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Effects of SpayVac® on Urban Female White-Tailed Deer Movements

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Abstract

*High white-tailed deer (*Odocoileus virginianus*) densities in urban areas typically result in human–wildlife conflicts (e.g., deer–vehicle collisions, transmission of disease to humans, and vegetation damage). Controlling deer densities via fertility control generally is more acceptable than lethal removal in many urban areas and can reduce conflicts by stabilizing deer numbers. Contraceptive vaccines that use PZP (porcine zona pellucida) proteins as antigens have been used for many years and generally are regarded as safe and effective. Side effects of immunocontraception may be repeated estruses, an extension of the breeding season, and increased movements and ranges of immunized deer. We evaluated the effects of SpayVac™, a long-lasting, single-dose PZP vaccine on ranges and movements of female white-tailed deer at the Lyndon B. Johnson Space Center near Houston, Texas, USA. We captured, treated, and radiomarked 38 female deer with SpayVac (treatment) and injected 11 deer with a placebo (control). Fawning rates for treated and control deer were 0% and 78%, respectively. We observed no difference in the movements and ranges of SpayVac- versus placebo-treated deer: annual ranges (95% probability area) between treated ($\bar{x} = 82 \pm 7$ ha) and control ($\bar{x} = 77 \pm 14$ ha) deer, core areas (50% probability area) between treated ($\bar{x} = 11 \pm 1$ ha) and control ($\bar{x} = 11 \pm 3$ ha) deer, and daily movements treated ($\bar{x} = 430 \pm 1.5$ m) and control ($\bar{x} = 403 \pm 3.6$ m) deer. However, we did not evaluate the potential effect of immunized females on ranges and movements of male white-tailed deer. Increased ranges and movements may be more pronounced for males than for females.* (WILDLIFE SOCIETY BULLETIN 34(5):1430–1434; 2006)

Key words

human–wildlife conflicts, immunocontraception, movements, Odocoileus virginianus*, ranges, SpayVac®, Texas, urban, white-tailed deer.*

White-tailed deer (*Odocoileus virginianus*) numbers in the United States have increased in recent years, particularly in urban landscapes where traditional means of population control are difficult to implement (McShea et al. 1997). High deer densities typically result in human–wildlife conflicts, such as deer–vehicle collisions (DVCs), transmission of disease to humans, or damage to ornamental vegetation (Baker and Fritsch 1997, McShea et al. 1997, Conover 2002). Deer–vehicle collisions are of particular concern because they are costly in terms of property damage or loss and human safety (Conover et al. 1995). Although several strategies for reducing DVCs have been used with some success (e.g., fencing [Peterson et al. 2003], speed reduction [Conover 2002], over- and underpasses [Clevenger and Waltho 2000]), simply controlling deer numbers potentially could reduce the risk of DVCs in urban areas (Etter et al. 2002, Lopez et al. 2003, Porter et al. 2004). Identifying methods of population control that are socially acceptable, effective, and applicable in urban areas is a challenge for wildlife biologists in the 21st century (Walter et al. 2002, Rutberg et al. 2004).

White-tailed deer at the National Aeronautics and Space Administration's Lyndon B. Johnson Space Center (NASA-JSC), Texas, USA, are regarded as a potential safety hazard. Center administrators began efforts to minimize any detrimental effects due to a burgeoning deer population. Reports of human–wildlife conflicts have increased over the last 5 years (G. Wessels, NASA, personal communication). Recent population studies estimate approximately 167 deer occupy the 552-ha facility, which is surrounded by urban development (Hernandez 2005). Lethal techniques, such as hunting or sharpshooting, are effective measures in controlling overabundant deer populations (DeNicola et al. 1997, Hansen and Beringer 1997, McShea et al. 1997); however, use of firearms within the JSC facility is restricted because of the surrounding residential areas and because of other safety concerns at JSC (Whisenant 2003). Therefore, use of contraceptives for the JSC deer population was viewed as the only feasible alternative in controlling deer numbers (Whisenant 2003).

Fertility control recently has gained public acceptance (Stout et al. 1997, Chase et al. 1999) and has been advocated as a potential alternative to lethal control (Kirkpatrick and Turner 1985, Warren 1995, Rutberg 1997). Historically, a number of approaches to fertility control have been tested, including hormone implants, contragestational agents,

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surgical procedures, and contraceptive vaccines (Fagerstone et al. 2002). Of these, contraceptive vaccines that use porcine zona pellucida (PZP) proteins as antigens have become the most widely accepted and are generally regarded as humane and safe (Rutberg et al. 2004); however, the practicality of PZP vaccine generally is limited because of the need for multiple boosters (DeNicola et al. 1997, Miller et al. 2000, Fraker et al. 2002).

Recently, Fraker et al. (2002) reported 100% contraceptive efficacy for feral fallow deer (*Dama dama*) treated with SpayVac® over a 3-year period. SpayVac is unique in that it can be administered once and works over a number of years without boosters (Fraker et al. 2002). One potential side effect in the use of SpayVac and other PZP vaccines is the increased number of estrous cycles that result when treated females fail to become pregnant, which causes them to remain sexually active beyond the usual breeding season (Fraker et al. 2002). Miller et al. (2000) observed this behavior in penned white-tailed deer immunized with a PZP vaccine. The potential for increased and extended movements of treated female deer is a concern for JSC managers because of the potential increase in human–wildlife conflicts. Wildlife managers interested in using SpayVac for controlling urban deer fertility need to understand the potential side effects of the vaccine on deer movements and ranges (i.e., potential increased range size and movement of treated deer). Although ranges and movements of suburban white-tailed deer have been reported (e.g., Porter et al. 2004), studies evaluating the effects of PZP vaccines, including SpayVac, on the movements of white-tailed deer populations are lacking.

The objective of our study was to determine the effects of SpayVac on female white-tailed deer movements and ranges. We predicted that ranges and movements would increase for immunized females because of the possible extended breeding season. This information will allow wildlife managers to better understand the effect SpayVac and other PZP contraceptives have on urban white-tailed deer.

Study Area

The JSC was located in Clear Lake, Texas, southeast of the Houston metropolis. The study area was completely enclosed by a 1.8-m chain-link fence topped by 3 strands of barbed wire projecting outward. Recent population estimates reported 167 (160–174) deer occupied the facility (Hernandez 2005). Because of the fence enclosure, emigration and immigration were limited during this study. The JSC was characterized by improved pasturelands and scattered park-like areas with oaks (*Quercus* spp.), hickories (*Carya* spp.), and pines (*Pinus* spp.) intermixed among numerous roads and buildings. Approximately 15,000 people were employed at JSC, and traffic within the compound was highly regulated (e.g., low speed limits [40 km/hr]).

Methods

We trapped female white-tailed deer at JSC in July–November 2003 and July–November 2004 using drop-nets (Lopez et al. 1998) and portable drive-nets (Silvy et al. 1975, Locke et al. 2004). We physically restrained deer (we used no drugs) with a holding time of 10–15 minutes, during which we recorded sex, age, body weight, body condition, and capture location. We permanently marked all captured deer with an ear tattoo (Silvy 1975). Deer capture and handling protocols were approved under Texas A&M University Animal Care and Use Committee Permit 2003–01.

Prior to release, we fitted all deer with a plastic neck collar (6 cm wide) equipped with a battery-powered, mortality-sensitive radiotransmitter (150–152 MHz, 115 g; Advanced Telemetry Systems, Isanti, Minnesota). We affixed numbered plastic ear tags to each side of the neck collar for easy identification. Prior to release and marking of all trapped deer, we injected animals intramuscularly in the rump with either 1.0 mL of SpayVac containing 200 μg of PZP encapsulated within liposomes in an emulsion containing the adjuvant AdjuVac (National Wildlife Research Center, United States Department of Agriculture, Fort Collins, Colorado; treatment) or 1.0 mL of a placebo containing liposomes and AdjuVac (control). We located radiomarked deer between July 2003 and May 2005 via homing 3–4 times/week using a receiver and portable antenna (White and Garrott 1990). We relocated deer within a randomly selected 4-hour segment in each 24-hour period sampled. We monitored females more intensively during the fawning season to determine fawning rates of treated and control deer (Hernandez 2005). We entered all radio locations into a geographical information system using ArcView (version 3.2; ESRI, Redlands, California) and Access (Microsoft, Redmond, Washington).

We calculated annual and seasonal deer ranges (95% probability area) and core areas (50% probability area) using a fixed-kernel home-range estimator (Worton 1989, Seaman et al. 1998, 1999) with the animal movement extension in ArcView (Hooge and Eichenlaub 1999). We used calculation of the smoothing parameter (kernel width) as described by Silverman (1986) in generating kernel-range estimates. We used only deer with >50 locations to calculate annual estimates as recommended by Seaman et al. (1999). We defined seasons in our study based on the biology of white-tailed deer as follows: prebreeding (Jul–Oct), breeding (Nov–Feb), and fawning (Mar–Jun). We calculated seasonal daily movements and ranges for radiomarked deer with >20 locations/individual (Seaman et al. 1999). We compared differences in ranges, core areas, and mean daily movements by treatment and season using an analysis of variance, followed by Tukey's test for multiple comparisons to separate means when F-values were significant ($P < 0.05$; Ott 1993).

Results

We captured and radiomarked 49 adult females at JSC. Of these, we injected 38 with SpayVac (treatment) and 11 with a placebo (control). We censored only 2 deer in our analysis (both treated deer) due to natural mortalities (Hernandez

2005). Based on fawning rates of treated ($n = 36$) and control deer ($n = 11$), we observed SpayVac to be 100% effective at preventing pregnancy when deer were inoculated >30 days prior to the breeding season (Hernandez 2005). Fawning rate for control deer was 78%.

Between July 2003 and May 2005, we obtained 4,661 locations for the radiomarked deer. We observed no differences ($P = 0.733$) in annual ranges (95% probability area) between treated ($\bar{x} = 82 \pm 7$ ha) and control ($\bar{x} = 77 \pm 14$ ha) deer. Core areas (50% probability area) also did not differ ($P = 0.944$) between treated ($\bar{x} = 11 \pm 1$ ha) and control ($\bar{x} = 11 \pm 3$ ha) deer. Daily movements did not differ ($P = 0.419$) between treated ($\bar{x} = 430 \pm 1.5$ m) and control ($\bar{x} = 403 \pm 3.6$ m) deer. Although we found differences among seasonal and core ranges ($P = 0.001$), no differences ($P = 0.733$) existed within season between treated and control deer (Fig. 1). Similarly, differences ($P = 0.035$) existed among seasonal movements but we observed no differences ($P = 0.419$) within season between treated and control deer (Fig. 1).

Discussion

We predicted that a potential side effect in use of SpayVac could be increased ranges and movements due to the multiple estrous cycles of treated females (Miller et al. 2000, Fraker et al. 2002). Although ranges and movements were slightly larger for females treated with SpayVac, we found no differences between treated and control deer in our study (Fig. 1). There may be several factors that explain our study findings. First, the lack of differences observed between treated and control deer ranges and movements may be due to the relatively small, enclosed area at JSC (552 ha), which would restrict the increase in ranges and movements for females treated with SpayVac. For all practical purposes, urban deer within the JSC complex cannot expand their ranges beyond the property boundaries. Intraspecific competition at high deer densities would further restrict deer movements and ranges. Kilpatrick et al. (2001) reported female white-tailed deer display a strong fidelity to their ranges despite changes in population density or other perturbations (i.e., hunting pressure [Kilpatrick and Lima 1999], hurricanes [Labisky et al. 1999]). Despite treatment of females with SpayVac, ranges and movements may not increase immediately due to site fidelity. Finally, treated females may not have exhibited an extended estrus as previously reported in other populations (Miller et al. 2000, Fraker et al. 2002) or it may not have contributed to increasing ranges and movements.

Thus, for the contraceptive program at JSC, the use of SpavVac likely will not increase ranges and movements of female deer. This may not be the case in other areas where an expansion of deer movements may not be as restricted. We did not evaluate the potential effect of immunized females on male ranges and movements in our study. Unlike those of females, movement and ranges of males may increase due to continuously pursuing females in estrus. Urban wildlife biologists should be aware of potential side effects on male white-tailed deer.

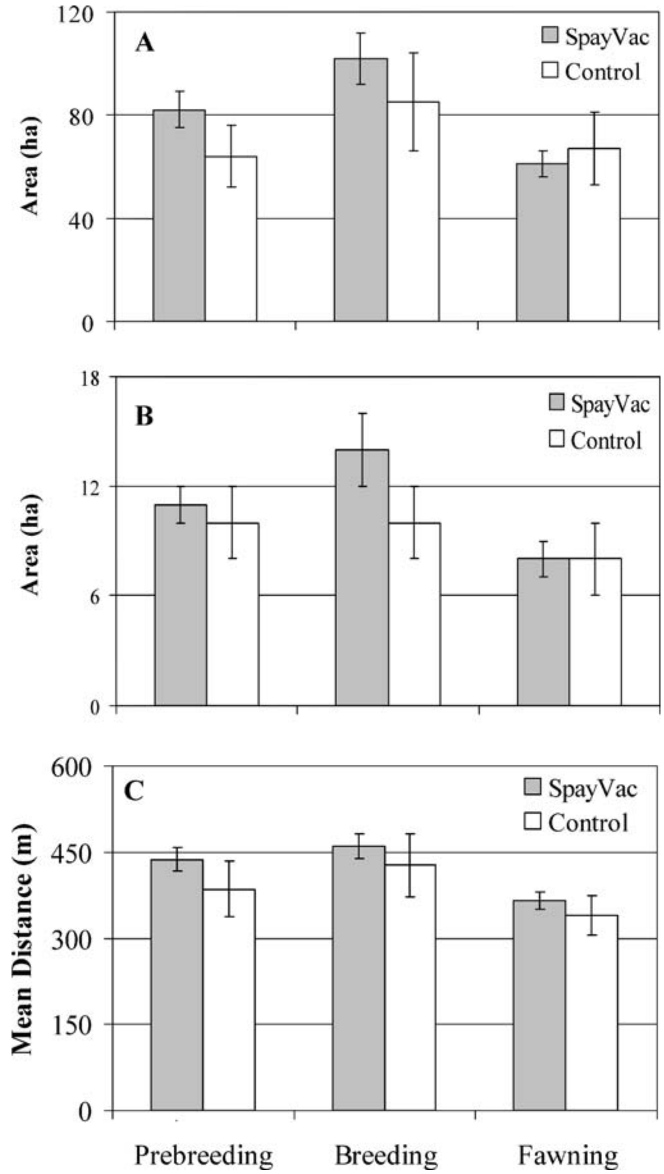

Figure 1. Seasonal comparison of (A) ranges (95% probability area), (B) core areas (50% probability area), and (C) mean movements of female white-tailed deer treated with SpayVac® or a control at the Lyndon B. Johnson Space Center, Houston, Texas, USA, during 2003 and 2004. Whiskers represent SE.

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