into tongue. Evidence tag on ear; removed.
No other body marks. Though 36 hour PMI to site, ambient temps were cool enough that carcasses were in
good condition with no insect activity.

Weight: 47 pounds
Total body length: 53”
Body length: 34”
Girth: 21.5

4. Carcass L 2
   - 22 November 2006 carcass brought to site by Jay Kolbe, FWP Clearwater biologist; fresh/unfrozen

Mountain lion, yearling female/one of three litter mates brought this day
Trapping incident with TOD w/in 36 hours; incidental trapping. Snare trap around neck and drowned. Mark of snare around neck. Slight wire cut with blood left side of neck. No other body marks. Though 36 hour PMI getting to site, ambient temps were cool enough that carcasses were in good condition with no insect activity.

Weight: 39 pounds  
Total body length: 51.0”  
Body length: 32.0”  
Girth: 20.0”

5. Carcass L 3  
- 22 November 2006 carcass brought to site by Jay Kolbe, FWP Clearwater biologist; fresh/unfrozen

Mountain lion, yearling male/one of three litter mates brought this day
Trapping incident with TOD w/in 36 hours; incidental trapping. Snare trap around neck and drowned. Mark but no wound of snare around neck. No other body marks. Though 36 hour PMI getting to site, ambient temps were cool enough that carcasses were in good condition with no insect activity.

Weight: 48 pounds  
Total body length: 52.0”  
Body length: 33.0”  
Girth: 21.5”

6. Carcass L 4  
- 25/26 November 2006 management removal 
- 10 January 2007 transported from MT FWP Bozeman lab via Greg Johnson; retrieved in Bonner, MT 
- 11 January transport to site via snowmobile (Frank Maus)

Mountain lion, male
Euthanized due to management action and held in MT FWP wildlife lab freezer in Bozeman; unknown circumstances.
Excellent condition. Bullet hole center of right side of torso. Blood on fur on right side, feet and mouth area. Foot pads rough, maybe some scarring. Torn medial dew claw on front right foot. No other wounds found.

Weight: 130 pounds  
Total body length: 86”  
Body length: 53”  
Girth: 32.75”

7. Carcass W 1  
- 16 June 2006, pick up from FWS Special Agent Tim Eicher in Livingston, MT 
- 17 June 2006, unwrap at 1500 and place under mosquito net for protection as thaw 
- 19 June 2006, thawed and placed at site

Female wolf, yearling
Management action in Wyoming; unknown circumstances
Flies attracted to already. Zip tie around legs.
Nose flattened slightly from being packed, especially on left lobe. Scar, left side of muzzle. Right ear split. Long scar front, upper leg on inside. Left front foot, 1st medial toe pad, hole. Short tail with fresh but dried wound on end. Abrasion, left shoulder. Wounds: left rear leg through skin, possibly from trap? Right rear same, but no broken skin. Right shoulder.

Weight: 79 pounds  
Total body length: 56.5” (tail: 13”); previous injury unknown  
Body length: 43.5”  
Girth: 27.5”
8. Carcass W 2
- 16 June 2006, pick up from FWS Special Agent Tim Eicher in Livingston
- 17 June 2006, unwrap at 1500 and place under mosquito net for protection as thaw
- 19 June 2006, thawed and placed at site

Female wolf, yearling
Management action in Wyoming; unknown circumstances.
Flies attracted to on 17 June (protected w/mosquito net tent). Bound with wire.
Bleeding underneath, right side; laying on right side. Scar on right side of muzzle. Fur in right ear bloody. Small
open wound right side of neck. Left shoulder bullet wound. Abrasion on right flank.

Weight: 88 pounds
Total body length: 57.0”
Body length: 40.0”
Girth: 27.0”

9. Carcass W 3
- 11 September 2006 received carcass from Jason Husseman, Idaho FG Salmon wolf biologist
- 11 September 2006 set out to thaw under mosquito net
- 15 September 2006 set out in carcass pen

Female wolf, adult
Flies attracted to in shed as thawing; protected in mosquito net tent.
Management action via Wildlife Services on 1 September 2006; frozen the same day at Salmon, ID. Backside
bloodied; possibly from 00 Buck. Left rear leg/back of thigh above hock, slightly swollen with blood on
outside; possible bullet wound.

Weight: 86 pounds
Total body length: 65”
Body length: 47 ¾”
Girth: 34 ½”

10. Carcass W 4
- 11 September 2006 received carcass from Jason Husseman, Idaho FG Salmon wolf biologist
- 11 September 2006 set out to thaw under mosquito net
- 15 September 2006 set out in carcass pen

Female wolf, adult
Flies attracted to in shed as thawing.
Roadkill 21 February 2005. Unintentionally hit by an anti wolf person, within a few miles of the area Idaho FG
conservation officer, Gary Gadwa (208 774-7735) and reported immediately. Gadwa had her at his residence
within a few hours of TOD. Was in pickup overnight, but freezing temps. Was placed in freezer the next day.
Abrasions on left shoulder and hip points; no other marks found. Shoulder abrasion area: 2.8 cm wide x 3.0 cm
high. Hip: 4.9 cm wide x 3.6 cm high. Pelt in excellent condition; winter.
Missing upper left incisor 1.

Weight: 92 pounds
Total body length: 65 ½”
Body length: 48;
Girth: 31 ½”

11. Carcass W 5
- 11 September 2006 received carcass from Jason Husseman, Idaho FG Salmon wolf biologist; held in
freezer at Lubrecht for late fall placement
- 1 December 2006 placed in carcass pen
Adult wolf, male
Condition of carcass at time of placement: eyes appeared to be missing (deeply sunken appearance; frozen solid) and due to moderate odor it was thought carcass had been thawed and refrozen. Also size of feet and length of body relative to weight indicate poor condition of animal at time of death. Located Idaho conservation officer who euthanized the wolf, Chris Wright (208 287-2759); Management action performed by Wildlife Services initially on 20 July 2005; wounded and at large. A sick/hurt wolf was reported by hunters in that area Oct 2005. C. Wright investigated and located the wolf, which appeared to have a damaged rear leg. He shot it w/40 cal bullet/service handgun, behind left shoulder. Wright enlarged the rear leg wound (left/thigh/posterior) to look for 00 buck to make sure it was the same wolf wounded by Wildlife Services. Did not find 00 buck in leg wound, but did find 00 buck pellet in bed of pickup where he had the wolf. He immediately took it to his residence and placed it in a freezer that same day. It was intact, eyes in. It was then transported to the ID FG Salmon office and placed in that freezer. It possibly thawed for a period of time after that date; unknown as to circumstances. It was solidly frozen, but well wrapped when I received it on 11 September. I placed it in a freezer within 3 hours of receiving it.

On 11 December, area around left eye partially thawed. Was able to partially open lid. Eye is present, but deeply sunken, shriveled, opaque. Unknown if caused by extremely poor condition at time of death, or from possible thawing and refreezing.

Weight: 62 pounds
Total body length: 68 ½”
Body length: 54”
Girth: unable to measure on 1 December 2006 due to position of frozen body

Carcass was placed on top of the snow.

12. Carcass W 6
- 2 November 2006 TOD; placed in freezer
- 16 November 2006 transported to MT FWP/Bozeman freezer by FWS SA Tim Eicher
- 28 November 2006 transported to Missoula by FWP vet Mark Atkinson and given to C. Gonder; it remained solidly frozen in her vehicle until placement
- 1 December 2006 placed in carcass pen

Adult wolf, male
Management action/removal by Wildlife Services, Powell County, WY. Fur red/blood near anus indicates bleeding from anus, also from mouth. Blood left side of torso, hair frozen in solid mass just behind shoulder could indicate bullet entrance wound. Carcass in excellent condition.

Weight: 110 pounds
Total body length: 71”
Body length: 56”
Girth: 37.5”

Carcass was placed on top of the snow.

13. Carcass W 7
- 15 November 2006 TOD; placed in freezer
- 26 March 2007 transported to Bonner, MT by FWP vet Mark Atkinson for Gonder pickup; held in storage for thaw at Lubrecht
- 30 March 2007 placed in large tub and covered with mosquito net tent to protect from insects as thaw in new pen at site 3 (1045 hrs)
- 04 April 2007 placed on ground for decomposition (approx 1500 hrs)

Adult wolf, male; state FWP numbers: 184814; SW146M; Battlefield Pack

Weight: 102 pounds
Total body length: 76”
Body length: 58”
Girth: approx. 44” (not accurate due to leg positions)

14. Carcass W 8
   - 11 December 2006 TOD; placed in freezer
   - 26 March 2007 transported to Bonner, MT by FWP vet Mark Atkinson for Gonder pickup; held in storage for thaw at Lubrecht
   - 30 March 2007 placed in large tub and covered with mosquito net tent to protect from insects as thaw in new pen at site 3 (1050 hrs)
   - 04 April 2007 placed on ground for decomposition (approx 1500 hrs)

Adult wolf, female; state FWP numbers: 184813; SW151F; Battlefield Pack

Weight: 79 pounds
Total body length: 64”
Body length: 47”
Girth: 32”

15. Carcass WT 1
   - 22 November 2006 carcass brought to site by Jay Kolbe, FWP Clearwater biologist; fresh/unfrozen

Whitetail deer, buck, yearling
Road/wounded morning of 22 November 2006. Killed w/bullet behind left shoulder. Broken jaw/lower jaw damage. Remainder of body in good condition. 3” spike on left, button on right.

Weight: 82 pounds
Total body length: 60.5”
Body length: 50.0”
Girth: 34.0”
APPENDIX I-1
1 - WEATHER DATA

Date_______________________Collector name________________________________________

**General Climate**

- [www.wrh.noaa.gov](http://www.wrh.noaa.gov)

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Weather notes:

- Time arrive/depart______________POWER ON/OFF when depart (reason left off______________
- Lab activity and notes______________________________

General site notes (birds and animals in area, tracks, sign, human incursion, etc)____________________

Condition of pens/energizer/amount of charge, work done, etc________________________

Photos: Time________________Notes______________________________________________

Site notes (insects present/location, animal/bird sign, odor, other observances)____________________

General notes:
**APPENDIX I-2**

2 – **INSECTS** – *First observe, then collect according to protocols*

Observer/collector  | Site  | Date  | Time
--- | --- | --- | ---

*For the following, describe: masses, size of masses, location, behavior (digging, feeding, mating) etc. Start with northern most, working left to right.*

**Site general;** swarms/masses, flying, crawling, vegetation, soil, 

---

General notes

---

**Carcass 1** – Species | ID Number | Notes
--- | --- | ---

Flying, near/over

On (crawling and flying type; describe)

---

Under (as above)

---

Collected

---

**Carcass 2** – Species | ID Number | Notes
--- | --- | ---

Flying, near/over

On (crawling and flying type; describe)

---

Under (as above)

---

Collected

---

**Carcass 3** – Species | ID Number | Notes
--- | --- | ---

Flying, near/over

On (crawling and flying type; describe)

---

Under (as above)

---

Collected
**APPENDIX I-3**  
**4 – CARCASS DESCRIPTIONS AND OBSERVATIONS**

Observer __________________________ Date ________________ Time ________________

Species __________________ ID Number __________________ Site number ________________

**Daily documentation** (Locations starting with northern most, working left to right)

**Observation/sampling sequence**: “Tip of nose to tip of tail”. Anterior to posterior; proximal to distal; dorsal then ventral; left then right.

1. **Head**: a. Muzzle: nose, mouth/lips, between lips and gums/teeth, tongue; b. Eyes; c. Ears
2. **Torso**: dorsal then ventral (whatever can be observed)
3. **Left front leg**: right front leg
4. **Left rear leg**: right rear leg
5. **Anal area**
6. **Tail**

- As cavity opens, organ ID and decomposition descriptions (desiccation stage, etc; below*) of organs will be worked anterior to posterior.
- As external tissue (hair, hide, etc) falls away or is scavenged exposing underlying soft tissue and bones, those exposed areas will be ID and described following the above sequence and desiccation (below*).

**Nose pad; degree of desiccation**: Surface – moist, dry; Pad – soft/pliable, moderately pliable, hard/rigid

Describe_____________________________________________________________________________

**Paw pads (toe and plantar pads) Degree of desiccation:**

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<thead>
<tr>
<th></th>
<th>Front left: Plantar</th>
<th>Toes</th>
<th>Front right: Plantar</th>
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Describe_____________________________________________________________________________

**Early decomposition/describe appearance** (moist/dried, clear/opaque, stiff/flexible, loose/tight, drooping from gravity, etc):

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<tr>
<th></th>
<th>Eyes</th>
<th>Ears</th>
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<tr>
<td>Tongue/mouth/lips</td>
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**General**: livor mortis or other skin discoloration, rigor per Oates, etc______________________________

_____________________________________________________________________________________

Note hair loss following above observation sequence______________________________________________

_____________________________________________________________________________________

**Odor** mid ventral, one foot from carcass (circle): Normal, Faint (pre putrefaction), Mild, Moderate, Strong, Moderate, Mild, Faint (post), None

**Decomposition stage (circle)**: Fresh, Bloat, Active decay, Advanced decay, Dry, Remains

*Note desiccation* following above observation sequence (circle): Fresh, Intermediate, Dry, Mummified

**Disarticulation**: head, legs, shoulder girdle, pelvic girdle, vertebral/tail; Fully intact/attached; Partially attached by soft tissue; separated___________________________________________________________

**Teeth**: L – line, C – crack, S – separate; i – incisor, c – canine, p – premolar, m – molar; white, pink, gray

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<th>Groundside</th>
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| Lower            |        |            |

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APPENDIX I-4
5 – PHOTO LOG

Name_________________________ Date________________ Time________

Camera and other general equipment used ______________________________________

*Note size lens and settings. Include: soil adjacent carcasses, insect activity, etc.*

*Conditions of carcass to note include: overall shot, eye rigor, stages of decomposition, tissue desiccation, disarticulation, scavenging activity.*

Site, general, and each carcass starting with northernmost and working left to right.

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### Site Data

- **Date**: 
- **Collector name**: 

#### General Climate

- Website: [www.wrh.noaa.gov](http://www.wrh.noaa.gov)
- Missoula - 329-4840

#### SITE

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<th>RH</th>
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</table>

- **Time arrive/depart**: 
- **POWER ON/OFF when depart (reason left off)**

#### Lab activity and notes

- General site notes (birds and animals in area, tracks, sign, human incursion, etc)

#### Condition of pens/solar panel/amount of charge, work done, snow shoveled, etc

#### Photos: Time __________ Notes

#### Site 1 notes (insects present/location, animal/bird sign, odor, other observances)

#### Site 2 notes (insects present/location, animal/bird sign, odor, other observances)

---

**Carcasses IF OBSERVABLE note same criteria from full data sheet. If a substantial area of carcass is exposed, use full data sheet.**

- Insects (location on/near, behavior, type, whether collected), exposed area (location, size area exposed, odor (normal, faint, mild, moderate, strong, moderate, mild, faint, none), decomposition stage (fresh, bloat, active decay, advanced decay, dry, remains), describe hair/skin (hair loss, skin color, skin pliability), describe ear/nose/foot and toe pads (dry, moist, pliable, stiff, flexible, loose, soft, drooping from gravity, etc), describe eyes (moist, dry, clear, opaque, texture), desiccation (fresh, intermediate, dry, mummified), teeth/which tooth (line, crack, separation, color: white, pink, gray)

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Carcasses IF OBSERVABLE note same criteria from full data sheet. If a substantial area of carcass is exposed, use full data sheet: Insects (location on/near, behavior, type, whether collected), exposed area (location, size area exposed, odor (normal, faint, mild, moderate, strong, moderate, mild, faint, none), decomposition stage (fresh, bloat, active decay, advanced decay, dry, remains), describe hair/skin (hair loss, skin color, skin pliability), describe ear/nose/foot and toe pads (dry, moist, pliable, stiff, flexible, loose, soft, drooping from gravity, etc), describe eyes (moist, dry, clear, opaque, texture), desiccation (fresh, intermediate, dry, mummified), teeth/which tooth (line, crack, separation, color: white, pink, gray)

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NOTES
APPENDIX J
Terms and frequent abbreviations used

FWS – US Fish and Wildlife Service

Hyperphagia – intense feeding period

Illegal take – the legal term for poaching

MSU – Montana State University

Plant phenology – plant development in relation to climate

Postmortem interval or PMI – the period after death

Subnivian space – a one to two inch air space between ground and snow

TOD – time of death

UM – University of Montana
RESEARCH AREA

PLEASE DO NOT ENTER

Audio and Visual Surveillance

For Information Contact 244-0007
HIGH VOLTAGE
ELECTRIFIED FENCING

PLEASE STAY BACK