Survival and Movements of Translocated White-tailed Deer in South Texas

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Abstract: In south Texas, white-tailed deer (*Odocoileus virginianus*) translocations have become a common technique for non-lethal means of deer removal with the implementation of a Trap, Transport, and Transplant (TTT) permit program. However, the effectiveness of TTT as a management tool has not been evaluated. We monitored survival, movements, and body condition of 51 adult white-tailed deer from two translocations to two 2,000-ha south Texas properties, one of which was partially enclosed by a 2.5-m net-wire fence. Annual survival of all translocated deer was lower in the partially fenced property (64%) compared to the unfenced property (80%), but overall survival was similar to survival rates of adult native south Texas deer reported in previous studies (68%–74%). As expected, more deer left the unfenced property (52%) than the partially enclosed property (14%). Cumulatively, 40% of deer survived and remained on the release area after one year. Young (1.5–3.5 years old) translocated males had below average antler gain, body condition scores, and rump fat measurements 6–8 months post-release compared to resident males. Results of this study indicate reasonable survival rates can be achieved, but released deer may not remain in the vicinity of the release site and tend to have below-average body condition 6–8 months after release compared to native deer.

Key words: Odocoileus virginianus, survival, Texas, translocation, white-tailed deer

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Translocations have played a role in white-tailed deer (*Odocoileus virginianus*) management since the 1870s (Mackie 2000). Early translocations focused on restoration of extirpated populations (Williamson 1987). Currently, deer are translocated for a variety of reasons, including augmenting low-density populations (O'Bryan and McCullough 1985), removal of deer from areas of high density (Jones and Witham 1990, Cromwell et al. 1999), or to improve perceived deficiencies (e.g., antler size) in intensively-managed populations.

In general, public support for deer translocations is high because translocations represent an alternative to lethal methods of population control (Ishmael et al. 1995); the public's implicit assumption being that re-located deer experience high survival. Translocations performed for population control or intensive management also assume that deer remain in the vicinity of the release site; this criterion is often defined loosely relative to the size of the managed area.

Several researchers have evaluated post-translocation survival and movements of white-tailed deer (Hawkins and Montgomery 1969, Jones et al. 1997). These studies, as well as retrospective assessments of translocations using genetic markers (Ellsworth et al. 1994, Leberg and Ellsworth 1999, DeYoung et al. 2003) indicate that not all translocations are successful due to emigration or death. Reasons for success or failure of specific translocations are uncertain, but may involve some combination of conditions during capture, similarity of capture and release sites, source stocks used, animal condition, and possibly others. For example, some deer translocation studies used capture methods such as rocket-nets (Jones and Witham 1990, Cromwell et al. 1999), Stephenson box traps (Jones et al. 1997), and chemical immobilization (Hawkins and Montgomery 1969) that may have high rates of capture-related mortality or negative effects on near-term survival and performance of translocated deer (Webb et al. 2008). Furthermore, in south Texas, drought conditions can cause fluctuations in the amount and quality of food available, a potentially serious challenge for translocated animals.

Interest in survival and performance of translocated deer in Texas has increased during the past decade with implementation of a Trap, Transport, and Transplant (TTT) permit program administered by the Texas Parks and Wildlife Department (TPWD). Landowners who are granted a TTT permit may capture and translocate wild white-tailed deer if capture and release sites are biologically suitable. Number of permits issued annually increased from 40 to 77 during 2004–2007 and the number of deer trapped and relocated increased from about 1,700 to >4,500 (R. McGillicuddy, TPWD, personal communication). Number of deer trapped and relocated in the 1990s may have been higher prior to additional restrictions aimed at ensuring capture sites were free of chronic wasting disease. Helicopter net gunning (Barrett et al. 1982) is used ~72% of the time as the trapping method (R. McGillicuddy, TPWD, personal communication). Helicopter net gunning results in lower capture mortality than alternative methods of capture involving prolonged restraint or chemical immobilization (Webb et al. 2008), which may equate to better post-translocation survival or performance.

Although the number of deer relocated under the Texas TTT program continues to rise, no formal post-translocation evaluations have been performed. Our objectives were to conduct a preliminary assessment of deer movements, survival, and body condition from two separate translocations in south Texas performed to augment low-density populations (e.g., below carrying capacity). The stock sources originated in different ecoregions of the state and the release areas represent different intensities of management (e.g., partially enclosed vs. free-ranging).

Study Areas

Translocation 1

Webb County (capture site) was in the Rio Grande Floodplain ecoregion, and was characterized by brushy species such as mesquite (*Prosopis glandulosa*) and blackbrush (*Acacia rigidula*) (EPA 2008). Annual precipitation averaged 565 mm (NOAA 2008). Calhoun County (release site) was in the Northern Humid Gulf Coastal Plains ecoregion characterized by grasslands and scattered oak (*Quercus* spp.) savannahs (EPA 2008). Annual precipitation averaged 1124 mm (NOAA 2008). The release site had few resident deer due to historically high harvest rates and low recruitment rates (S. Mitchell, TPWD, personal communication) on adjacent properties. Helicopter counts revealed a deer density of 165 ha/deer in 2002 and 140 ha/deer in 2003 during the two years prior to translocation. In 2004, the release site was enclosed by a 2.5 m net-wire fence on two sides and water of the upper Laguna Madre and associated bays on the other sides.

Translocation 2

The capture and release areas were located in Kleberg County, part of the Southern Subhumid Gulf Coastal Prairie ecoregion (EPA 2008). Typical brushy plants include huisache (*Acacia farnesiana*) and mesquite. Average annual precipitation was 718 mm, but highly variable among years (NOAA 2008). Trends in relative density estimated from aerial surveys suggested that the release area (17.2 ha/deer) contained a lower deer density than the capture area (8.4 ha/deer), probably due to differences in recruitment and harvest during previous years. The capture and release sites contained only standard livestock fencing <1.25 m in height.

Methods

Both translocations were approved with Texas Parks and Wildlife Scientific permits SPR-0496-773 and SPR-0907-1424.

Translocation 1

We captured 15 female and 7 male adult white-tailed deer in Webb County via helicopter net gunning (Barrett et al. 1982) during March 2005. Most TTT translocations occur in March because females are pregnant and post-rut males are replenishing energy reserves expended during rut and may be more likely to remain in the vicinity of the release area. March is also when males begin to cast their antlers, affording translocated males an opportunity to integrate into the social structure of the population prior to having hardened antlers the following fall. We estimated age based on tooth replacement and wear (Severinghaus 1949) and recorded gross Boone and Crocket antler scores (Nesbitt and Wright 1981). We removed antlers with a hand-held saw about 2.5 cm above the burr to prevent injuries during transport. We marked each animal with color-coded, numbered plastic livestock ear tags and attached VHF radio-collars (Advanced Telemetry Systems, Inc., Isanti, Minnesota) equipped with a mortality sensor. We placed deer in a covered trailer and relocated them about 240 aerial km northeast (approximately three hrs drive) to a private ranch in Calhoun County. Ambient temperatures reached 32 C during transport. All deer were released inside one ~2,000 ha pasture. We monitored radio-collared deer once per month for 12 months to monitor movements and survival. We obtained confidence intervals on survival rates by using a normal approximation for a binomial distribution (Fleiss 1981). We recaptured three males in December 2005, nine months after translocation to adjust radio collars. We recorded antler measurements for their first set of antlers produced in their new environment. Two of the 2.5-year-old recaptured males had broken main beams so we used measurements from the unbroken antler to estimate missing values for the broken antler.

Translocation 2

In March 2007, we captured 29 male deer in Kleberg County via helicopter net gunning. We recorded age and antler size, removed antlers, and attached ear tags and VHF radio-collars on 25 males using the same procedures as described above. We affixed radio-ear tags (Advanced Telemetry Systems, Inc.) on the remaining two males. Two males were not found due to either extreme dispersal or radio-collar failure. Those two males were omitted from analysis. Ages of two males were not recorded. We placed deer in a covered trailer and relocated 30–50 aerial km east (approximately 45 minutes drive) on an unenclosed private ranch. Ambient temperatures reached 25 C at midday during transport. All deer were released in one 2,000-ha pasture.

We monitored deer monthly for 12 months. We used raw data of deer that survived and died to calculate survival rates. A normal approximation for a binomial distribution was used to obtain confidence intervals (Fleiss 1981). We recaptured four males during October of the same year (seven months post-translocation) and recorded antler measurements. We also estimated body condition using three methods. First, we visually assigned each deer a subjective body condition score (BCS) based on the amount of tissue along the spine, ribs, and hip areas, after the methods of Cook et al. (2007). Scores ranged from 1 to 5, with 1 being the poorest and 5 being excellent. We measured rump fat using a portable ultrasound (E.I. Medical Imaging, Fort Collins, Colorado, Cook et al. 2007). Rump fat measurements using portable ultrasound are a good index of total body fat in cervids because the relationship between rump and total body fat remains linear over a wide range of body conditions, unlike kidney or marrow fat indices (Stephenson et al. 2002). The BCS also served as a basis for interpreting the ultrasonogram (e.g., discerning fat from skin and muscle tissue), because deer in poor condition will have little or no rump fat. All BCS and ultrasound were performed by the same observer. Body condition scores and rump fat were only recorded for males captured in Kleberg County. To determine whether rump fat measurements from translocated deer differed from resident deer, measurements were compared with resident males (n = 15) captured on the release site in October 2007. We used a Mann-Whitney test (Mann and Whitney 1947) for differences in body condition scores between 3.5-year-old resident and translocated males.

Expected Annual Difference (EAD) in Antler Score for Both Translocations

On both study sites, we measured antler scores of a subset of translocated deer that were harvested or re-captured to determine the difference between pre-translocation and post-translocation antler growth. Antler development is sensitive to male nutritional condition, especially during late spring and early summer (French et al. 1956). Below-average antler growth can indicate poor nutritional condition. Deer were translocated before antler casting and new growth. Thus, any stress or other effects of the new habitats could be apparent in antler development after release. However, antler development is also influenced by age, particularly in physically immature males (< 5.5 years of age). Therefore, we derived an expected annual difference (EAD) in antler scores for all male age classes (e.g., the expected increase in antler size from 1.5 to 2.5 years; 2.5 to 3.5 years, etc) based on antler measurements of resident deer (n = 2,639) captured on five south Texas ranches during 2002–2007 (D. Hewitt, unpublished data). We compared the antler size for translocated individuals during October following release to the EAD for the appropriate age class.

Results

Annual survival rate (excluding the two harvested males from Translocation 1) was 72% (95% CI = 58%–84%) for both translocations. Furthermore, 40% (95% CI = 27%–56%) of the deer survived and remained on the release area after one year for both translocations (excluding the two harvested males from Translocation 1).

Translocation 1

Fourteen of 22 (64%) deer survived 12 months after release during Translocation 1 (Table 1). Male survival rate was 43% (95% CI = 12%–78%) and female survival rate was 73% (95% CI = 45%–91%). No 2.5-year-old females died, but 4 of 11 ≥3.5-year-old females died (Table 1). Two of 7 males left the release area, while no females permanently left. One female left the release area but returned after 13 days and subsequently died. Overall, 50% (95% CI

Table 1. Status of white-tailed deer by age classes 12 months after translocation in Calhoun and Kleberg Counties, Texas, 2006–2008.

Translocation	Sex	*n*	Age class	Left property	Alive on property	Survived	Died
1 (Calhoun)	Male	3	1.5	1	0	1	2
		3	2.5	1	0	1	2
		1	3.5+	0	1	1	0
	Female	4	2.5	0	4	4	0
		11	3.5+	1	6	7	4
2 (Kleberg)	Male	1	1.5	0	0	0	1
		9	2.5	3	6	9	0
		15	3.5+	9	2	9	4[a]
		2	N/A	2	0	2	0
Translocations 1 and 2		49		17	19	34	13[a]

a. Does not include two harvested males from Kleberg County.

= 29%–71%) of the translocated deer survived and remained on the release area after one year. We continued to monitor deer for a total of 24 months. Only one death occurred >12 months, which was a female that died 15 months post-release.

Translocation 2

Eighty percent (95% CI = 59%–92%) of deer released during Translocation two survived (Table 1) for 12 months, excluding the two harvested males. Five of the seven deaths were natural mortalities, while two were legally harvested during the following hunting season. All natural mortalities occurred within one month of release; exact causes of mortalities were unknown due to scant evidence left by scavengers.

Twelve of 20 surviving males left the release area, including one male that returned to the original capture area approximately one week later and the two males that were subsequently harvested. Average aerial distance for those males that left the property was 10.4 ± 6.9 km (range = 0.8–22.5 km) from the center of the release area. Most ($^{9}/_{12}$) of the dispersers moved >9.3 km from the center of the release area and $^{3}/_{12}$ remained within <1 km of the boundary of the release area. Whether those deer established a permanent home range is unknown. Males that left the property tended to be older than those that remained on the property (Table 1, $z = 1.84$). Furthermore, 4 of 12 (33%) deer that remained on the property died, compared to 3 of 15 (20%) dispersers.

Antler growth of the two translocated yearling males was below EAD; one male gained 22 inches (about half of the EAD for age 1.5–2.5 years) and the other male was 16 inches smaller at 2.5 years old than his previous antler size (Figure 1). Antler growth of males 2.5 years and older was variable (Figure 1).

Average rump fat thickness was 16.8 mm (SE = 3.8) and 24.8 mm (SE = 1.5) for 3.5-year-old translocated and resident males, respectively (Figure 2). Median body condition scores of translo-

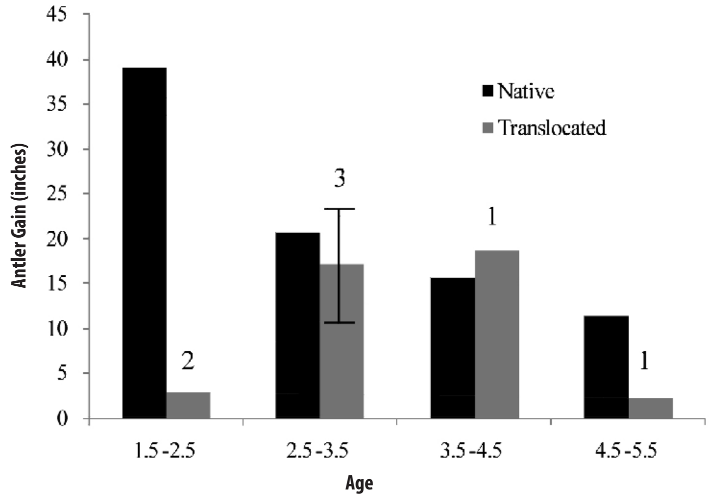

Figure 1. Mean (+/- S. E.) Expected Annual Difference (EAD) for four age classes of native white-tailed deer from five ranches in southern Texas and of translocated white-tailed deer in Calhoun and Kleberg counties, Texas. Sample sizes are shown for translocated deer.

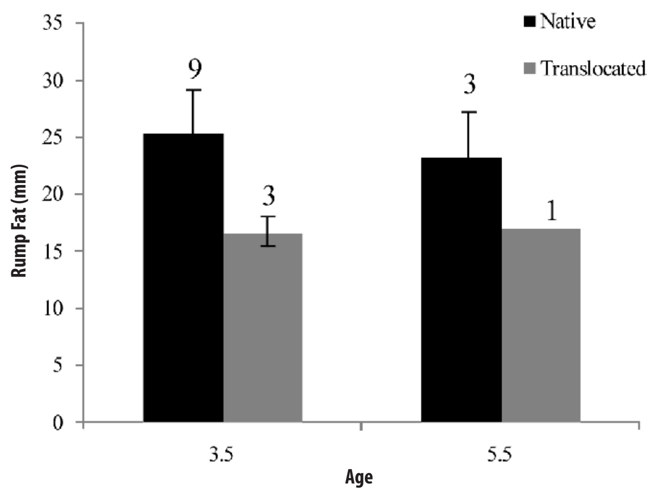

Figure 2. Mean (+/–SE) rump fat measurements for two age classes of native and translocated male white-tailed deer in Kleberg County, Texas. Numbers above bars indicate the sample size.

cated males tended to be less than resident males ($z = 1.77$, $P = 0.08$) in the 3.5-year-old age class.

Discussion

Survival rates of translocated deer in our study (72% combined) compare well with annual survival rates of adult resident male deer in south Texas (72%, Webb et al. 2007; 71%, DeYoung 1989) and adult resident female deer in south Texas (68%–74%, Kie and White 1985). In other regions of the United States, reported survival rates for white-tailed deer post-translocation have been variable (32%, Hawkins and Montgomery 1969; 15%, O'Bryan and McCullough 1985; 75%, Pais 1987). The reasons for the range of survival rates likely involve differences in capture methods, postcapture handling, habitat types, and animal condition. Therefore, the two translocations we monitored could be considered successful in terms of survival to one-year post-release.

In this study, nearly all natural mortalities occurred within one month of release and likely reflect capture and transport conditions. We did observe some qualitative differences in survival and performance among age classes. For example, deer in Translocation 2 appeared to have a higher survival rate to one-year post-release. The reasons for the difference in survival between the two translocations are not clear, but may be related to differences in habitat type or the travel time among capture and release sites. Deer exposed to different habitat types may need some time to adjust to different forage available and different sources of drinking water. An increase in travel time may hinder survival rates. Beringer et al. (2002) mentioned long processing times may have hindered survival of translocated deer in Missouri.

The 14% (including the female deer that briefly left the release area) and 52% of surviving translocated deer that left the release areas after Translocations 1 and 2, respectively, were not within percentages reported in other studies (32% partially fenced, Jones and Witham 1990; 26% free-ranging, Hawkins and Montgomery 1969; and 50% free-ranging, Cromwell et al. 1999). Variation in proportion of deer that left the release areas could be explained in part by differences in the size of the areas and the type of properties (e.g., enclosed vs. free-ranging). Our release areas were ca. 2,000 ha, considerably larger than the study area of Cromwell et al. (1999) and considerably smaller than the study area of Hawkins and Montgomery (1969). A property size of 158,000 ha would be needed to keep all of surviving deer on property in Translocation 2. However, 10 of 12 dispersed deer moved less than the mean distance of 10.4 km; therefore, 33,900 ha would be needed to maintain 90% ($^{18}/_{20}$) of the surviving deer. Much of the northern and western section surrounding the release area consisted of unsuitable deer habitat (e.g., extensive fields of cotton and grain sorghum). The property size needed to maintain a high percentage of translocated deer would likely decrease with continuous deer habitat. Future studies should examine if dispersal occurs with translocated females on low fenced properties which could negatively influence population growth.

Age may have influenced emigration even though Hawkins and Montgomery (1969) did not find a relationship among movements of translocated deer by sex or age. The median age of males that remained on the release area in Translocation 2 was lower (2.5) than the median age of males that left the release area (4.0; Table 1). This includes two males that left the property and were harvested. Movements away from the release area may be attributed to social stress (see Beringer et al. 2002), carrying capacity (Ideal Free Distribution, Fretwell and Lucas 1972), homing (Campbell 1999), or simply be an artifact of arbitrary property boundaries which animals can not recognize.

Young males (≤3.5 years) tended to have lower body condition and antler growth approximately 6–8 months post-translocation when compared to resident deer. Capture and translocation are stressful events but young deer may show a greater response than older deer because young deer are still undergoing skeletal growth and often do not have fat reserves that would buffer stressful conditions (Harder and Kirkpatrick 1996). Our results, though preliminary, suggest that the stress of translocation may reduce body and antler development of the young age classes for one year or more.

Our study indicates that reasonable, based on typical survival rates of resident deer, white-tailed deer survival rates can be achieved through common TTT practices in south Texas. However, the size of the managed area should be considered, as a large proportion of deer left the unfenced release site. Depending on the goals of the translocation, larger release sites, or game-fenced areas, may be necessary to ensure that all individuals remain on the release area. We did not recapture enough deer to quantify trends in condition and performance by sex and age class. Additional research is necessary to further refine effects of translocation on performance and survival among sex and age classes. One approach could be to replicate this experiment using different variables such as distance between capture and release areas, temperature during relocation, age structure, and sex ratios on the release area. Further study on the response of females to translocations is warranted.

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