Effects of tooth extraction on body condition and reproduction of mule deer

Vernon C. Bleich, Thomas R. Stephenson, Nathan J. Holste, Ian C. Snyder, Jason P. Marshal, Philip W. McGrath, and Becky M. Pierce

Abstract The removal of an incisiform tooth to determine age in live cervids has generated disagreement among wildlife professionals, but few data are available to resolve whether or not study animals are affected by that technique. We found no effect of tooth removal on body mass, percent body fat, pregnancy rate, or fetal rate among mule deer (*Odocoileus hemionus*) inhabiting a Great Basin winter range. Results from a population of deer in the Sonoran Desert were similar. This information is provided to assist others contemplating tooth removal as a method to determine age in cervids and to help resolve the current controversy.

Key words aging, California, mule deer, *Odocoileus hemionus*, technique, tooth extraction

Removal of an incisiform canine tooth from live white-tailed deer (*Odocoileus virginianus*) or mule deer (*O. hemionus*) to determine age is a simple (Nelson 2001, Swift et al. 2002) and controversial (Festa-Bianchet et al. 2002, Nelson 2002) procedure. Festa-Bianchet et al. (2002) recently argued that tooth removal was unethical and noted that the procedure could affect feeding efficiency, with resultant influences on body mass, reproduction, and long-term survival. Further, Festa-Bianchet et al. (2002) suggested that tooth removal could introduce biases to long-term investigations that might more than offset benefits of knowing ages of adult animals. Moreover, those authors stated that the onus of demonstrating that tooth removal has no harmful consequences falls upon investigators using that technique.

Nelson (2002) responded to that challenge and provided some data useful in resolving the controversy. Specifically, Nelson (2002) conducted a number of retrospective analyses and reported no discernible short-term effects of tooth removal on mortality, body mass, or fawn production. He also provided limited information on bite size and age-specific effects of tooth removal. Those findings were consistent with the hypothesis that tooth removal does not have a significant effect on study animals.

It will be many years before investigators can ascertain whether tooth removal influences timing of senescence in cervids (Festa-Bianchet et al. 2002), and specific experiments will be required to resolve that issue. In this paper we report results that may facilitate further understanding and help resolve questions about potential impacts of tooth removal. We use data from a large sample of mule deer from which an incisiform tooth had been removed (extracted deer) and compare them to data from another sample of mule deer with complete incisor arcades (intact deer) to test for effects of tooth removal on body mass, body condition, pregnancy rates, and fetal rates, all of which may be influenced by nutrient intake.

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Methods

During March and April 2001, we used a helicopter and net-gun (Krausman et al. 1985) to capture female mule deer inhabiting a Great Basin winter range in Round Valley, Inyo and Mono counties, California, and additional animals inhabiting the Sonoran Desert, Imperial County, California (Swift et al. 2002). We removed an incisiform canine from each animal following the methods of Swift et al. (2002). We fitted each animal with a telemetry collar (MOD 505, Telonics, Mesa, Ariz.). During March 2002, we recaptured deer sampled during 2001 in Round Valley, and during June 2002 we recaptured deer sampled during 2001 in the Sonoran Desert. During 2002 we also sampled animals from both study areas that had complete incisor arcades. All animals were part of ongoing, long-term ecological investigations (Pierce 1999, Pierce et al. 2000*a*, *b*; Marshal et al. 2002), and detailed descriptions of the study areas have been provided elsewhere (Andrew et al. 1999, Pierce et al. 2000*a*, *b*). We followed animal-handling protocols (Jessup et al. 1986) approved by the California Department of Fish and Game.

We determined body mass (nearest 0.5 kg), absolute body condition (percent ingesta-free body fat), reproductive status (pregnant, not pregnant), and number of fetuses for nearly all individuals. We used ultrasonography to determine reproductive status and fetal rates (Stephenson et al. 1995, Drew et al. 2001) and to estimate percent total body fat (Stephenson et al. 2002). We assigned deer to age categories (yearling, adult) based on tooth replacement patterns, body mass, and body conformation. We eliminated from analyses all yearlings and 1 abnormally small (40-kg) and, based on tooth wear, apparently very old adult deer.

We divided our sample into 2 independent groups: deer captured in the Great Basin and deer captured in the Sonoran Desert. For deer from the Great Basin, we used one-way Analysis of Variance (ANOVA; Zar 1984) on rank-transformed data (Conover and Iman 1981) to test for differences in mass of intact and extracted deer. Similarly, we used ANOVA to test for differences in percent body fat and in fetal rates, and a *G*-test to determine whether differences existed in pregnancy rates. Because of the small sample of extracted deer from the Sonoran Desert, we present only summary statistics for those animals. To control for potentially confounding effects of inter-annual differences in forage quality on deer body condition, we limited our comparisons to data obtained during 2002 rather than conducting before-and-after comparisons. Means and standard errors are presented as descriptive statistics unless otherwise noted; for all tests, we set alpha at 0.05.

Results

Among deer from the Great Basin, no difference ($F_{1,100}=1.064$, $P=0.305$) existed in the mean mass (kg) of intact ($\bar{x}=50.1\pm0.6$; $n=33$) versus extracted ($\bar{x}=50.8\pm0.4$; $n=69$) deer. Similarly, no difference ($F_{1,102}=0.295$, $P=0.588$) existed in percent body fat between intact ($\bar{x}=6.62\pm0.19$; $n=33$) versus extracted ($\bar{x}=6.37\pm0.13$; $n=71$) deer, or between fetal rates of intact ($\bar{x}=1.75\pm0.10$; $n=32$) versus extracted ($\bar{x}=1.56\pm0.07$; $n=68$) deer ($F_{1,98}=2.626$, $P=0.108$). Further, pregnancy rates of intact (93.9%; $n=33$) and extracted (94.4%; $n=71$) deer were nearly identical ($G_1=0.007$, $P=0.931$).

No apparent differences in biological parameters occurred between extracted ($n=3$) and intact ($n=19$) deer (Table 1) from the Sonoran Desert. On average, extracted deer weighed less and had slightly less body fat than intact deer, but extracted deer exhibited higher pregnancy rates and fetal rates than intact deer.

Discussion

The debate over tooth extraction (Festa-Bianchet et al. 2002, Nelson 2002) is founded as much in philosophical differences as it is in concerns over the impact(s) of tooth extraction on ungulate ecology; our focus here is on ecology. Nelson (2002: 285) posited the notion that the debate would "provide additional grist for thought, discussion, and ideas for future research." In response, we

Table 1. Descriptive statistics (means, standard deviations, and ranges) for biological parameters of intact (n = 19) and extracted (n = 3) mule deer captured in the Sonoran Desert, Imperial County, California, June 2002.

Status	Mass (kg) (range)	% body fat (range)	Fetal rate (range)	Pregnancy rate (%)
Intact	64.2 ± 5.2[a] (54.1–73.2)	12.26 ± 4.44 (5.68–21.10)	1.79 ± 0.54 (0–2)	94.7
Extracted	59.2 ± 4.3 (55.9–64.1)	11.22 ± 3.62 (8.05–15.17)	2.00 ± 0.0	100.0

[a] Data on mass are for 16 intact deer.

compared 4 biological parameters from extracted and intact deer from disparate environments and controlled for potential interannual differences in effects of climate and forage quality on deer body condition. Our findings, when combined with the negative results reported by Nelson (2002), suggest a repeatable pattern (Robinson and Wainer 2002) that has implications for resolving the issue of ecological effects of tooth extraction on ungulates; consistent results from replicated studies are the primary means by which an understanding of such effects will be obtained (Johnson 2002*a*, *b*). Collectively, our results and those of Nelson (2002) are consistent with the hypothesis that tooth removal does not negatively affect survival, body mass, or fawn production over short time periods. Moreover, none of our findings suggest that tooth removal will influence outcomes of ecological or behavioral investigations.

The extreme inaccuracy of using tooth replacement and wear to determine age in deer recently was pointed to by Gee et al. (2002), who questioned the efficacy of that time-honored technique. Given the importance of age-specific reproductive success to demography (e.g., Clutton-Brock et al. 1982, Nelson and Mech 1990, Festa-Bianchet et al. 1995, Jorgensen et al. 1997) and, ultimately, evolutionary processes (Clutton-Brock 1988), future investigators are likely to view tooth extraction as a useful method of determining age. Investigators are reminded, however, that techniques involving counts of cementum annuli are not without potential problems (Cook and Hart 1979, McCullough 1996).

Our purpose has been to collect demographic data and provide information that is potentially useful in resolving a controversy, but additional tests will be necessary before reaching closure (Johnson 2002*a*, *b*). Further analyses of age-specific differences may be warranted because old animals could be more susceptible to negative influences than younger deer (Festa-Bianchet et al. 2002). There may be effects on animals that cannot be detected over short time periods, and only carefully designed, long-term research will answer such questions. Ultimately, impacts of tooth removal might best be measured by examining reproductive success of extracted and intact deer. Final resolution of the question will depend on additional investigations that, out of necessity, involve a technique that has generated controversy among professional wildlife biologists.

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