From the Field: Efficacy of aerial telemetry as an aid to capturing specific individuals—a comparison of 2 techniques

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Abstract Long-term investigations of wild ungulates often dictate that telemetry collars on specific individuals be replaced. We described and evaluated the use of aerial telemetry to facilitate recapture of individual ungulates. Capture of marked animals was much more efficient using fixed-wing telemetry when compared to helicopter telemetry. Total time to capture (P=0.012) and pursuit time (P=0.002) differed significantly, but no difference (P=0.434) in body temperature of mule deer (*Odocoileus hemionus*) occurred at time of capture. Application of fixed-wing telemetry during net-gun captures of ungulates resulted in greater safety for capture crews and study animals and in potentially substantial monetary savings.

Key words aerial telemetry, fixed-wing aircraft, helicopter, mule deer, *Odocoileus hemionus*, safety

Long-term investigations involving capture and immobilization of wild ungulates (Schemnitz 1996) are becoming commonplace. Such endeavors may require that individuals be captured multiple times to obtain estimates of body condition (e.g., Stephenson et al. 2002, Bleich et al. 2003), for reproductive studies (e.g., Testa and Adams 1998), or to replace telemetry collars (e.g., Krausman et al. 2004). Impacts of those actions may range from temporary and subtle behavioral changes to those that affect survival and reproduction (White and Garrott 1990). Thus, development of methods and protocols that are reliable and efficient (Weckerly and Kovacs 1998) and minimize impacts to study animals is important, especially when repeated sampling is necessary.

For the past 7 years, we have utilized fixed-wing aerial telemetry to support helicopter net-gun captures (Krausman et al. 1985) of collared mule deer (*Odocoileus hemionus*). We used a Cessna 185 equipped with an H-antenna on each wing strut (Krausman et al. 1984) to locate radiomarked animals and then directed the helicopter to each individual. This technique appeared to markedly decrease time necessary to implement each capture, but until now, time and fiscal constraints precluded any attempt to quantify potential benefits of that technique. Recently, we were provided the unexpected opportunity to explore that question and designed a simple experiment to compare efficacies of fixed-wing aerial telemetry support of net-gun captures and use of telemetry equipment in the helicopter alone. We also examined physiological responses by mule deer subjected to one or the other of those techniques.

Methods

Our study area was located in Round Valley, Inyo, and Mono counties, California, an area (90 km^2) heavily used by migratory mule deer during winter. Vegetation in Round Valley was composed largely of species typical of the western Great Basin, including bitterbrush (*Purshia tridentata*), sagebrush (*Artemisia tridentata*), and blackbrush (*Coleogyne ramosissima*). The study area has been described in detail by Kucera (1988) and Pierce et al. (2000*a*,*b*); investigations of predator–prey interactions have been ongoing in Round Valley since 1991 (Pierce et al. 2000*a*,*b*), and included multiple captures of mountain lions (*Puma concolor*) and their primary prey, mule deer.

During March 2004 we recaptured 19 mule deer that had been fitted with collars incorporating Global Positioning System (GPS) technology (Krausman et al. 2004). Prior to the experiment, we assigned each of those animals to a group that would involve use of fixed-wing telemetry to guide the helicopter pilot to the animal (FW; $n=9$), or to a second group that would be captured without benefit of fixed-wing telemetry (H; $n = 10$). Locations of deer in group FW were determined by the fixed-wing pilot and then relayed to the helicopter pilot, who used that information to locate each target animal. Additionally, the fixed-wing pilot directed the helicopter to the next proximate deer, and the helicopter pilot used that information to minimize time between captures.

We captured animals assigned to group H without benefit of fixed-wing telemetry, but the helicopter pilot used a multidirectional omni antenna (Samuel and Fuller 1996) and a forward-facing H-antenna mounted in a fixed position to locate target animals. In addition, the helicopter pilot alone determined the most efficient order of animals for capture. Neither pilot had prior knowledge of the distribution of target animals. Weather on both days of the trial was nearly identical, with bright, clear skies and ambient high temperatures of approximately 23°C.

We determined locations of target deer one day prior to capture efficacy trials. We randomly assigned deer to each group (H, FW) within blocks stratified by distance from the centroid of their joint locations to minimize biases (e.g., clumping) inherent in complete randomization of spatial units (Dutilleul 1993). We captured deer assigned to group FW on day 1 and deer assigned to group H on day 2.

We examined total "time to capture" telemetered individuals using a receiver in the helicopter when compared to a fixed-wing aircraft working in tandem with the helicopter; we compared pursuit time in an identical manner. Further, we compared body temperature at time of capture (an index to physiological stress; Kock et al. 1987*a*). We hypothesized that total time to capture, pursuit time, and initial body temperature would be lower among animals captured with the benefit of fixed-wing telemetry than when helicopter telemetry alone was used. Total "time to capture" was defined as the time elapsed from the initiation of a search by the helicopter for a specific individual and began at time of liftoff from the location of the most recently captured animal. Pursuit time was defined as the amount of time necessary to pursue and capture an individual after it was acquired visually as a target by the capture crew. Each day, the helicopter pilot initiated his activities from the centroid of the joint distribution of telemetered animals. The capture crew determined body temperature immediately after netting each animal. Previous experience suggested an increase in capture efficiency when fixed-wing telemetry was utilized; hence, we used a one-tailed *t*-test (Zar 1984) to compare "time to capture," pursuit time, and body temperature.

Results

When using fixed-wing telemetry support, mean "time to capture" ($\bar{x}=5.54\pm3.21$ [SD] min) and mean pursuit time ($\bar{x}=1.53\pm1.14$ min) were significantly less ($t_{17}=2.81$, $P=0.012$, and $t_{17}=3.56$, $P=0.002$, respectively) than those values ($\bar{x}=10.86\pm4.79$ min and $\bar{x}=3.30\pm1.03$ min, respectively) obtained using helicopter telemetry. No difference existed ($t_{15}=-0.80$, $P=0.434$) between initial body temperatures of animals captured with the benefit of fixed-wing telemetry ($\bar{x}=40.2\pm0.6$°C [104.3 ± 1.1°F]) when compared with those captured without ($\bar{x}=39.9\pm0.8$°C [103.8 ± 1.4°F]).

Discussion

Our results indicate that both total time to capture and pursuit time can be substantially reduced by employing fixed-wing telemetry during helicopter capture operations. Such differences can translate into substantial monetary savings and increased safety for helicopter crews. Additionally, lower pursuit times enhance safety of target animals because they are less subject to injuries associated with falls or collisions with inanimate objects, both of which can result in morbidity or mortality (Kock et al. 1987*b*).

Total time to capture and pursuit time are not independent of each other; nonetheless, both have important ramifications for capture efficiency. Mean time to capture likely was lower when fixed-wing telemetry was employed because the helicopter flew directly to the location of the target animal, which then was sighted almost immediately. Similarly, mean pursuit times likely differed because target animals did not have time to respond strongly to the helicopter when it appeared suddenly. In the absence of assistance from the fixed-wing aircraft, additional search time required by the helicopter may have resulted in more extreme evasive maneuvering by the deer that, in turn, increased pursuit time. Results indicating no difference in initial body temperature were equivocal, but may be consistent with a rapid rise in body temperature upon initiation of pursuit and then a slower rate of increase as pursuit continued. Nonetheless, capture strategies that result in lower pursuit times and lower chase times likely will result in fewer physiological challenges to target animals.

Aircraft accidents are a leading cause of mortality among wildlife professionals (Bleich 1983, Sasse 2003), and human safety is of paramount importance during capture and survey activities (Bleich 1983). Safety is a direct function of time aloft (Bleich et al. 2001) and simply put: if one is not airborne, one cannot fall out of the sky. Similarly, fewer hours in the air translate to lower costs (Bleich et al. 2001), and cost-reduction has become a serious consideration among wildlife agencies (Bleich et al. 1982, Bildstein 1998).

Our results indicate that time necessary to capture target animals may be reduced by an average of 50% through the use of fixed-wing telemetry. In small, confined areas, such as Round Valley, savings are proportional to the number of animals captured. Since 1997 we have captured 287 individual female mule deer a total of 455 times ($\bar{x}$ = 1.58 captures/individual). Assuming an average savings of 5 minutes/recapture based on data reported herein, the savings in helicopter time alone was approximately 60 hours. Savings will be disproportionately greater when target animals are distributed widely across the landscape because helicopter telemetry will become less efficient as distances between target animals increase.

Long-term investigations are becoming more commonplace and involve the commitment to repeatedly capture specific individuals. Further, increased use of "store-on-board" GPS collars that must be physically retrieved to download data is occurring. Moreover, decreased hazards to animals and personnel are associated with fewer hours spent pursuing animals. When these points are considered, investigators are well-advised to consider the benefits of fixed-wing telemetry to support helicopter capture efforts that target specific individuals.

Costs of operation for fixed-wing aircraft are much lower than those for helicopters, and generally fewer individuals (at most, a pilot and one observer) participate in telemetry flights when compared to helicopter capture crews (pilot, shooter, and handler). The fiscal and safety benefits associated with the use of fixed-wing telemetry to support helicopter captures easily can be estimated by those planning capture operations, and investigators may wish to consider them prior to project implementation.

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