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Handling adjustments to reduce chemical capture-related mortality in black-tailed deer

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The capture of free-roaming animals is an important foundation of wildlife research and minimizing harm, especially mortality, is a paramount ethical concern (Kilpatrick and Spohr 1999, DelGiudice et al. 2005, Wildlife Investigations Lab 2010, Sikes et al. 2011). However, injuries or mortality are inherent to capture and chemical immobilization, and often necessitate adjustments to accepted techniques (Valkenburg et al. 1983, 1999; Jessup 2001; DelGiudice et al. 2005). In order to limit the potential for harm to study animals the California Department of Fish and Wildlife (CDFW) has formalized training and ethical guidelines for capture and chemical immobilization of wildlife (Wildlife Investigations Lab 2010). Nevertheless, training cannot replace real-time field experience and handling of animals; it is through experience that biologists are able to minimize injuries or mortalities to animals by making proactive adjustments to standardized capture protocols (Jessup 2001; DelGiudice et al. 2001, 2005).

Ungulates are the most common large mammals captured by wildlife biologists, and special care in the capture of *Odocoileus* spp. is needed because of the high potential for injury due to excitability and lengthy handling times (DelGiudice et al. 2005). A capture method that is becoming prevalent is remote delivery of immobilizing agents via free-range darting (Ferris 1990, Kilpatrick and Spohr 1999). Benefits of this approach are low animal capture stress relative to other methods (e.g., net-gunning), ability to select specific individuals, and its utility in dense cover; drawbacks include drug-induced decreases in respiratory and thermoregulatory abilities (Ferris 1990). Of special concern is the capture and immobilization of adult female deer within one month of parturition. Ideally, captures should be executed at other times due to the stressors associated with pregnancy, but circumstances may dictate that captures occur during this period (e.g., migratory animals that are accessible only during a short window on summer range).

During the month prior to parturition, respiration becomes increasingly labored as the size of the fetus increases, thereby reducing the capacity of the thoracic cavity and limiting the expansion of the lungs (Armstrong 1950). Many immobilizing agents (e.g., xylazine) further tax animals through a reduction in respiratory rate and gut motility, thereby resulting in bloat. Thus, chemical capture often results in respiratory distress manifested as low blood oxygen saturation (SpO_2) and reduced respiratory rate (Kreeger et al. 2002). The likelihood of mortality increases dramatically when appropriate adjustments are not made to mitigate respiratory depression, and raises ethical concerns that jeopardize approval or funding for investigations (Peterson et al. 2003). Here we describe adjustments to standard handling approaches (Wildlife Investigations Lab 2010) during the chemical capture of female black-tailed deer (*O. hemionus columbianus*) within one month of parturition in the Mendocino National Forest, California.

Adult female deer (n = 18) were captured via free-range darting during April – September 2012. Seven were determined to be in the latter stages of pregnancy using ultrasonography (Stephenson et al. 1995) and known parturition periods for this population (D. Casady et al., CDFW, unpublished data). We used Pneu-Dart® compression rifles (Pneu-Dart Inc., Williamsport, PA) and 1.5 or 2 ml Pneu-Dart® barbed tri-port darts with 3.17 cm needles. We determined distances to deer with a laser rangefinder and darted animals at distances from 5 to 50 m. A combination of Telazol® (tiletamine HCl and zolazepam HCl; Fort Dodge Animal Health, Fort Dodge, IA) and xylazine (Anased®, LLOYD Laboratories, Shenandoah, IA) (DelGiudice et al. 1986) was used to chemically immobilize the animals. Ketamine HCl (Ketaset®, Fort Dodge Animal Health, Fort Dodge, IA) at approximately 4.4 mg/kg was administered as needed to maintain anesthesia and peripheral analgesia.

After injection of the immobilizing agents, we waited 10 minutes before retrieval to minimize stress to the animal during drug induction. Once downed deer were located, their legs were bound front to back on same sides, their eyes were covered, and they were moved to a shaded location. The deer were positioned left side down with head uphill to prevent aspiration of rumen contents, and body temperature and respiratory rate were measured at 10 minute intervals. Blood oxygen saturation was continually monitored using a Nellcor™ pulse oximeter (OxiMax N-65; Nellcor, Mansfield, MA) with a lingual probe attached to the tongue. We fitted each animal with a GPS collar, recorded morphometrics, collected a tissue sample (ear) for biopsy, extracted a canine for age determination (Swift et al. 2002, Bleich et al. 2003), and estimated fetal rates (Stephenson et al. 1995) using an Ibex® portable ultrasound (E.I. Medical Imaging, Loveland, CO) and a CL3.8 abdominal curved linear probe (E.I. Medical Imaging, Loveland, CO). When immobilized deer exhibited signs of recovery (e.g., increased heart and respiratory rates, urination, tail flicking), approximately 60 minutes following the initial injection, we reversed the xylazine with 4.4 mg/kg of tolazoline HCl (Tolazine®, LLOYD Laboratories, Shenandoah, IA).

The need for adjustment to the standard deer handling procedures (Wildlife Investigations Lab 2010) became apparent when an animal experienced acute respiratory distress that resulted in mortality. We made three adjustments to mitigate the effects of respiratory depression, and none of the subsequent captures resulted in mortality. Due to the nature of the respiratory crisis encountered, some low SPO_2 values were not recorded because personnel were busy attending animals; hence, our results are based on what we observed in the field. We made the adjustments described below and low blood oxygen levels and respiratory rates improved markedly. We believe these adjustments will reduce capture-related mortality in black-tailed deer captured late in gestation.

Our first adjustment was with the amount and ratio of immobilizing agents. We began with 130 mg of Telazol® (n = 3; mean = 0.616 [SE = 0.030] mg/kg) and 130 mg of xylazine (*n* = 3; mean = 0.616 [*SE* = 0.030] mg/kg) at a 1:1 ratio (Wildlife Investigations Lab 2010). Because of the respiratory depression and bloat caused by the xylazine (Kreeger et al. 2002), we adjusted our mixture to 110 mg Telazol® (*n* = 3; mean = 0.478 [*SE* = 0.013] mg/kg) and 84 mg xylazine (*n* = 3; mean = 0.365 [*SE* = 0.010] mg/kg) at a ratio of 1.3:1. However, these dosages failed to produce unconsciousness in the animals and made handling difficult and unsafe for the subjects and personnel; an additional dosage of 100 mg of ketamine HCl (0.428 mg/kg) was administered to one animal to produce unconsciousness. A further adjustment to a dosage of 120 mg Telazol® (*n* = 5; mean = 0.572 [*SE* = 0.048] mg/kg) and 91 mg xylazine (*n* = 5; mean = 0.434 [*SE* = 0.036] mg/kg) at a 1.3:1 ratio enhanced respiration and produced adequate sedation for safe handling and sample collection. Our final reported dosage of the $alpha_2$-adrenergic drug xylazine is at a higher proportion than the 2:1 ratio of Telazol® to xylazine recommended by Kreeger et al. (2002), but lower than the 1:1 ratio recommended by the CDFW Wildlife Investigations Lab (2010). Further handling adjustments, described below, were necessary to mitigate the adverse effects of $alpha_2$-adrenergic drugs on respiration and cardiac function.

Our second adjustment involved the leg-binding configuration. The recommended method is to bind the front and back legs on the same side (Wildlife Investigations Lab 2010). However, among females in late gestation this configuration greatly increases pressure on the abdomen, thereby inhibiting its ability to expand during respiration. To alleviate abdominal pressure and enhance respiration, we bound the front legs together and the rear legs together, placing a third strap between the bindings to reduce the risk of injury to attending personnel as a result of kicking (Figure1). An alternative, but less safe, method is to leave the legs unbound during handling; this approach is sufficient, however, only for highly sedated animals.

Figure 1. —Suggested configuration for binding legs of chemically immobilized female black-tailed deer within one month of parturition that are experiencing respiratory distress. The front legs are bound together and the back legs are bound together, with a safety strap anchor providing adequate abdominal expansion for respiration and decreasing the potential for injury to personnel.

Our third adjustment involved body positioning. The recommended position for chemically immobilized deer is left-side lateral to minimize abdominal pressure and aspiration of rumen contents (Wildlife Investigations Lab 2010). However, we found that for animals near parturition this position did not allow for adequate abdominal expansion during respiration and inhibited eructation, which counteracts bloat. When SpO_2 readings dropped below 70% during handling, we immediately moved the animals into a sternal position with the legs folded ventrally, thus enhancing respiration by reducing pressure from the rumen and fetus. The head and neck were also held in an upright position to further promote unlabored respiration (Figure 2). After repositioning, an increase in respiratory rate, blood oxygen saturation, and frequency of eructation was noted. It is imperative that respiratory rate and SpO_2 be monitored continuously during handling, and the adjustments described above should be made as soon as the SpO_2 level drops below 70% for more than two minutes (Kreeger et al. 2002).

Figure 2. —Suggested sternal positioning of chemically immobilized female black-tailed deer within one month of parturition experiencing respiratory depression. The head and neck are held in an upright position to facilitate breathing, the body is held in a sternal position with the legs folded ventrally to provide relief from abdominal pressure caused by the rumen and fetal crowding.

We later continued our experimentation with xylazine dosages to minimize negative respiratory side-effects during a subsequent effort to capture black-tailed deer in September. During this session we captured 5 deer, 2 of which showed signs of respiratory distress during handling. On the first animal, SpO_2 fell to 31%, and immediately after adjusting the body position as described above, SpO_2 rose to ~ 45%; after administration of 100mg tolazoline (0.45 mg/kg), it returned to ~ 85%. SpO_2 for a second individual fell to 15%, and the individual actually stopped breathing. We immediately administered 100 mg tolazoline and SpO_2 again increased to ~85%.

We encourage open discussion among wildlife professionals regarding animal handling and safety, including adjustments to established procedures. There is a natural inclination to not share or discuss negative capture experiences (Jessup 2001), but open discussion of capture experiences — both positive and negative — is in the best interest of minimizing injuries or mortalities among study animals.

We do not recommend chemical capture of deer ≤1 month prior to parturition due to the potential for respiratory distress. However, we recognize there are times when captures are warranted during this period; in those cases the adjustments described above can reduce the likelihood of capture-related mortality. It is also crucial that field personnel understand the pharmacology of the chemical agent(s) they are using; this will allow them to develop strategies, on the spot if necessary, to minimize negative effects on study animals and, thereby, decrease risks of injuries or mortalities. Further research is needed on deer handling procedures, especially body positioning, and the optimal dosages of Telazol® and xylazine, to maintain adequate respiration and cardiac function during chemical immobilization.

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