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ESTIMATES OF RELATIVE ABUNDANCE OF THE MEDIUM-SIZED MAMMALS OF FORT HOOD, TEXAS, USING SCENT-STATION VISITATION

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INTRODUCTION

Fort Hood consists of 884 square kilometers in Bell and Coryell counties of central Texas. It is controlled by the United States Army and is utilized for large scale military training maneuvers. Previous studies have examined the effects of short term military exercises on mammals, but knowledge regarding the effects of such military activities on mammal species is generally limited (Severinghaus et al., 1981; Gese et al., 1989). The geographic regions occurring within this area are the Blackland Prairie and the Lampasas Cut Plain. The Blackland Prairie consists of mixed grasslands underlain by Upper Cretaceous limestone. Little bluestem (*Schizachyrium scoparium*) is the dominant grass species, but scattered honey mesquite (*Prosopis glandulosa*) and sugar hackberry *(Celtis laevigata*) stands are often found within these grasslands. Pecan (*Carya illinoinensis*), american elm (*Ulmus americana*), red ash (*Fraxinus pensylvanica*), and other woody vegetation occur in riparian habitats. The Lampasas Cut Plain is characterized by grass-covered low hills and oak-juniper woodlands with thin, stoney soils and narrow valleys cut in Lower Cretaceous limestones. Ashe juniper (*Juniperus ashei*), blackjack oak (*Quercus marilandica*), and post oak (*Quercus stellata*), are the dominant species found in this area (Kutac and Caran, 1994).

Previous studies pertaining to the medium-sized mammals of Fort Hood are restricted to a cursory report compiled in 1978 (Miller-Talley Associates and Espey, Huston, and Associates, Inc.), an unpublished survey on land condition trend plots (Baumgardner, 1990), and a study of the effects of tactical vehicle activity on the mammals, birds, and vegetation at Fort Hood (Severinghaus et al., 1981; Goran et al., 1983). The first investigation was brief, and information regarding the medium-sized mammals consisted only of a literature search of mammals known to occur in the habitats found on Fort Hood. The latter two studies focused primarily on small mammals with little information on medium-sized mammal species. In the present study, carnivores, rabbits, the Virginia opossum (*Didelphis virginiana*), armadillos (*Dasypus novemcinctus*), and large rodent species such as squirrels (*Sciurus*), will be considered medium-sized mammals.

Scent-stations have been used to monitor the presence and relative abundance of many mammalian species. A scent-station consists of a circle 1m in diameter cleared of debris and covered with a tracking medium consisting of sifted sand, dirt, or lime. An attractant such as synthetic fermented egg powder (Linhart and Knowlton, 1975), fatty acid scent (Diefenbach et al., 1994), or bobcat (*Lynx rufus*) urine (Conner et al., 1983; Leberg and Kennedy, 1987) is placed in the center of the circle. Animals attracted to the scent leave tracks in the tracking medium which are recorded as a visit by that species.

Scent-stations were first used to determine the relative abundance of red fox (*Vulpes vulpes*) and gray fox (*Urocyon cinereoargenteus*) (Richards and Hind, 1953; Wood, 1959). Although the relationship between scent-station indices and population size has been questioned (Minser, 1984; Smith et al., 1994), scent-stations provide an effective method for determining the relative abundance of several species of mammals (Lindzey et al., 1977; Conner et al., 1983; Leberg and Kennedy, 1987; Hein and Andelt, 1995), including most of the medium-sized mammals thought to occur at Fort Hood.

Since the development of scent-stations, many refinements of the techniques have been made, such as determining the proper spacing required between stations, and identifying the most effective attractants, and optimum number of stations per transect (Roughton and Sweeny, 1982). Morrison (1981) determined that powdered lime, when used as the tracking medium, may aid in the attraction of many medium-sized mammals. Bobcat urine appears to be the most effective attractant for multi-species surveys (Morrison, 1981).

The goals of this research were specifically: (1) to identify and describe the medium-sized mammal species composition and relative abundance at Fort Hood, (2) to identify important or species rich medium-sized mammal habitats, (3) to determine the effectiveness of scent-station survey methods for monitoring medium-sized mammals, and (4) to calculate and compare the relative abundance of the medium-sized mammal species present in high and low military use areas among selected habitat types in order to determine the effect of military activities on those populations occurring at Fort Hood.

MATERIALS AND METHODS

Field work was conducted between October 1995 and January 1997. During this period, six different sites were surveyed, representing areas of high and low military use in three different habitat types. The three habitats surveyed were savannah, riparian, and upland oak-juniper woodland. Meetings with Fort Hood environmental personnel and a four month preliminary survey were conducted to select appropriate study areas. The degree of military use in each area was quantified by comparing the mean number of vehicle paths present in the two areas representing the same habitat type (Severinghaus et al., 1981). In each area, 15 locations (every other station in each of the three transects) along the route to be surveyed were selected. At each location a 50-m transect was walked in a randomly selected direction (Severinghaus et al., 1981), and every vehicle path encountered along this transect was recorded. A mean number of roads per area was calculated based on the 15 transects. A t-test was used to compare the mean number of paths for the two areas. This test showed that at the $P= 0.05$, the high use site in each habitat type received significantly more military use than did the corresponding low use site.

A site within training area 27 in south Fort Hood represented mixed grassland habitat with low military use. The mixed grassland habitat with high military use was located in training area 43 in northwestern Fort Hood. Transects within training area 44 in north central Fort Hood, represented an oak-juniper woodland habitat with high military use. The low military use, oak-juniper woodland habitat was located in training areas 2, 3, and 5 in northeastern Fort Hood. A site representing low military use riparian habitat was located in training area 8 in east Fort Hood. The riparian habitat with high military use was located in training area 53 in north Fort Hood (Fig. 1). Each site was surveyed once each season. A survey consisted of an area of approximately 7.6 km^2 in which three transects

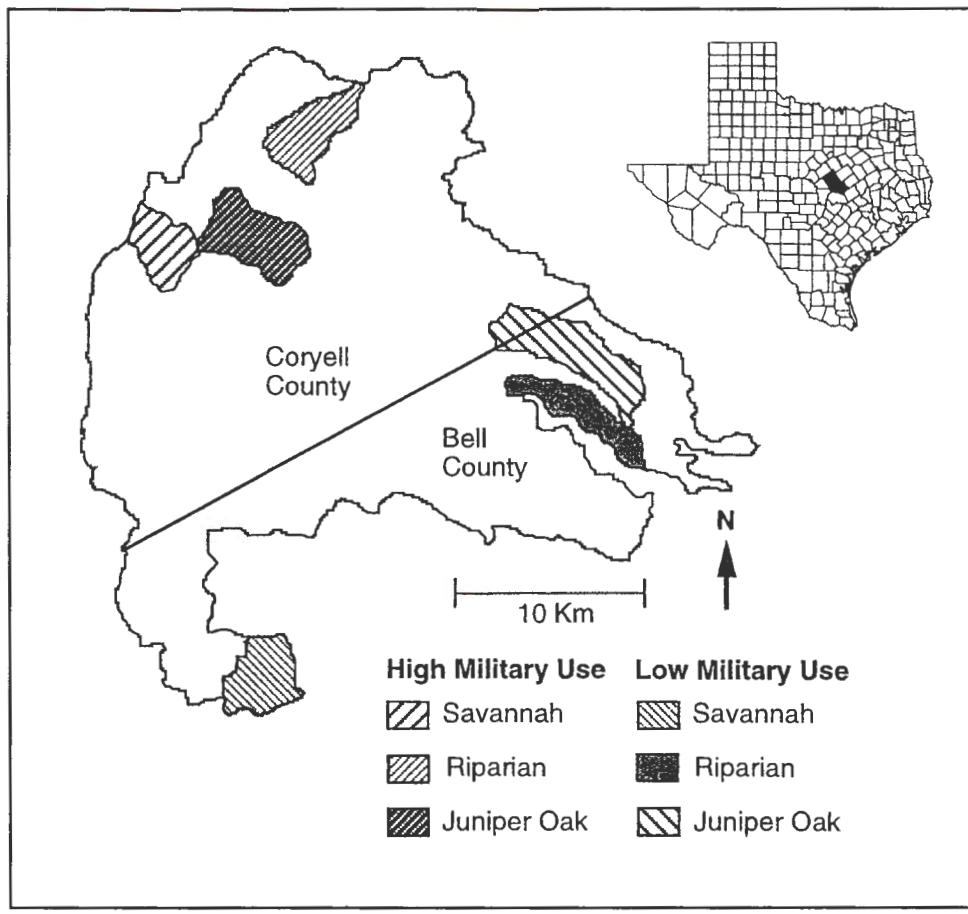

Figure 1. Map of Fort Hood, Texas. Shaded regions depict the location of the six survey sites. The Texas map indicates the position of Bell and Coryell Counties in Central Texas.

of scent-stations and Tomahawk® live traps (three different sizes) were placed. For methods and data regarding the live-traps see Edwards et al. (1998). Scent stations consisted of 1-meter diameter areas with two different surfaces, bare ground (earthen) and a melamine board, used at alternating locations along transects. Both surfaces were covered with lime to increase track definition. A cotton ball attached to an applicator stick in the center of each station was saturated with bobcat urine, which served as the attractant. Knuckle impressions made in the tracking medium aided in identification of stations rendered inoperable by either wind or rain. A station was considered operable if the attractant remained undisturbed and the knuckle imprint was visible.

The stations were set up, then checked daily for three days. Urine was reapplied each day and the surface, if visited or disturbed, was retreated with lime. Positively identified tracks were recorded as a visit by that species. Multiple tracks by the same species were considered a single visit due to the inability to distinguish single or multiple visits by the same species. Three 10-station transects were used in each survey (Conner et al., 1983). A total of 72 transects, each consisting of 10 scent-stations, were constructed and monitored for three days each during this survey for a total of 2,160 station nights. Stations were placed at 0.48 km (0.3 mi.) intervals, to minimize the possibility of multiple station visits by the same animal (Linhart and Knowlton, 1975). The scent-station index (SSI) for each species on each transect was calculated by dividing the number of visits of each species by the number of operable stations and then multiplying by 1000 (Conner et al., 1983; Henke and Knowlton, 1995; Travaini et al., 1996).

The statistical computer program JMP (SAS Institute, Inc. 1995) was used to perform all statistical tests. Variation between the SSI for each species in each season, habitat type and station type (board or earthen) was analyzed using analysis of variance (ANOVA) for repeated measures. Transects in which more than half of the stations were inoperable, were excluded from the statistical analysis. F-values were computed using the sequential sum of squares for unbalanced data, due to inoperable stations.

RESULTS

Of the 2,160 stations, 555 stations were inoperable due to environmental conditions such as rain and high winds, or disturbance by domestic livestock or military training exercises. The exclusion of inoperable stations yielded 1,605 operable station nights consisting of 803 board stations and 802 earthen stations. Visitation at these stations included 15 different species of medium-sized mammals: Virginia opossum, armadillo, fox squirrel (*Sciurus niger*), eastern cottontail rabbit (*Sylvilagus floridanus*), black-tailed jackrabbit (*Lepus californicus*), eastern spotted skunk (*Spilogale putorius*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), red fox, gray fox, coyote (*Canis latrans*), domestic dog (*Canis familiaris*), bobcat, and domestic cat (*Felis domesticus*). A concurrent study using live-traps to estimate the relative abundance of medium-sized mammals in these same areas and mammals killed on roads within Ft. Hood, provided voucher specimens for all species recorded by scent-station visitation (Edwards et al., 1998).

No significant season or day effect was detected for any species, therefore the seasons were combined for all other tests. Mean SSI's for each species in each habitat are presented in tables 1 and 2. These indices were calculated by excluding transect nights in which more than half of the stations within any transect were inoperable, resulting in the analysis of 59 transects for three days. The mean number of operable stations per transect per day was 9.07. The data contained in Table 1 were used to statistically analyze the SSI's for striped skunks, raccoons, ringtails, gray foxes, coyotes, and domestic cats for comparisons by habitat type, degree of military use, and season. The nine species excluded from the statistical analysis were those in which the visitation rates were too low for valid comparison (Table 2).

All of the species tested showed significantly different ($P<0.05$) SSI's among habitat types. Raccoons, ringtails, gray foxes, coyotes, and domestic cats all showed different SSI's ($P<0.05$) between areas of high

Table 1. Mean annual scent-station indices (SSI's) for the six statistically analyzed medium-sized mammal species occurring at Fort Hood.

	High Use Savannah	Low Use Savannah	High Use Juniper Oak	Low Use Juniper Oak	High Use Riparian	Low Use Riparian
Mephitis mephitis	2.78	5.56	16.67	36.88	5.56	15.28
Procyon lotor	46.56	107.87	4.63	51.20	39.49	25.46
Bassariscus astutus	——	62.35	——	5.56	2.78	36.11
Urocyon cinereoargenteus	77.58	13.89	——	129.01	34.88	100.93
Canis latrans	26.00	——	27.78	37.96	47.36	27.78
Felis domesticus	30.86	128.71	48.50	75.35	16.32	46.47

Table 2. Mean scent-station indices (SSI's) for nine species of mammals occurring at Fort Hood.

	High Use Riparian	Low Use Riparian	High Use Savannah	Low Use Savannah	High Use Juniper Oak	Low Use Juniper Oak
Dasypus novemcinctus	——	——	11.11	——	——	——
Sciurus niger	10.19	2.78	11.11	2.78	12.78	7.26
Sylvilagus floridanus	21.88	9.03	2.78	23.26	48.85	22.84
Lepus californicus	5.56	——	2.78	——	——	2.78
Spilogale putorius	——	——	10.56	——	——	——
Vulpes vulpes	2.78	——	——	——	9.72	2.78
Canis familiaris	4.17	5.55	7.41	11.11	16.67	22.53
Lynx rufus	13.89	2.78	8.33	8.33	20.59	7.41
Didelphis virginiana	5.21	5.87	9.72	9.72	11.25	47.53

and low military use. The striped skunk was the only species showing no difference in the SSI between high and low military use sites within the same habitat. The SSI between board and earthen stations were also calculated. Except for coyotes and domestic cats, all species showed statistically equal visitation ($P<0.05$) regarding board and earthen stations. Both of these species visited significantly fewer of the board stations.

Maps illustrating the survey transects within each of the six sites and their vegetative composition can be found in Carroll, 1997. Five native species and one introduced species (domestic cat) were detected in sufficient numbers to allow for reliable statistical analysis. The native species included striped skunks, ringtails, raccoons, gray foxes, and coyotes. For most species analyzed the overall relative abundance was greater in the low military use areas. In the high use riparian area coyotes were the most common species, while gray foxes were the most common in low use areas within the riparian habitat. In the high military use savannah, gray foxes were the most frequently detected species. Of the native species, raccoons were the most abundant in the low use savannah area and coyotes were the most common in the high use upland juniper and riparian habitat. Gray foxes were the most common species in the low use upland juniper area.

Scent-station visitation confirmed the presence of nine other native species, as well as the domestic (feral) dog, but visitation rates were not sufficient to allow for statistical comparisons between habitats or abundance of other species. These species include opossums, armadillos, foxes, squirrels, cottontail rabbits, the jackrabbits, eastern spotted skunks, bobcats, and red foxes. The visitation rate for these species was relatively low; therefore it is difficult to determine the effects, if any, of military training on them. Within the riparian habitat there was little difference in the relative abundance of medium-sized mammal species between the high and low use sites. It is apparent that the diversity of these species is relatively low in both of these areas. The only armadillo visits occurred in the low use savannah. Two introduced species, the house cat and the domestic dog, were present in all of the areas surveyed, but only the house cat visitations were sufficient to allow for statistical analysis.

DISCUSSION

Visitation rates across seasons were compared to determine any difference in the visitation rates among the four seasons and also to test for any decrease in scent-station visitation over time due to acclimation to the scent. Morrison (1981) found no significant difference among seasons for scent-station visitation by bobcats in north central Louisiana. Leberg and Kennedy (1987), however, found that raccoons showed a seasonal difference in visitation rates in Tennessee. The lack of seasonal differences in these data may reflect uneven temporal spaces between sampling periods, as well as the less distinct seasons in central Texas compared to other states. Coyotes may become habituated to a scent if it is used repeatedly (Fagre et al., 1981). For the Fort Hood medium-sized mammal species tested, there was no decrease over time in the visitation rate.

Raccoons had significantly greater visitations in savannah than in riparian or upland juniper habitats. This is atypical for this species which is usually most abundant in riparian habitats (Lotze and Anderson, 1979; Kaufman, 1982; Minsner and Pelton, 1982; Leberg , 1985). Riparian areas showed statistically greater SSI's than did upland juniper areas for this species. Within savannah and upland juniper habitats, raccoons occurred more frequently in areas with low military use, but in riparian habitats, there was no statistical difference between high and low use areas. These trends could be due to the fact that areas within savannah and upland juniper habitats have a greater difference between the high and low military use sites. The high use areas within these two habitats were used more heavily than high use areas within the riparian habitat. Even within impacted riparian sites at Fort Hood, large vegetated "islands" exist which receive little military use (Goran et al., 1983).

Ringtails inhabit a variety of habitats including all of the types sampled in this study (Neuwall and Toweill, 1988). Visitations for ringtails were significantly higher in low use savannah habitats as compared to all other sites sampled. Ringtails typically inhabit rocky outcroppings and abandoned burrows of other medium-sized mammals (Chevalier, 1984; Nuewall and Toweill,1988; Davis and Schmidly, 1994). Armadillos also were detected in the greatest numbers at this site, which would provide a relatively high number of abandoned burrows. Relative abundance of ringtails in upland juniper and riparian areas were similar regarding habitat and degree of military use within habitats. No visits were recorded in high use savannah or high use upland juniper but visits were recorded in both high and low use riparian. This pattern of relative abundance in these habitats agrees with the data for raccoons. Due to low visitations by this species caution must be used in interpreting these data.

Coyotes showed no difference between habitat types or areas of high and low use when comparing riparian and upland juniper. Visitation indices for both of these habitats were higher than in savannah areas. High use savannah transects had higher SSI's than low use savannah transects in which no coyotes were detected. Over all for this species savannah areas had the lowest SSI's. Linhart and Knowlton (1975) noted that coyotes are distributed more uniformly in short grass savannah than in areas of dense vegetation, so larger home range size in savannah sites could lead to decreased visitation. Also, in riparian and juniper areas, stations placed near a road would be more likely to be visited due to use of the road by this species as a pathway through the dense vegetation.

As with coyotes, no significant difference was found between the riparian areas and the upland juniper areas for gray foxes. Both of these areas again had higher SSI's than the savannah areas. Gray foxes shared similar habitat use preferences with coyotes, in that the savannah habitat within the high military use area was favored. In both riparian and upland juniper habitats, the low use sites had significantly higher SSI's. The high use upland juniper site was the only site in which there were no visits by this species. Again, this indicates the possibility of a difference in degree of military use between the different habitat types.

The domestic cat showed significantly higher visitation in low use savannah than in the other habitats. Overall, visitation by this species was higher than that of any other species in this study which could

indicate the presence of a fairly large feral population. The low use savannah study site, where the highest number of visits was recorded, was on the southern boundary of the installation near several houses. This might indicate that the higher visitation in this area could be due to domestic rather than feral cats, although the possibility was great that there were some feral cats in this area. According to Fort Hood wildlife officials it is common practice for soldiers, when they are reassigned to other military installations to release their cats into the wild.

Domestic dogs were present in every area surveyed, but in fairly low numbers. This could indicate the presence of a feral population, but even when present, these data suggest that populations are probably small. However, feral dogs usually adapt well to most situations and populations could increase rapidly in the future.

For most of the species tested, no difference was found between board and earthen stations. Board stations generally yield more defined tracks due to their smooth and level surface, which is difficult to create in some soil conditions for earthen stations. A disadvantage of the board stations is that in damp conditions they often become warped and no longer are level with the ground which might influence visitation by cautious species. The coyote and the feral cat showed significantly lower visitation on the stations in which a board was used when compared to the earthen stations. Thus, future scent-station surveys targeting these species should use the earthen station. For the other species, board stations are recommended due to the ease with which they are set up and the better track definition they provide.

Some species, as previously stated, were detected with greater frequency in high use sites within certain habitats. However, the low use sites within each of the three habitat types had a greater overall diversity of species when compared to their corresponding high use sites. Both riparian sites had relatively high diversities of medium-sized mammal species and the low use riparian site had the highest total number (twelve native and two introduced) of species detected. Although military activity within this area is relatively low, there is a great deal of civilian recreational activity. The savannah and upland juniper sites had the same number of species detected.

It is not surprising that many species were detected only in low frequencies. Most likely visitation by many of these species is due to incidental contact, rather than attraction to the scent. Evidence also exists which suggests that some noncarnivorous mammals such as rabbits may be attracted to novel objects such as the large white circular station (Morrison, 1981; Drew et al., 1988). The effectiveness of scent-stations in determining the relative abundance of both the bobcat and red fox are well documented (Conner et al., 1983; Diefenbach et al., 1994; Travaini et al., 1996). The low visitation indices reported here for these two species may indicate relatively small populations on Fort Hood.

CONCLUSIONS

These data suggest that the scent-station survey technique is an effective way to monitor the relative abundance of the medium-sized mammals of Fort Hood. Six of the 15 species whose presence was documented by this study were detected in sufficient numbers to allow for statistical comparisons between habitat types and areas of high and low military use within each habitat. Most of these data support conclusions from a concurrent live-trap study (Edwards, 1998) with the exception of the identification of the most species rich habitat. This discrepancy is due to the absence of a larger species in the live-trap data. Scent-station data indicate riparian habitats had the greatest overall diversity of medium-sized mammal species. Upland juniper and savannah habitats had the same number of species present.

Striped skunk visitations in this study indicate no significant difference between populations in areas of high or low military use within any of the habitats sampled. Raccoons and ringtails showed significantly higher visitation in low military use areas within sa-

vannah and upland juniper habitats. Ringtails showed higher visitation within the low use riparian area, while raccoon visitations were statistically equal between high and low military use sites in this habitat. Fort Hood savannah habitats showed the lowest coyote and gray fox visitation of any habitat sampled, but within this habitat both of these species showed higher visitation in the high military use areas. Gray fox visitation was higher in the low use areas within upland juniper and riparian habitats, whereas coyote visitation showed no significant difference between the high and low military use areas in these habitats.

The existence of two feral species (feral cats and dogs) was documented at every site surveyed. Feral dog populations although present, seem fairly low at this time. Feral cat visitations were high in all of the survey areas. These data suggest that control efforts are needed to reduce or eliminate the feral populations at Fort Hood.

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LITERATURE CITED

Baumgardner, G. D. 1990. Mammal surveys on land condition trend plots at Fort Hood Texas. Unpublished report for U.S. Army Construction Engineering Research Lab.

Carroll, D. S. 1997. Estimates of relative abundance of the medium-sized mammals of Fort Hood, Texas using scent-station visitation. Unpublished M.S. thesis, Angelo State University. 39 pp.

Chevalier, C. D. 1984. Water requirements of free-ranging and captive ringtail cats (*B. astutus*) in the Sonoran Desert. Unpublished M.S. thesis, Arizona State Univ., Tempe, 82 pp.

Conner, M. C., R. F. Labinsky, and D. R. Progulske, Jr. 1983. Scent-station indices as measures of population abundance for bobcats, raccoons, gray foxes, and opossums. Wildlife Society Bulletin, 11(2):147-152.

Davis, W. B. and D. J. Schmidly. 1994. The mammals of Texas. University of Texas Press., Austin, Texas, 338 pp.

Diefenbach, D. R., M. J. Conroy, R. J. Warren, W. E. James, L. A. Baker, and T. Hon. 1994. A test of the scent station survey technique for bobcats. Journal of Wildlife Management, 58:10-17.

Drew, G. S., D. B. Fagre, and D.J. Martin. 1988. Scent-station surveys for cottontail rabbit populations. Wildlife Society Bulletin, 16:396-398.

Edwards, C. W., D. S. Carroll, and R. C. Dowler. 1998. Assessing medium-sized mammal abundance at Fort Hood Military Installation using live-trapping and spotlight counts. Mus., Texas Tech University, 185:1-23.

Fagre, D. B., B. A. Butler, W. E. Howard, and R. Teranishi. 1981. Behavioral responses of coyotes to selected odors and tastes. Worldwide Furbearer Conference Proceedings, Frostberg MD. pp. 966-983.

Gese, E. M., O. J. Rongstad, and W. R. Mytton. 1989. Changes in coyote movements due to military activity. Journal of Wildlife Management, 53:334-339.

Goran, W. D., L. L. Radke, and W. D. Severinghaus. 1983. An overview of the ecological effects of tracked vehicles on major U.S. Army installations. USA- CERL Technical Report N-142. 75 pp.

Hein, E. W. and W. F. Andelt. 1995. Evaluation of indices of abundance for an unexploited badger population. The Southwestern Naturalist, 40:288-292.

Henke, S. E. and F. F. Knowlton. 1995. Techniques for estimating coyote abundance pp 71-78 *in* Coyotes in the Southwest: a compendium of our knowledge. (Rollins, D., C. Richardson, T. Blankenship, K. Canon, and S. Henke eds). Texas Parks and Wildlife Department, 1-180.

Kaufman, J. H. 1982. Raccoon and allies. Pp 567-585 *in* Wild mammals of North America. (J. A. Chapman and G. A. Feldhamer, eds.). The Johns Hopkins University Press, 1-650.

Kutac, E. A. and C. C. Caran. 1994. Birds and other wildlife of south central Texas. University of Texas Press, Austin Texas, 203 pp.

Leberg, P. L. 1985. Density and habitat relationships of the raccoon, *Procyon lotor*, in western Tennessee. Unpublished Masters Thesis, Memphis State University, Memphis, Tenn. 71 pp.

Leberg, P. L. and M. L. Kennedy. 1987. Use of scent-station methodology to assess raccoon abundance. Proceedings of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies, 41:394-403.

Lindzey, F. G., S. K. Thompson, and J. I. Hodges. 1977. Scent station index of black bear abundance. Journal of Wildlife Management, 41:151-153.

Linhart, S. B. and F. F. Knowlton. 1975. Determining the relative abundance of coyotes by scent station lines. Wildlife Society Bulletin, 3:118-124.

Lotze, J. and S. Anderson. 1979. Procyon lotor. Mammalian Species 119: 1-8.

Miller-Talley Associates and Espey, Huston, and Associates, Inc. 1978. Ecological baseline report, Fort Hood, Texas. Unpublished environmental impact statement prepared for The Department of the Army, 138 pp.

Minser, W. G., III. 1984. Comments on scent-station method for monitoring furbearers. Wildlife Society Bulletin, 12:328.

Minser, W. G., III and M. R. Pelton. 1982. Impact of hunting on raccoon populations and management implications. University of Tenn. Agriculture Experimental Station Bulletin. 612:1-32.

Morrison, D. W. 1981. Evaluation of specific variables for a scent station survey in north central Louisiana. Unpublished Masters thesis, Louisiana Tech University, 35 pp.

Neuwall, I. P., and D. E. Toweill. 1988. Bassariscus astutus. Mammalian Species. 327:1-8.

Richards, S. H. and R. L. Hind. 1953. Wisconsin fox populations. Wisconsin Conservation Department of Technology Wildlife Bulletin, 6:78 pp.

Roughton, R. D. and M. W. Sweeny. 1982. Refinements in scent-station methodology for assessing trends in carnivore populations. Journal of Wildlife Management, 46:217-229.

SAS Institute, Inc. 1995. SAS/STAT guide for personal computers. Version 6 ed. SAS Inst., Cary, N.C. 593 pp.

Severinghaus, W. D., W. D. Goran, G. D. Schnell, and F. L. Johnson. 1981. Effects of tactical vehicle activity on the mammals, birds, and vegetation at Ft. Hood, Texas. USA-CERL Technical Report N-113, 22 pp.

Smith, W. P. , D. L. Borden, and K. M. Endress. 1994. Scent-station visits as an index to abundance of raccoons: an experimental manipulation. Journal of Mammalogy., 75:637-647.

Travaini, A., R. Laffitte, and M. Delibes. 1996. Determining the relative abundance of European red foxes by scent-station methodology. Wildlife Society Bulletin., 24(3):500-504.

Wood, J. E. 1959. Relative estimates of fox population levels. Journal of Wildlife Management. 23:53-63.

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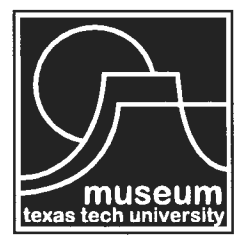

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