BODY CONDITION OF RADIO-COLLARED MULE DEER WHILE INJURED AND FOLLOWING RECOVERY

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ABSTRACT—We evaluated levels of body fat, body condition scores, live weight, and fetal rates of mule deer (*Odocoileus hemionus*) compromised by injuries from radiocollars and compared them to non-injured animals before and after those injuries had healed. Compromised animals had lower values for all parameters at the time injuries were discovered, and that pattern repeated itself 4 mo later when subjects again were examined. Investigators must consider ramifications of their activities for research subjects, as well as for research results.

RESUMEN—Evaluamos los niveles de grasa corporal, valores totales de la condición corporal, peso del animal vivo, y tasas fetales del venado buro (*Odocoileus hemionus*) comprometidos por heridas sufridas a consecuencia de radio-collares, y los comparamos con animales no heridos antes y después de que las heridas sanaran. Los animales comprometidos tuvieron valores más bajos en todos los parámetros en el momento en que las heridas fueron descubiertas, y ese patrón se repitió 4 meses más tarde cuando los sujetos fueron examinados nuevamente. Los investigadores deben considerar las ramificaciones de sus actividades de investigación en los sujetos, al igual que los resultados de las mismas.

Investigators should minimize impacts to research animals for reasons that are ethical (Schmidt and Bruner, 1981; Cuthill, 1991), legal (Morton et al., 2003), political (Bleich et al., 1990; Bleich et al., 1994), and pragmatic (White and Garrott, 1990; Bleich et al., 1994). One common activity that can compromise research subjects is the attachment of radiotelemetry

TABLE 1—Mean (± *SD*) depth (cm) of rump fat (an index to total body fat), body condition score, live weight (kg), and fetal rate of adult female mule deer (*Odocoileus hemionus*) from Round Valley, Inyo and Mono counties, California, exhibiting injuries from telemetry collars compared to those without injuries in November 2002, when lesions were discovered and collars removed, and 4 mo later in March 2003, after lesions had healed.

Month	Status	Depth of rump fat	Condition score	Live weight	Fetal rate
November[1]	Injured	0.61 ± 0.08	7.4 ± 0.8	51.3 ± 1.9	
	Non-injured	1.40 ± 0.20	9.2 ± 0.3	54.0 ± 0.7	
March[2]	Injured	0.43 ± 0.66	8.5 ± 1.5	51.3 ± 2.7	1.3 ± 0.6
	Non-injured	0.79 ± 0.61	8.8 ± 1.0	54.1 ± 5.1	1.6 ± 0.5

[1] Data are for 8 injured deer and 57 others that wore radiocollars but were not injured.

[2] Data are for 3 deer from which collars were removed in November and that had healed from injuries, and 13 animals that had never been captured and did not wear radiocollars.

collars (Bleich et al., 1990; Krausman et al., 2004). It is important that investigators obtain a proper fit of radiotelemetry collars (Kenward, 2001) because of the potential for study animals to be injured if collars do not fit properly (Bleich et al., 1990). Furthermore, it is important to publish both positive and negative aspects of radiomarking, because much remains to be learned and conveyed about effects of that practice on study animals (Fuller et al., 2005).

Recently, Krausman et al. (2004) described injuries to mule deer (*Odocoileus hemionus*) and mountain sheep (*Ovis canadensis*) that resulted from telemetry collars; among mule deer, wounds exhibited all stages of ulcer formation except bone involvement. Those lesions and associated bacterial infections were severe enough that the collars were removed from affected animals when they were recaptured as part of long-term ecological investigations in Round Valley, Inyo and Mono counties, California (Pierce et al., 2000; Pierce et al., 2004). Before release, a numbered and color-coded plastic tag was placed in one ear of each compromised animal to ensure that it would be identifiable in the future. Animals handled during this investigation were captured with a hand-held net gun fired from a helicopter as described by Krausman et al. (1985). With the exception of individuals captured for the first time, all had been caught at least once (range 1 to 7), but no more than twice in any 12-month period.

We used analysis of variance on rank-transformed data (Conover and Iman, 1981) to test for differences ($P < 0.10$) in depth of rump fat (an index to percent body fat; Stephenson et al., 2002), body condition score (adapted from Gerhart et al., 1996), and live weight between radiocollared female deer exhibiting injuries and those without (Table 1). Four months after collars were removed from injured animals, we again recaptured them and compared mean depth of rump fat, body condition score, live weight, and fetal rate of recovered deer with deer that had never been collared and, hence, had not been injured. We used deer without collars for this comparison to reduce biases that might occur if an unrecognized cost (Côté et al., 1998) was associated with telemetry collars or capture history. This approach might have underestimated the cost of previous captures, but we assumed any such influences were negligible when compared to those associated with injuries.

Ultrasonography (Stephenson et al., 2002) revealed that deer from which collars were removed had lower ($F_{1,62} = 3.829$, $P = 0.055$) reserves of body fat than deer that did not exhibit lesions (Table 1). Similarly, body condition scores were lower ($F_{1,63} = 4.735$, $P = 0.033$) among compromised deer than among uninjured controls. We were not able to detect a difference between live weights of injured and uninjured animals ($F_{1,58} = 2.558$, $P = 0.115$).

We captured and examined 3 of the ear-tagged deer 4 mo after we had removed collars; by then, lesions had healed completely. Small sample sizes precluded statistical comparisons, but mean fetal rate (number of fetuses/female) determined by ultrasonography (Stephenson et al., 1995), depth of rump fat, condition score, and live weight were lower than for uncollared females captured during the same week (Table 1).

Significantly lower values for indicators of body condition of injured animals in November are consistent with the hypothesis that substan-

tial costs were incurred by those individuals. Although sample sizes were inadequate for statistical comparisons, a similar pattern was observed during March and, when combined with information on fetal rates (Table 1), our observations suggest that negative effects persisted following removal of collars. Although deer would not be expected to gain in condition during winter, relatively lower fat reserves among injured deer have important implications for overwinter survival (Mautz, 1978).

Our results strongly imply that there are costs associated with injuries to study animals and reaffirm the notion that actions of investigators have important implications for research results. Although we did not examine the question, there also might be heretofore unrecognized costs associated with telemetry collars, and that possibility warrants consideration by investigators (Côté et al., 1998). Investigators should ensure that marking devices do not influence outcomes (White and Garrott, 1990). Injuries caused by marking devices can affect subjects in a variety of ways (Murray and Fuller, 2000; Withey et al., 2001), including changes in behavior, foraging ecology, energy balance, body condition, reproduction, recruitment, and survival. Ultimately, all of those can impact reproductive success, which has serious implications for individual study animals (Bleich et al., 2003), and can lead to biased research results.

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