Overwinter survival of wild turkeys on central Virginia's industrial forests

by

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(ABSTRACT)

Overwinter survival of wild turkeys on industrial forests managed for short-rotation pines (treatment) and typical Piedmont forests and farmland (control), was investigated in Virginia's central Piedmont during 1986 - 1988. Ninety-six percent of the turkeys ($N = 106$) were captured in early fall with alpha-chloralose laced bait. Sixty-three percent of the captured turkeys recovered and were released with transmitters; 15% were released without transmitters; and 21% died from capture related causes.

Overwinter survival for all turkeys was $<2\%$ regardless of area or year. Daily survival was lower on the control areas ($P < 0.01$), however, due to the small (13) and scattered sample of turkeys captured over the 3 years on control areas, these data were omitted from further analyses. Daily survival on treatment areas over the 3 years was 97.6%. Thirty-seven percent of radio-equipped turkeys on treatment areas died within 2 weeks of release suggesting that factors related to the trapping process influenced survival. Possibilities considered were residual effects from alpha-chloralose, capture myopathy, and/or a negative effect from the transmitter and/or harness. Four weeks after release daily survival rates improved significantly ($P < 0.01$) indicating the influence from trapping had subsided.

While hardwoods composed 38% of the primary treatment area, 65% of turkeys died in hardwood stands; predation accounted for 81% of the turkey mortality ($N = 42$). Field evidence and necropsy results plus scent station data indicated that gray foxes (*Urocyon cinereoargenteus*) were the main turkey predators. Fox scats contained no detectable turkey remains but indicated that eastern cottontails (*Silvilagus floridanus*) were a primary prey species.

Management practices on industrial forests such as, clearcutting, slash piling, and dense young pine stands may be beneficial to rabbits and other small mammals that attract predators which also prey on turkeys. It is suggested that predator densities be monitored and furbearer trapping allowed on industrial forests to reduce predation pressure on turkeys.

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General Introduction

During the 1950's - 1970's commercial timberland in Piedmont forests of the southeastern U.S. increased 5.9% due to cropland retirement and reforestation (Frampton 1981). Over this period, oak-hickory, oak-pine, and loblolly pine (*Pinus taeda*) increased 19, 43, and 40% respectively, while shortleaf pine (*Pinus echinata*), with low economic value, decreased by 46%, and lowland hardwoods, which were still being cleared for agriculture, decreased by 39% (Johnson et al. 1974, Frampton 1981). Much of the increase in loblolly pine occurred on forest industry lands when farmland and hardwood forests were converted to pine plantations. This trend toward short-rotation pines on industrial forests continued into the 1970's as economic conditions were favorable for conversion of hardwoods to pines (Johnson et al. 1974).

While research on the effects of short-rotation pines on wild animal populations has been limited, available information suggests that pine plantations after canopy closure, particularly without thinning or burning, are not suitable for most wildlife species (Johnson et al. 1974). Atkeson and Johnson (1979) found that small mammals in the Georgia Piedmont used clearcuts and young loblolly stands but use diminished after canopy closure. Similar results were reported by Childers (1982) regarding songbird populations in the Virginia Piedmont.

The symposium on *Habitat requirements and habitat management for the wild turkey in the southeast* (Bromley and Carlton 1981) recognized the lack of knowledge concerning wild turkey (*Meleagris gallapavo*) use of pine plantations and emphasized that more research was needed. Around this time researchers began investigating the relationship between wild turkeys and industrial forests (Kennamer et al.1980, Holbrook and Vaughan 1985, Holbrook et al. 1985, Exum et al. 1987, Holbrook et al. 1987). These studies have shown that turkeys use pine plantations, although not necessarily in proportion to availability (Kennamer et al.1980, Exum et al. 1987). There is however a question of how well turkeys survive in industrial forests (Holbrook and Vaughan 1985). Turkey survival can be affected by weather, hunter harvest, poaching, crippling loss, disease, and predation, and changes to the forest may make turkeys more susceptible to these mortality factors.

The primary objective of this study was to compare overwinter survival rates of turkeys on unconverted Virginia Piedmont habitat and Piedmont industrial forests. Also, mortality factors and the importance of roads and leave strips to survival were to be determined. These objectives are discussed in chapter 1.

During the study it became apparent that there were aspects of the trapping and tagging techniques which deserved closer examination, thus 2 secondary objectives were added. Wild turkey response to 2 different dosages of alpha-chloralose and the effect of radio transmitters on turkey flying and roosting behavior were examined during the last 2 years of the study. These objectives are discussed in chapters 2 and 3 respectively.

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Chapter 1: Overwinter survival of wild turkeys on central Virginia's industrial forests

Eastern wild turkey (*Meleagris gallapavo*) habitat contains large tracts of undisturbed hardwoods, scattered pines, open understories, and small clearings (Mosby and Handley 1943, Schorger 1966, Shaffer and Gwynn 1967, Holbrook 1973). But, in the Piedmont and Coastal Plain of the southeastern U.S., much of the habitat suitable for wild turkeys is being converted by forest industry to short-rotation pine stands. In Virginia's Piedmont alone, land owned or leased by forest industry increased by 37% between 1965 and 1986 (Sheffield 1976, 1977, Brown 1985, 1986) and land area planted in loblolly pine increased 159% (Southeast Forest Exp. Station, unpubl. data). In industrial forests, hardwoods and natural pines generally are restricted to narrow strips along creek drainages and steep slopes. These hardwood "leave strips" have been left uncut purposely due to topography, for watershed protection, or for wildlife benefits. The greatest benefit to turkeys in industrial forests comes from these residual hardwood stands and clearcuts and young pines, but benefit decreases as cover density in pine stands increases and food sources are out-competed (Felix 1981, Victor 1981).

Early research indicated that short-rotation pine management was detrimental to turkeys (Mosby 1975, Markley 1967, Schaffer and Gwynn 1967). However, recent studies suggest that wild turkeys can adapt to areas of marginal habitat (Little 1980, Clark 1985, Wunz 1985), including southern industrial forests (Gehrken 1975, Kennamer et al. 1980a, Exum et al. 1987, Holbrook et al. 1987). Whether viable populations can be maintained there is less certain. Two studies conducted in Piedmont industrial forests reported high mortality rates for poults and adult turkeys. In the Alabama Piedmont poult losses averaged 87.3% due primarily to mammalian and avian predation during the first few weeks after hatching (Exum et al. 1987). Exum et al. (1987) also reported that predation was responsible for 85% of mortality on adult turkeys, primarily by gray foxes, (*Urocyon cinereoargenteus*), bobcats (*Lynx rufus*), and dogs (*Canis familiarus*). In the Virginia Piedmont annual survival for adult and juvenile wild turkeys was only 15% (Holbrook and Vaughan 1985). Ninety-one percent of the fall-winter mortality occurred during the fall hunting season. Holbrook and Vaughan (1985) suspected crippling loss as the major mortality factor because turkeys died significantly closer to roads during the hunting season than outside the hunting season. However, since mortality-detecting transmitters were not used, cause of death was difficult to determine and predation may have been a mortality factor involved. Atkeson and Johnson (1979) demonstrated that industrial forests often support high densities of small mammals, thus predators also may be present in large numbers (Baker and Brooks 1981, Kenward et al. 1981).

This study was designed as a follow-up to Holbrook's earlier (1984) research. Using the same areas and procedures, the objective in this study was to determine overwinter survival rates of wild turkeys on industrial forests in Virginia's central Piedmont and to compare these rates to survival of turkeys on near-by areas not yet converted to short-rotation pines. Also, using mortality-sensing transmitters, the causes of mortality in both areas were to be determined, as well as an assessment of how management practices on industrial forests such as, roads, clearcuts, and limited and fragmented hardwood areas, may influence turkey survival and factors of mortality.

Study Area

General description

The study was conducted on 5 tracts of land in Buckingham County, Virginia (Appendix Figs. 1 and 2). Two tracts, Horsepen Lake Wildlife Management Area (1184 ha) managed by the Virginia Department of Game and Inland Fisheries (VDGIF) and a private tract of land leased by the Taylor Hunt Club (1200 ha), were typical Piedmont habitat, containing mixed hardwoods (oaks [*Quercus* spp.], hickories [*Carya* spp.], maples [*Acer* spp.] and others), Virginia pine (*Pinus virginianus*), old fields, and agricultural areas. These tracts, designated control areas, contained 8.3 and 6.3 km of gated and ungated roads/1000 ha respectively. Three tracts, Gunstock (3003 ha), Fisher (1886 ha), and Eldridge (1090 ha), were owned and operated by Westvaco for short-rotation pine production. These were designated treatment areas. Fifty-four percent of the land was in plantations of loblolly pine, ranging in age from 1-28 years and compartment size from 1-179 hectares. The remainder was mixed hardwoods (45%, species similar to above) and old fields (< 1%). Fifty-three percent of the hardwoods were in "leave strips", primarily along creek drainages. The remaining hardwoods were in large blocks which had not been cut. Treatment areas contained 4.4 and 15.4 km of gated and ungated roads/1000 ha respectively.

Gunstock tract

Over two-thirds of the study effort (birds trapped) took place on Westvaco's 3238 ha Gunstock tract (including 235 ha of privately owned land; Appendix Fig. 3). The tract was subdivided into six different habitats earlier identified as important to wild turkeys (Felix 1981, Victor 1981). These were hardwood blocks (22%), hardwood leave strips (16%), fields(<1%), and loblolly pine stands 0-3 yrs(12%), 4-15 yrs (37%), and >16 years (13%). Gunstock had 4.6 km of gated and 15.9 km of ungated roads/1000 ha.

Methods

Study period

The study period extended from September 1985 through May 1988. A study-year ran from 1 September - 31 May and was broken down into 4 periods: prehunting season (September-October), fall hunting season (November-December), winter (January-March), and spring hunting season (April-May).

Trapping and handling

Wild turkeys were trapped during prehunting and winter seasons each year with alpha-chloralose laced bait (Williams 1966, Williams et al. 1973) or a rocket net (Austin 1965, Bailey et al. 1980). Age and weight were determined for all captured turkeys. Sex was determined for all adults, and juveniles past their post-juvenal molt. Recovery time was noted for all drugged birds. Apparently healthy turkeys were tagged with a VDGIF aluminum leg band (National Band Co., size 24) and a plastic patagial wing tag (Allflex cattle ear tags). Most turkeys weighing > 2.0 kg also were equipped with motion-sensitive radio transmitters attached with a cable harness looped around each wing (Advanced Telemetry System [ATS], Bethel, MN) which at maximum was 3.7% of a bird's body weight. During the first year the harness used was a rigid plastic coated cable (ATS). However, this rigid harness resulted in bruising to the wings and may have restricted flight, so thinner more flexible cable covered with a nylon braided cord (Telonics Inc., Mesa, AZ) was used the last 2 years. Turkeys captured with alpha-chloralose were released within 200 m of the capture site early in the morning on the first day after recovery (1-5 days). Netted birds were released where captured as soon as they were processed. In each case, behavior at release was noted.

Telemetry data collection

Radio-marked turkeys were checked daily for survival (based on transmitter pulse rate) using a hand-held 2-element H-antenna and a portable receiver. Turkeys were located by triangulation (Cochran 1980) approximately twice weekly to determine movements and habitat use. Radio locations were used only if azimuths were recorded within 20 minutes and were separated by at least 30°. To calculate telemetry error (Lee et al. 1985, Springer 1979, Mills and Knowlton 1989), 8 transmitters were placed at known locations by one person and located by another. The standard deviation of bearing error was 3.8° at a mean distance of 678 m (N=20 bearings). Turkey radio-locations were collected from an average (SE) of 825 m (19). The error polygon associated with telemetry at this distance was 3.9 ha.

Survival, mortality factors, and habitat use on Gunstock

Radio-marked turkeys were approached when the pulse rate indicated inactivity or when 2 consecutive locations overlapped. Estimates of overwinter and daily survival during the interval 1 September - 31 May were calculated using program MICROMORT (Heisey and Fuller 1984). Survival was calculated by sex and age class for the 3 years pooled, individual years, and periods within years. Cause of death was determined for all turkeys by field sign, condition of the carcass, and laboratory necropsy results.

The Gunstock tract was used to assess the impact of industrial forest management on wild turkey survival. Habitat use of turkeys while alive was compared to habitat at locations of carcasses. To calculate use vs. availability of live turkeys radio-locations of birds were plotted using program TELEM (Koeln 1980) on a map of the study area digitized with respect to the 6 habitats discussed earlier. A composite home range for all turkeys was calculated by the convex polygon method using TELEM. Habitat use vs. availability was then determined by considering the entire Gunstock tract as available habitat, and only that portion of the tract contained within the composite home range as available habitat. Also, distance to the nearest road, stream, and hardwood leave strip, and the width of the nearest leave strip was determined for each carcass location.

Assessment of human and predator impact

Traffic counters, scent station routes, owl call surveys, and scat collections were used to assess the impact of humans, and mammalian and avian predators on wild turkey survival.

Traffic counters were placed on the 4 primary entrances to Gunstock, the only entrance to a section of Gunstock leased to the Greese Creek Hunt Club, and the 2 primary entrances to the Taylor Hunt Club. Road use was checked weekly 2 weeks prior though 4 weeks after the 1987 fall turkey hunting season.

Scent stations and owl call routes were set up and run on Gunstock and the 2 control sites (VDGIF 1986a). Scent station routes consisted of a 1 m circle of sand with a sardine in the middle, placed on the side of the road every 0.3 km for 3.0 km, skipping 1.0 km and starting again. Forty stations were placed at Gunstock and 30 at each of the control areas. Routes were run for 2 consecutive nights twice during the winter of 86/87 at Gunstock and Horsepen and 3 times during the winter of 87/88 at Gunstock and Taylor. Scent station use for individual areas was compared to expected values calculated from scent station use on all areas combined. Owl call surveys were conducted once each week during February and early March at Gunstock and Horsepen in 1987, and Gunstock, Horsepen, and Taylor in 1988. These surveys followed the same routes as the scent stations using every third station. At each station a tape recording of a great-horned owl (*Bubo virginianus*) was played for 1 minute. After waiting 5 minutes for a response it was repeated.

Gray fox and bobcat scats were collected on Gunstock throughout the winters of 1986/87 and 1987/88, and analyzed to determine predator food habits, using procedures similar to that described by Korschgen (1980). Scats were analyzed macro- and microscopically after being air dried for approximately 6 months. Prior to their identification, major food items such as hair, bone, feathers, and vegetation were separated. Leaves or seeds were identified by comparison to known samples. Feathers were identified by color and banding patterns and comparison to known samples. Mammal identification involved examining guard hairs macroscopically looking at characteristics such as length, texture, color, and banding patterns. Then, under a microscope, the negative impression of the cuticle scale pattern from a guard hair was examined. This was obtained by pressing a hair between 2 microscope slides coated with clear nail polish. Identification was then made by comparison to impressions from known hairs (Spiers 1974).

Population estimation

Minimum estimates of the turkey population on Gunstock were made by keeping track of individual birds trapped and handled, turkeys coming to bait sites but not trapped, other turkeys seen on the study area, and tracks in the snow.

Statistical analysis

Differences in weight and recovery times between sexes and age classes were tested for using Wilcoxon rank sums analysis. Habitat use vs. avalability was analyzed by Chi-square tests and Bonferroni confidence intervals (Neu et al. 1974). Survival rates obtained from MICROMORT were compared using a Z statistic (Heisey and Fuller 1984). The distance carcasses were found from roads, streams, and leave strips were compared to random points using Wilcoxon rank sums analysis. Difference in road use throughout the period was tested using Kruskal-Wallis tests. Observed scent station use was compared to expected use by Chi-square goodness-of-fit tests.

Results

Trapping and handling

Trapping effort (time spent searching for turkey sign, and bait sites/1000 ha) was constant regardless of season or site, but trapping success (percent of trap attempts successful) varied seasonally and by area. Both control areas and the Gunstock tract were searched daily for turkeys and turkey sign. During the last 2 years of the study, searches on the Fisher and Eldridge tracts revealed little use by turkeys and trapping effort on these areas was limited. Even though there was less evidence of turkey use on control areas, potential trapping sites on Horsepen and Taylor were baited at a rate similar to Gunstock (18, 19, and 18 bait sites/1000 ha respectively). However, trapping success at Horsepen and Taylor was 0% (8 trap attempts (TA)) and 10% (20 TA) respectively, while trapping success at Gunstock was 25% (40 TA), 33% (24 TA) during fall and 13% (16 TA) in the winter.

During the 3 year study 106 wild turkeys were captured including 1 recapture (Appendix Table 1). One hundred and five were captured with alpha-chloralose, 93 were captured in treated areas, and all but 4 were captured during the fall trapping season. Females and juveniles accounted for 52 and 72% of the capture respectively (Table 1). Weight averaged (SE) 3.5 kg (0.16) and was different for all combinations of age and sex ($P < 0.05$; Table 1).

Seventy-eight percent of the 105 turkeys captured with alpha-chloralose apparently recovered and were released (Table 2). Eighty percent (N=66) of released turkeys were equipped with a transmitter. Turkeys < 2.0 kg were deemed too small to carry a transmitter. Six turkeys lost their transmitters at the time of release. Thirteen percent died from a drug overdose, however, this varied by year (see chapter 2). Eight percent recovered from the effects of the drug but lost the use of their legs and could not be released. These birds eventually died from complications or were sacrificed. One bird died from a brain hemorrhage after hitting its head in the holding box. Recovery time for all turkeys averaged (SE) 43 hrs (1.5), and did not differ by sex, or age class ($P > 0.05$; Table 3). The behavior of turkeys at release included running directly into the forest and not attempting to fly, long sustained flight, and unsuccessful attempts to fly. The absence of full flight at release is not unusual (E. W. Kurzejeski, Mo. Dept. Cons., pers. commun.) but raised suspicions that the transmitter and/or harness, or some aspect of handling, negatively affected some birds (see chapter 3).

Overall survival and mortality factors

Survival data was obtained from 65 of 66 different turkeys released with transmitters during the 3 years of the study (Appendix Table 2). Overall, 80% of the turkeys died from predation,

Table 1. Mean weight[a] and standard error (kg), and number of wild turkeys captured, Buckingham County, Virginia, 1985-1988.

	Male	Female	Undetermined	Total
Adult N	7.1±0.19 11	4.0±0.10 18	-	5.2±0.30 29
Juvenile N	3.5±0.19 25	2.9±0.12 21[b]	2.0±0.11 29	2.8±0.11 75[b]
Total	4.6±0.32 36	3.4±0.12 39[b]	2.0±0.11 29	3.4±0.16 104[b,c]

[a]Different for all combinations of age and sex ($P < 0.05$, Wilcoxon rank sum)
[b]Includes 1 recapture
[c]Actual total 106 - 1 juvenile female and 1 juvenile male weight not available

Table 2. Results of wild turkey trapping, Buckingham County, Virginia, 1985-1988.

	Number of turkeys (%)
Died from drug overdose	13 (12)
Died from leg dysfunction complications	9 (8)
Miscellaneous handling death	1 (1)
Released without transmitter	16 (15)
Released with transmitter	67 (63)[a]
Total	106[a]

[a]Includes 1 recapture and 1 turkey captured with a rocket net

Table 3. Mean recovery time[a] and standard error (hrs.), and number of wild turkeys captured with alpha-chloralose, Buckingham County, Virginia, 1985-1988.

	Male	Female	Undetermined	Total
Adult N	46.0±2.83 9	50.2±5.69 16	-	48.7±3.75 25
Juvenile N	43.9±2.77 22	38.8±1.99 19[b]	39.4±2.41 23	40.9±1.42 64[b]
Total	44.5±2.11 31	44.1±2.93 35[b]	39.4±2.41 23	43.0±1.50 89[b,c]

[a]Not different for any combination of age and sex ($P > 0.05$, Wilcoxon rank sum)
[b]Includes 1 recapture
[c]Actual total 92 - 1 juvenile female and 2 juvenile males recovery time not available

6% were harvested legally, 5% were poached, 5% apparently dropped their transmitters, 2% were alive at the end of the study, and contact was lost with 3% (Table 4).

Because overwinter survival (1 September - 31 May) was < 2% for all radio-equipped turkeys regardless of site or year, daily survival estimates were used to make comparisons (Table 5). No turkeys were trapped on control areas in 86/87, and only 2 were trapped in 87/88 despite extensive trapping efforts. Only the 11 turkeys trapped on Horsepen in 1985 yielded a survival estimate which could be compared to the treatment areas, and in that year survival was significantly greater on the treatment areas ($P < 0.01$). Because of the low number of turkeys captured on control areas and the extremely low survival when compared with treatment, further survival analysis will consider only the 52 radio-equipped turkeys released on treatment areas.

One-third of radio-equipped birds on treatment areas died from predation within 2 weeks of release during the last 2 years of the study (see chapter 3). Daily survival calculated for each week after release, and cumulatively by week (Tables 6 and 7, Figs. 1 and 2) began to improve 4 weeks after the release date. Survival during the first 4 weeks was less ($P < 0.01$) than survival 5+ weeks after release.

Survival during 87/88 was less ($P < 0.01$) than 85/86, but among years survival after week 5 was similar. Survival was lowest during the prehunting period and improved throughout the study year (Table 8). However, when only those turkeys surviving past 4 weeks were considered, survival during the prehunting period was higher ($P < 0.01$) and survival was in general more uniform throughout the periods.

Adult survival was higher than juvenile survival ($P < 0.01$) and female survival was higher than male survival ($P < 0.01$; Table 9). However, the latter was due to extremely poor daily survival (94%) of juvenile males (Table 9). Only 2 of 13 radio-equipped juvenile males but 6 of 12 juvenile females survived the first month after release.

Juveniles captured in late October were heavier ($P < 0.05$) than those captured earlier in the trapping period and survival of juveniles captured in late October was higher ($P < 0.01$), approaching that of adults (Table 10).

Table 4. Mortality factors (%) of radio-equipped turkeys, Buckingham County, Virginia, 1985-1988.

	Treatment Areas	Control Areas	Total
Predation	42 (81)	10 (77)	52 (80)
Harvest	2 (4)	2 (15)	4 (6)
Poached	3 (6)	0	3 (5)
Lost contact	2 (4)	0	2 (3)
Dropped transmitter	2 (4)	1 (8)	3 (5)
Alive	1 (2)	0	1 (2)
Total	52	13	65

Table 5. Daily survival (95% C.I.) of wild turkeys during the interval 1 September - 31 May, Buckingham County, Virginia, 1985-1988.

Site	85/86	86/87	87/88	3 years pooled
Control	0.918 (0.871-0.964) (11,134)[a]	No data	0.937 (0.819-1.000) (1,16)	0.920 (0.877-0.963) (12, 150)
Treatment	0.983 (0.976-0.991)[a] (19,1148)	0.974 (0.958-0.989) (11,419)	0.957 (0.938-0.977)[b] (18,421)	0.976 (0.969-0.983) (48, 1988)
Total	0.977 (0.968-0.985) (30,1282)	0.973 (0.958-0.989) (11,419)	0.957 (0.937-0.976) (19,437)	0.972 (0.965-0.979) (60, 2138)

[a]Number of deaths and radio-days respectively
Values within rows followed by different letters are significantly different ($P < 0.01$, Z statistic)

Table 6. Daily survival (95% C.I.) weekly after release of radio-equipped turkeys on treatment areas, Buckingham County, Virginia, 1985-1988.

Week	Radio days	Deaths	Survival	
1	317	15	0.952 (0.929-0.976)	
2	243	4	0.983 (0.967-0.999)	0.964**
3	189	7	0.963 (0.936-0.990)	(0.952-0.976)
4	141	6	0.957 (0.924-0.991)	
5	118	3	0.975 (0.946-1.000)	
6	96	2	0.979 (0.951-1.000)	
7	85	1	0.988 (0.965-1.000)	0.987**
8	75	2	0.973 (0.937-1.000)	(0.981-0.993)
9	65	2	0.969 (0.927-1.000)	
10+	842	7	0.992 (0.986-0.998)	

**Significantly different ($P < 0.10$, Z statistic)

Table 7. Cumulative daily survival (95% C.I.) weekly after release of radio-equipped turkeys on treatment areas, Buckingham County, Virginia, 1985-1988.

Week	Radio days	Deaths	Survival
1	317	15	0.953 (0.929-0.976)
2	560	19	0.966 (0.951-0.981)
3	749	26	0.965 (0.952-0.978)
4	890	32	0.964 (0.952-0.976)
5	1008	35	0.965 (0.954-0.977)
6	1104	37	0.967 (0.956-0.977)
[illegible]	1189	38	0.968 (0.958-0.978)
8	1254	40	0.968 (0.959-0.978)
9	1329	42	0.968 (0.959-0.978)
10+	2171	49	0.977 (0.971-0.984)

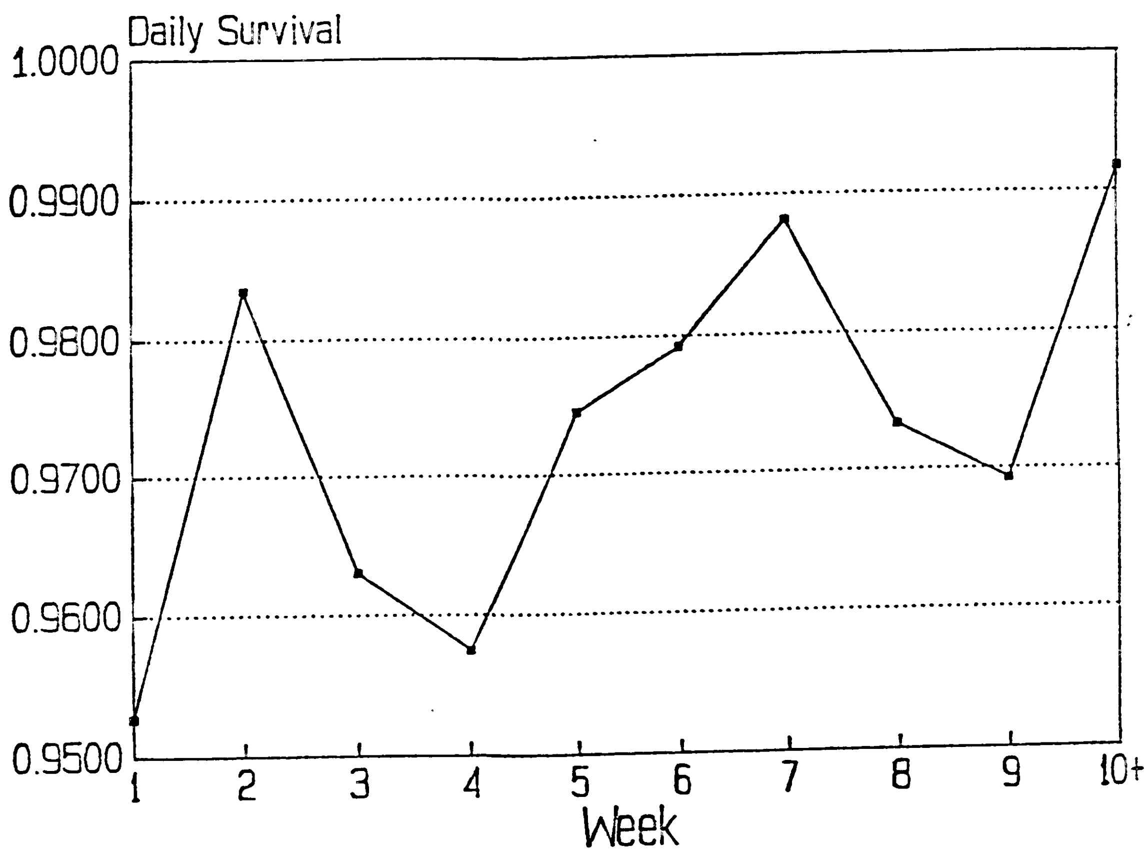

Figure 1. Daily survival of wild turkeys weekly after release on treatment areas, Buckingham County, Virginia, 1985-1988.

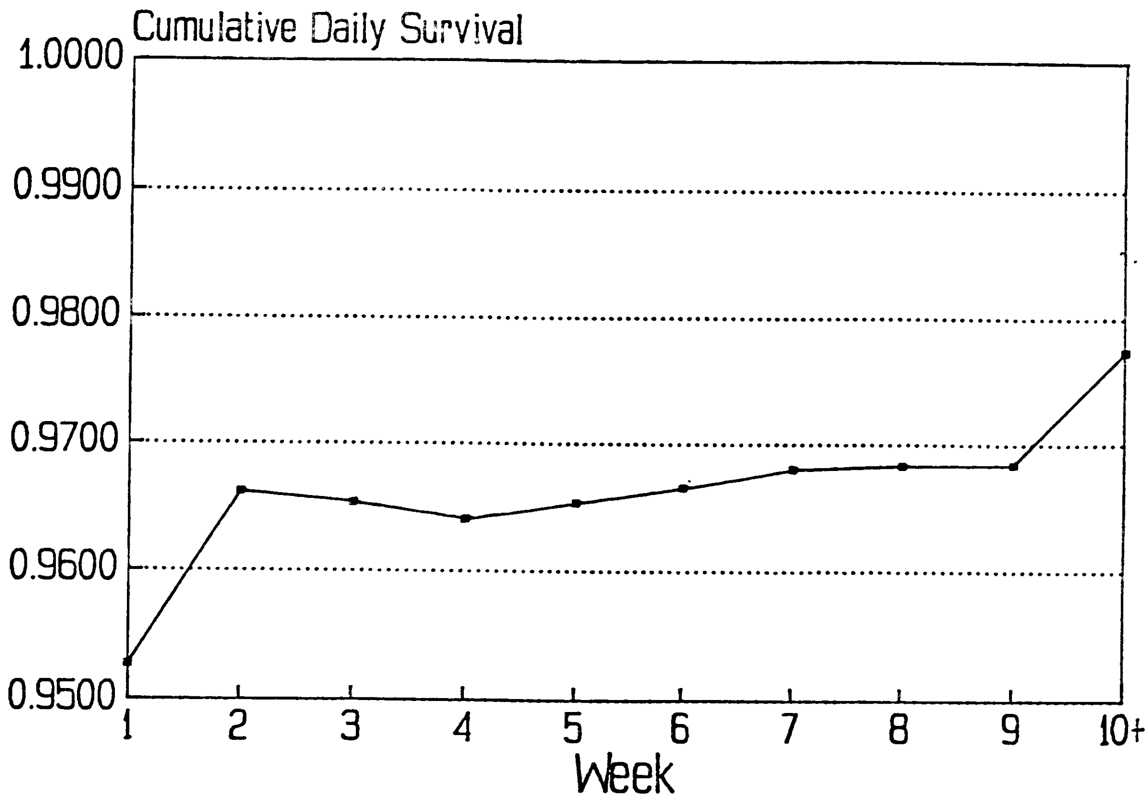

Figure 2. Cumulative daily survival of wild turkeys weekly after release on treatment areas, Buckingham County, Virginia, 1985-1988.

Table 8. Daily survival (95% C.I.) of all wild turkeys on treatment areas and only those surviving past 4 weeks, Buckingham County, Virginia, 1985-1988.

Period	All birds	Only those which survived past 4 weeks
Prehunting	0.965 (0.952-0.978)[a] (27, 771)*	0.998 (0.994-1.000)[b] (1, 465)
Fall hunting	0.978 (0.967-0.989) (15, 680)	0.982 (0.972-0.993) (11, 622)
Winter	0.983 (0.970-0.997) (6, 354)	0.988 (0.976-0.999) (4, 332)
Spring hunting	1.000 (1.000-1.000) (0, 183)	1.000 (1.000-1.000) (0, 183)

*Number of deaths and radio-days respectively
Values within rows followed by different letters are different ($P < 0.01$, Z statistic)

Table 9. Wild turkey daily survival (95% CI) by age and sex, for 3 years pooled, on treatment areas, Buckingham County, Virginia, 1985-1988.

	Adult	Juvenile	Total
Male	0.987 (0.968-1.000) (2, 149)[*]	0.940 (0.908-0.971) (13, 216)	0.959 (0.979-0.979)[c] (15, 365)
Female	0.985 (0.977-0.994) (12, 825)	0.989 (0.968-0.991) (12, 593)	0.983 (0.976-0.990)[d] (24, 1418)
Undetermined	-	0.956 (0.928-0.984) (9, 205)	0.956 (0.928-0.984)[c] (9, 205)
Total	0.986 (0.978-0.993)[a] (14, 974)	0.966 (0.955-0.977)[b] (34, 1014)	0.976 (0.969-0.983) (48, 1988)

[*]Deaths and radio-days respectively
Values within rows and columns followed by different letters are significantly different ($P < 0.01$, Z statistic)

Table 10. Weight (kg)[a] and daily survival[b] of juvenile wild turkeys from treatment areas, Buckingham County, Virginia, 1985-1988.

Release date	N*	Weight $\bar{x}$ (SE)	Daily survival (95% C.I.)
September - Early October	23, 380	2.7 (0.11)	0.945 (0.922-0.968)
Late October - Early November	12, 728	3.5 (0.28)	0.983 (0.974-0.993)

*Deaths and radio-days respectively
[a]Significantly different ($P < 0.05$, Wilcoxon rank sum)
[b]Significantly different ($P < 0.01$, Z statistic)

Habitat use, survival, and mortality factors on Gunstock

During fall 1986 through winter 1988, 31 turkeys were captured and released with transmitters on the Gunstock Tract (Appendix Table 1). Based on 295 radio locations or direct observation of these birds, 2 distinct groups were apparent (Fig. 3), thus 2 composite home ranges were calculated (Koeln 1980). Because habitat outside the Gunstock boundary was not under industrial forest management, turkey locations outside the tract were not considered in use vs. availability analysis. Habitat use for locations within Gunstock was different from availability ($\chi^2 = 131.96$) with the entire tract considered as available habitat. Use was > availability for the hardwood blocks and the older loblolly stands (16+ yrs.) and < availability for the hardwood leave strips and younger loblolly stands (0-15 yrs.; Table 11). Habitat use also was different from availability ($\chi^2 = 42.34$) within the 2 composite home ranges. Use was > availability for the older loblolly stands (16+ yrs.) and < than availability for the mid-age pine stands (4-15 yrs.; Table 12).

Contact was maintained with 27 of the 31 radio-marked turkeys released on Gunstock. Twenty died on the tract, 18 from predation (Appendix Tables 2 and 3). Based on field sign, condition of the carcass, and necropsy results it was determined that 8 of the 18 were killed by gray foxes, 2 by bobcats, 1 by a great-horned owl, and the cause of death for 7 could not be determined. X-rays showed that none of the carcasses recovered were crippled by shot. Sixty-five percent of the 20 died in hardwood areas even though they used these areas only 47% of the time (Table 13). The remaining 35% died in loblolly stands which were used 53% of the time. Turkeys died an average (SE) of 177 m (29) from a road and 329 m (55) from a hardwood leave strip, neither of which was different from expected ($P > 0.05$; Appendix Table 3). Turkeys died an average (SE) of 127 m (30) from a stream, which was closer than expected ($P < 0.05$).

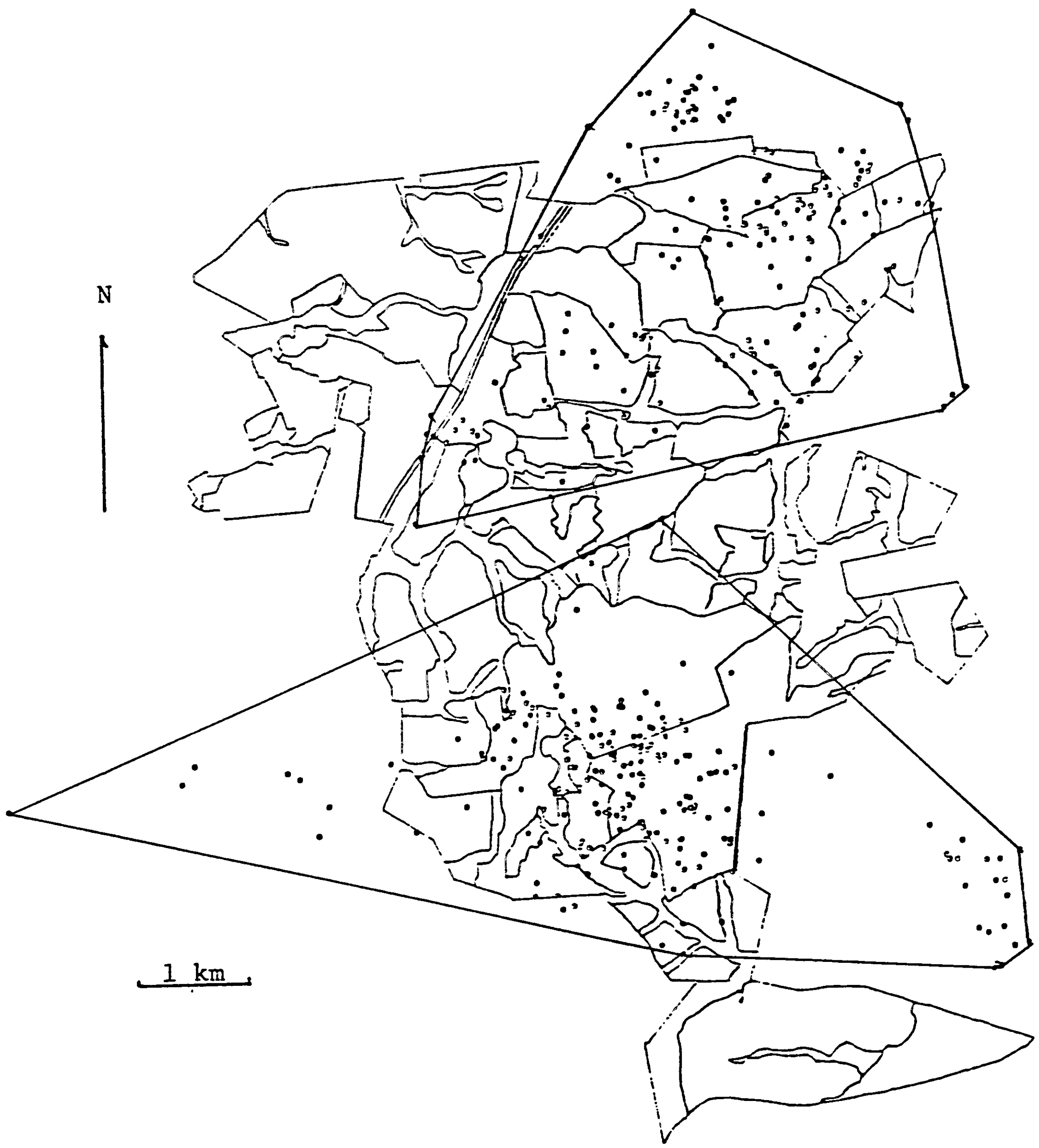

Figure 3. Individual locations and 2 composite home ranges of radio-equipped turkeys on the Gunstock tract, Buckingham County, Virginia, 1986-1988.

Table 11. Use vs. availability of turkey locations on the entire Gunstock tract, Buckingham County, Virginia, 1985-1988.

Habitat	Habitat proportion	Location proportion (N)	Bonferroni 95% CI	
HW Blocks	0.216	0.356 (105)	(0.291 - 0.421)	use > availability
HW Leave strips	0.160	0.108 (32)	(0.066 - 0.151)	use < availability
Fields	0.003	0.010 (3)	(0.000 - 0.024)	use = avalability
Loblolly 0-3 yrs.	0.118	0.058 (17)	(0.026 - 0.089)	use < availability
Loblolly 4-15 yrs.	0.374	0.180 (53)	(0.128 - 0.232)	use < availability
Loblolly > 15 yrs.	0.129	0.288 (85)	(0.227 - 0.349)	use > availability

Table 12. Use vs. availability of turkey locations within 2 composite home ranges on the Gunstock tract, Buckingham County, Virginia, 1985-1988.

Habitat	Habitat proportion	Location proportion (N)	Bonferroni 95% CI	
HW Blocks	0.291	0.356 (105)	(0.291 - 0.421)	use = availability
HW Leave strips	0.134	0.108 (32)	(0.066 - 0.151)	use = availability
Fields	0.005	0.010 (3)	(0.000 - 0.024)	use = avalability
Loblolly 0-3 yrs.	0.067	0.058 (17)	(0.026 - 0.089)	use = availability
Loblolly 4-15 yrs.	0.317	0.180 (53)	(0.128 - 0.232)	use < availability
Loblolly > 15 yrs.	0.184	0.288 (85)	(0.227 - 0.349)	use > availability

Table 13. Use (live locations of individual turkeys) and mortality (carcass locations) data for 20 turkeys dying in 6 habitats on the Gunstock tract, Buckingham County, Virginia, 1986-1988.

Habitat	Locations N (%)	Mortality N (%)
HW Blocks (22, 29)[a]	105 (36)	9 (45)
HW Leave strips (16, 13)	32 (11)	4 (20)
Fields (< 1, < 1)	3 (1)	0
Loblolly 0-3 yrs. (12, 7)	17 (6)	0
Loblolly 4-15 yrs. (37, 32)	53 (18)	2 (10)
Loblolly > 16 yrs. (13, 18)	85 (29)	5 (25)

[a]Percent habitat for entire Gunstock and portion within 2 home ranges respectively

Assessment of human and predator impact

Road use during fall hunting season on the 3 areas where traffic counters were placed followed similar patterns (Fig. 4). Road use was grouped as the 4 weeks prior to deer season, the 7 weeks of deer season, and the 4 weeks following the end of turkey and deer seasons. Traffic on Gunstock during the first week of deer season was 7 times the preseason average of 2.7 vehicles/km road/week (Fig. 4). Road use during the rest of the hunting season averaged 5.6 vehicles/km road/week and dropped off to almost 0 after hunting season closed. On Taylor Hunt Club, traffic during the first week of deer season was almost 4 times the preseason average of 1.5 vehicles/km road/week (Fig.4). But at Taylor, road use maintained this level throughout hunting season, again dropping off to almost 0 after hunting season ended. Road use on Greese Creek Hunt Club (a leased portion of the Gunstock tract with the only access being through a locked gate) averaged < 3 vehicles/km road/week throughout the period following a similar pattern to the other areas.

Gray fox and dogs were the most common potential turkey predators to visit scent stations (Fig. 5). Gray foxes came to scent stations > expected at Taylor, < expected at Horsepen, and = expected at Gunstock ($\chi^2 = 33.36$, $P < 0.05$). Dogs came to scent stations > expected at Taylor and Horsepen and < expected at Gunstock ($\chi^2 = 68.38$, $P < 0.05$). No great-horned owls were heard at any site throughout the census periods, however 1 was seen at Gunstock and 1 turkey was killed by a great-horned owl in this vicinity.

Percent occurrence of eastern cottontail in 45 gray fox and 13 bobcat scats found during the winter season was 56 and 50% respectively (Table 14). Scats from both species contained feathers, however these were all from passerines. The foot of an American woodcock (*Scolopax minor*), the largest bird detected, was found in a fox scat.

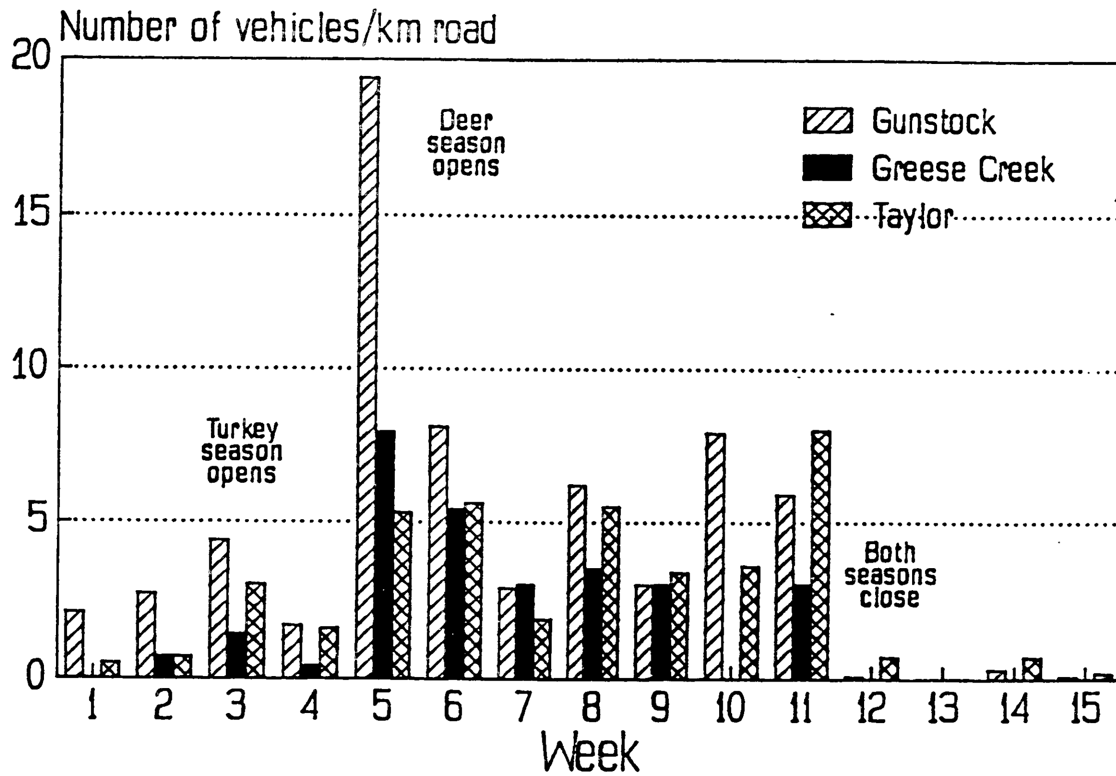

Figure 4. Average weekly road use/study area during 1987 hunting season, Buckingham County, Virginia.

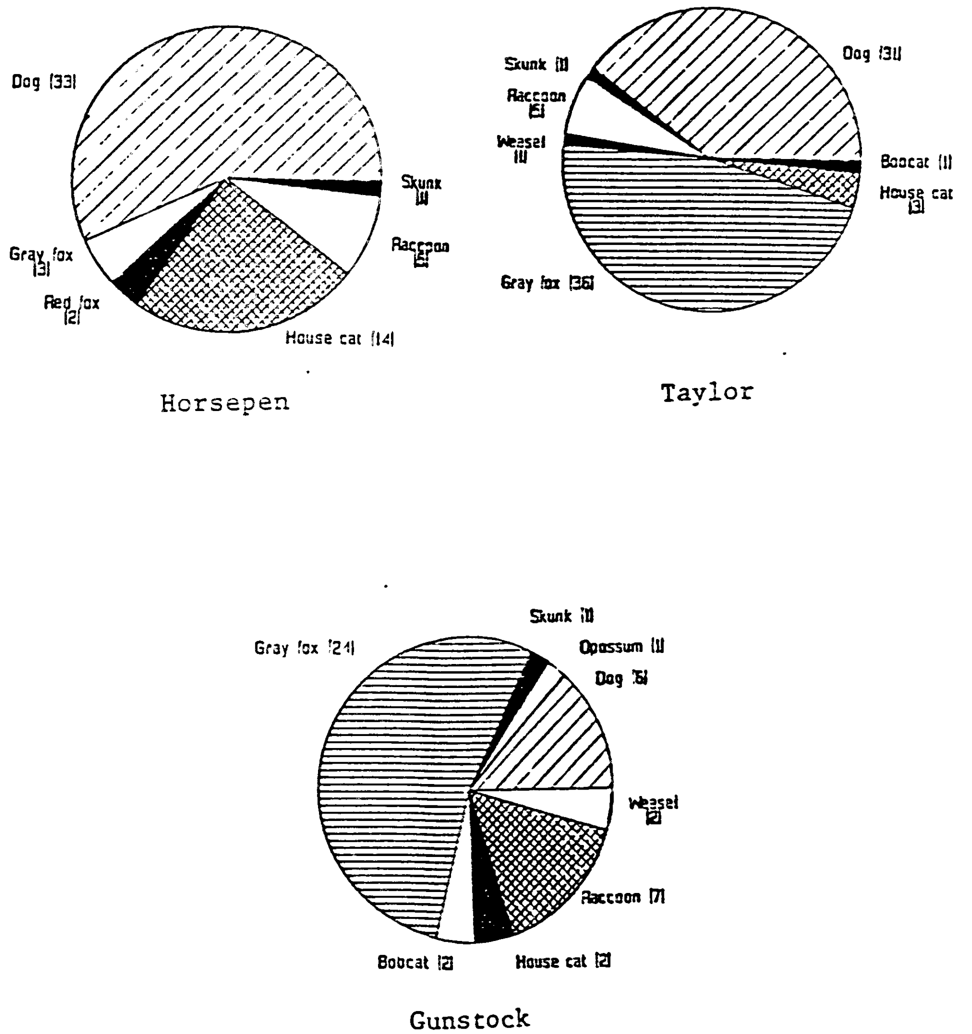

Figure 5. Scent stations visited (%) by predators on primary treatment and 2 control areas, Buckingham County, Virginia, 1986-1988.

Table 14. Percent occurance and volume of food items found in gray fox and bobcat winter scats from the Gunstock tract, Buckingham County, Virginia, 1986-1988.

	Gray fox		Bobcat	
Food Item	% Occurance	% Volume	% Occurance	% Volume
Cottontail	56	38	50	43
Opposum	9	5	36	17
Squirrel	9	5	7	3
White-tailed deer	9	7	7	7
Vole	2	1	7	1
Shrew	2	<1	7	2
Gray fox	2	<1	-	-
Bobcat	-	-	21	6
Woodcock	2	<1	-	-
Passerine	9	1	14	8
Insects	4	<1	-	-
Persimmon	44	28	-	-
Corn	4	1	-	-
Pokeberry	2	1	-	-
Eastern red cedar	2	2	-	-
Grass	20	5	21	5
Dirt	20	3	21	6

Population estimation

Minimum fall and winter estimates of the turkey population on the 3238 ha Gunstock tract were 1.65 and 0.49/km^2 respectively.

Discussion

Trapping and handling

Wild turkeys rarely are trapped in the fall (Sweeny 1980, Kennamer and Kennamer 1985) because natural foods are abundant then and juvenile turkeys often are not large enough to be captured safely by alpha-chloralose or to carry radio transmitters. In this study fall trapping was necessary to meet project objectives. In addition, oral anesthetics were used to capture turkeys because most of the study site was not suitable for trapping with projectile nets. Because of weight differences between adults ($\bar{x}$= 5.3 kg) and juveniles ($\bar{x}$= 2.8 kg) and the inability to control the amount of drugged bait eaten, birds took varying lengths of time to become narcotized. The 12% overdose rate, 77% of which was juveniles, was similar to the 9% mortality for winter trapped turkeys reported by Williams et al. (1966). (See chapter 2 for treatment of drug overdose.)

Trapping success (percent of trap attempts successful) varied between treatment and control areas and between fall and winter trapping periods. Trapping success on treatment areas was 56% in early fall (Sep.- Oct.) but only 20% in late fall when hard mast was most abundant. Trapping success in winter was only 13%, and likely was influenced by a heavy mast crop in 86/87 (VDGIF unpub. data), poor weather conditions (snow and rain) in 86/87 and

87/88, and a low density of turkeys throughout the study. Trapping success on the control areas was low in fall and winter (13 and 0% respectively). Neither control area was as large as the Gunstock tract or as isolated as any treatment area, hence, the proximity of residential areas to control areas and the associated disturbance from humans and dogs may have kept turkeys from finding and/or returning to bait sites. Dogs came through bait sites during 6 of 28 trapping attempts on control areas and only 2 of 40 on treatment areas.

In this study trapping was conducted without regard to sex or age and the sex and age ratios of turkeys captured were 52% females and 72% juveniles. Sex and age ratios of fall harvested turkeys in Virginia average 51% females and 61% juveniles (VDGIF 1986b), similar to statistics from other harvest studies (Mosby 1967). However, harvest statistics may underestimate the proportion of juveniles in the population because of selective hunting for adult males. In this study, trapping took place prior to fall hunting season when juveniles were relatively abundant, possibly contributing to the higher percentage of juveniles.

The leg dysfunction phenomenon observed in this study was similar to that described by Spraker et al. (1987) and diagnosed as capture myopathy. The phenomenon had varying degrees of severity and occurred in both sexes but only in juveniles. Spraker et al. (1987) reported muscle lesions in turkeys trapped in clover traps, clover traps with alpha-chloralose, and drop nets. Williams et al. (1966) reported leg paralysis in turkeys held in burlap sacks with their legs tied and advocated the use of holding boxes. In this study turkeys captured with alpha-chloralose may have developed capture myopathy from sitting on their legs in holding boxes for extended periods of unconsciousness (T. R. Spraker, Colorado State University [CSU], pers. commun.). Turkeys with severe cases could not or would not support their body weight, even though they had some strength in the upper portion of the leg. Their toes curled back similar to a severely arthritic human hand, and there appeared to be limited grasping ability. This may have been due to muscles being damaged while contracted (T. R. Spraker, CSU, pers. commun). In mild cases one leg appeared much worse than the other and the bird could move around. In one case a turkey that appeared normal standing in the holding box had to be retrieved immediately after release when a problem with its legs was observed. H. T. Holbrook (Ga. Dept. Nat. Res., pers. commun.) earlier observed the same phenomenon in adult male turkeys captured with alpha-chloralose and held in boxes.

Four of 9 turkeys with leg dysfunction were examined by the College of Veterinary Medicine at Virginia Tech. One was sacrificed immediately to examine fresh tissues. The remaining 3 were held for observation in an outdoor covered pen with food and water available *ad libitum*. Although capable of moving to the food, they did not and were force fed commercial turkey food through a feeding tube. All 3 eventually died, 2 within 10 days and 1 after 4 weeks. Gross examination revealed hemorrhages of varying degrees in the upper leg which is characteristic of capture myopathy and is possibly a result of turkeys forcing the use of damaged muscles (T. R. Spraker, CSU, pers. commun.).

Radio-equipped turkeys exhibited various behaviors at release. At 1 extreme, turkeys (approx. 20%) ran into cover not attempting to fly. At the other extreme, turkeys (approx. 40%) took off into long sustained flight (> 100 m) with no apparent problems. The remaining turkeys all attempted flight but stayed aloft only for short distances (1-20 m). The latter appeared to have trouble flying due to the transmitter package, although it was not clear whether the problem stemmed from the harness around the wings, the added weight of the package, a behavioral response to the package, or something else. In any case, it appeared that something associated with the transmitter, attachment, or some part of the trapping and handling process affected the flying ability of some turkeys (see chapter 3).

Overall survival and mortality factors

Efforts to trap turkeys on control areas met with little success and only 13 turkeys were radio-equipped on these areas. Survival of the 13 turkeys was less than ($P < 0.01$) survival of the 52 radio-equipped birds on treatment areas, but survival was low throughout the study regardless of area. Low survival on control areas may have in part resulted from the timing of release. Nenno and Healy (1979) reported that radio-equipped turkeys need time to become accustomed to transmitters. The 11 turkeys captured at Horsepen, a heavily hunted area, were released 2 days before turkey season began, and 2 were subsequently harvested, 1 within 2 days of release. Also, dogs used to chase deer during hunting season break up turkey flocks (Shaffer and Gywnn 1967, Coggin and Perry 1975), possibly making them more prone to natural predation or harvest.

Shaffer and Gwynn (1967) concluded from field observations by a number of researchers that predation on adult and immature wild turkeys is rare. Markley (1967) agreed, but suggested that predation may become a problem when turkeys are forced into "unfavorable range" such as pine plantations. In an Alabama industrial forest 37% of turkeys trapped in late winter (N=59) were killed by predators (Exum et al. 1987) and in this study, 81% of the radio-equipped turkeys on treatment areas (N=52) were killed by predators (Table 4). Identifying the predator involved was often difficult but as in Alabama (Exum et al. 1987) the most abundant predators on the study area were gray foxes, bobcats, and dogs.

Only 10-14% of turkey mortality was human induced (Table 4). The 4% harvest rate and the 6 and 0% mortality rates from poaching and crippling respectively were low compared to other studies (Mosby and Handley 1943, Mosby 1967 Powell 1967, Lewis and Kelly 1973, Wright and Speake 1975, Kimmel and Kurzejeski 1985), but these low rates were not necessarily indicative of human pressure. The high predator-induced mortality kept the sample of radio-equipped birds low, decreasing the likelihood of a human encounter, legal or not.

Overwinter survival on treatment areas was < 2% each year. Mosby (1967) reported 40 and 24% annual survival rates respectively from hunted populations of turkeys in Florida and West Virginia. Holbrook and Vaughan (1985) reported 15% annual survival rates on the same study areas as the present study. The lowest reported annual survival was 6% from a heavily hunted population of turkeys in Florida (Williams et al. 1978). However, in the present study even using the upper limit of the confidence interval (Table 4) from the best year (85/86), annual and overwinter survival were only 3 and 8% respectively.

Poor survival soon after release was a major factor contributing to low overall survival. In Missouri, 10% of radio-equipped turkeys died during the first week after release (E. W.

Kurzejeski, Mo. Dept. Con., pers. commun.) Gilmer et al. (1974) reported 60% of predator mortality on radio-equipped mallards and wood ducks occurred within 3 weeks of release. In this study, one-third of the turkeys released with transmitters on the treatment areas died from predation within 2 weeks of release indicating that some factor associated with trapping and tagging may have made turkeys more vulnerable to predation, the overwhelming cause of mortality. Possible causes were capture myopathy, residual effects from alpha-chloralose, behavioral aberrations and/or physical impairment associated with trapping, the transmitter or harness, or any combination of the above.

As previously noted, drugged turkeys held for long periods could incur muscle damage similar to birds trapped by mechanical methods. Capture myopathy can cause a lower tolerance to exercise (Spraker et al. 1987) and even a mild case could have been enough to predispose an affected bird to a greater chance of predation. In this study, turkeys with capture myopathy symptoms were not released, however it is possible that birds were released with undetected muscle damage decreasing their chances of survival.

The full extent of the effect of alpha-chloralose on wild turkeys is unknown. How long alpha-chloralose remains in the body or at what concentration in the body alpha-chloralose influences a turkey's nervous system have not been determined. If when released, the increased activity mobilized unmetabolized alpha-chloralose and produced a second narcosis a turkey's ability to escape predation would have been impaired.

The influence of radio transmitter packages on animals, particularly avian species, is not fully understood. J. M. Lockhart (USFWS, pers. commun.) suggested that radio transmitters had a negative effect on breeding success of golden eagles in Wyoming. Obrecht et al. (1988) reported that transmitters increase drag and have a negative impact on non-stop flight distances. Pennychuick and Fuller (1987) described how the added weight of a transmitter could increase the power needed to support a bird in the air and that low-speed maneuvers such as take-offs could be affected. P. D. Major (In. Dept. Nat. Res., pers. commun.) suspected transmitters contributed to a 50% mortality rate "shortly" after release of radio-equipped turkeys in Indiana. The harness portion of the package also could affect flight and current research at the Patuxent Wildlife Research Center is being conducted in this area (M. R. Fuller, USFWS, pers. commun.). Reduced ability to take-off rapidly due to transmitter packages could have made turkeys more vulnerable to predation in this study.

Beside the physical effects of a transmitter package, turkeys may have been affected behaviorally. Greenwood and Sargent (1973) observed that radio-equipped mallards and blue-winged teal in North Dakota seemed preoccupied with the transmitter. Nenno and Healy (1979) described a number of behavioral aberrations of radio-equipped turkeys, such as the disintegration of the flock, pecking the transmitter, and difficulty roosting, all of which may increase chances of predation.

Combinations of the factors described above also are possible. A turkey released with undetected problems from capture myopathy or residual effects from alpha-chloralose would have more trouble handling the added burden of a transmitter and would be more vulnerable to predation.

Greenwood and Sargent (1973) noted that the first few weeks after release is a critical adjustment period for birds. Nenno and Healy (1979) suggested waiting 1 week after release before collecting telemetry data to eliminate bias from transmitter influence. In this study survival apparently was negatively affected up to 4 weeks after release (Tables 6 and 7, and Fig. 1 and 2). Although overwinter survival of the 18 turkeys living longer than 4 weeks was only 3%, this is probably a better representation of actual survival on these industrial forests.

Within year, differences in daily survival were related to trapping and tagging activities. The lowest daily survival (96.5%) occurred during the prehunting period (Sep.-Oct.), when 95% of the trapping was conducted and hence, when the influence from trapping and tagging activities had its greatest effect. Survival improved the remainder of the year as the handling effect on survival dissipated. Survival was lowest during the winter and hunting periods for those surviving past 4 weeks.

Another point which should be emphasized is that in this study, unlike many others, birds were being trapped in early fall and many small turkeys ($<$ 3 kg) were captured. Adults survived better than juveniles ($P < 0.01$), and large juveniles survived better than small juveniles ($P < 0.01$). Juveniles trapped and radio-equipped in September and October were lighter than those equipped later in the fall ($P < 0.05$) and their survival was lower ($P < 0.01$). This suggest that smaller birds were more adversely effected by trapping and handling, and by the transmitter package. Juveniles are more vulnerable to predation (Markley 1967) and harvesting (VDGIF 1986b) than adults and the added stress of trapping and handling, the burden of carrying a transmitter, and separation from the flock probably contributed to higher mortality among juveniles.

Habitat use, survival, and mortality factors on Gunstock

Westvaco's Gunstock tract was the focal area used to determine the influence of roads and hardwood leave strips on wild turkey survival. Habitat use on the area was examined: 1) considering the entire tract as available; and 2) considering only that portion of the tract used by turkeys as available. The former analysis indicated turkeys avoided hardwood leave strips but preferred hardwood blocks. The statistical analysis (Table 11) shows that the proportion of hardwood leave strips available falls just slightly above the 95% confidence interval for use by turkeys. Hardwood leave strips are important as travel corridors (Gehrken 1975), but turkeys may not spend much time in them. Avoidance possibly was due to the proximity of leave strips to undesirable stands such as clearcuts and young loblolly which also were avoided. Avoidance of young loblolly stands was surprising since many of these areas provide a good source of grasses, forbs, invertebrates, and soft mast associated with disturbed sites which are preferred by turkeys (Kennamer et al. 1980b). Dense mid-age pines also were avoided but older pines, with open understories, were preferred as was the case in an Alabama industrial forest (Exum et al. 1987).

In the latter analysis all habitats were used in proportion to availability except the middle and older loblolly stands (Table 11). Holbrook et al. (1987), in the same areas, reported use equal to availability in all habitats, although loblolly stands in that study were all < 5 years.

Exum et al. (1987) reported use $<$ availability in loblolly stands $<$ 10 years, $>$ availability in loblolly stands $>$ 10 years, and $=$ availability in bottomland hardwoods.

The latter analysis is probably more appropriate since it eliminates large portions of Gunstock where trapping did not take place and areas that were not used by radio-tagged turkeys.

To eliminate bias from birds whose movements may have been altered by capture the same analysis was run with just those turkeys that survived 4 weeks. The results were generally the same, indicating that trapping probably did not alter habitat use patterns.

Carcasses often were well scavenged even though mortality-sensing transmitters were used and recovery was usually within 24 hrs. However, based on field sign and identifiable marks on the carcass, it was still possible to determine that 44% of the predator kills on Gunstock were by gray foxes. Sixty-five percent of the predator kills occurred in hardwood areas, blocks and leave strips, whereas individual turkeys spent only 47% of their time in these areas when alive. The association between hardwoods and water and food sources probably contributed to turkeys being killed in hardwood areas. Stands were left in hardwoods and not converted to pines to benefit wildlife. The primary benefits to wildlife in these area were streams and mast, and the data demonstrates that turkeys died closer to streams than random points ($P < 0.05$).

Bailey et al. (1981) suggested that for a turkey population to thrive there should be no more than 6 km of roads/1000 ha. The 15.9 km of ungated roads/1000 ha on Gunstock apparently did not allow harvests or poaching to adversely affect turkeys in the area since no turkeys were harvested at Gunstock during the last 2 years and only 2 were poached (Appendix Table 2). However, only 7 of 28 turkeys radio-equipped prior to hunting season were still being monitored when hunting season began. The remainder already had died, had dropped their transmitters, or the transmitters had failed.

Assessment of human and predator impact

The data indicate that predation was the major source of mortality with humans accounting for only 10-14%. The traffic counter data indicate that most hunters are out for deer or at least do not spend much time hunting turkeys until deer season when both deer and turkey are legal. In Buckingham County, hunting deer, turkey, or other game with dogs is legal and common. The action of dogs chasing game through the forest has the potential to break up gangs of turkeys. This technique, typically used in fall hunting, along with calling in turkeys, makes them easier to harvest (Coggin and Perry 1975), but possibly makes individual birds more susceptible to predation as well.

Based on tracks and scats found near carcass sites, gray foxes and bobcats were apparently the major predators on turkeys at Gunstock. Scent station results indicated that gray foxes were numerous at Gunstock, or at least visited scent stations frequently (24%). Bobcats were not as numerous or were more wary of scent stations than foxes because they visited scent stations infrequently (2%). No turkey remains (eg: feathers or hollow bones) were found in the scats of either species. However, this was probably the result of the eating habits of these predators. The condition of carcasses indicated that the head and entrails were the most common part of the turkey eaten by a predator and that feathers and hollow bones were avoided.

It is apparent that turkey populations on Gunstock were subjected to a high degree of predator-related mortality, particularly from gray foxes. An indepth investigation into the fox population in these areas would be necessary to accurately examine this turkey/predator relationship. However, some observations can be made at this time. The forest management practices associated with short-rotation pine forests are beneficial to rodents and rabbits, eg: clearcuts and slash piles (Johnson et al. 1974). A high density of these prey species could elevate gray fox populations, which also prey on turkeys. Also, forest fragmentation, such as that created by hardwood leave strips in industrial forests, creates edge where predators concentrate (Gates and Gysel 1978). Hence, turkeys in this study possibly were more susceptible to predation because of the fragmented nature of the hardwoods and high predator density.

Population estimation

With the relatively small number of turkeys in these areas it was not possible to estimate population size by techniques used previously such as, mark-recapture (Everett et al. 1980) and gobbler counts (Porter and Ludwig 1980). However, because of the time spent on Gunstock trapping and looking for birds to trap it was possible to get an indication of the minimum number of birds using the tract. The minimum number of turkeys, based on birds handled and seen, for fall 1986 and 87 was 44 and 62 respectively (1.35 and 1.91/km^2). The 1987 and 88 winter estimates were only 10 and 16 respectively (0.31 and 0.69/km^2) and was possibly due to the impact this study had on fall turkey populations, natural losses, and/or greater difficultly in getting to all areas of the study site. Holbrook (1984) reported that considering the 15% survival observed, 50% of the fall population of turkeys had to be composed of immigrants in order to maintain the population level. It appears that this also was the case in this study. Estimated population levels remained fairly stable between the 2 years. However, considering the extremely poor survival, immigration or excellent reproductive success and recruitment would have been necessary to maintain the population.

Conclusion

The low survival of wild turkeys reported in this study substantiates similar findings reported by Holbrook and Vaughan (1985) in their work on the same areas. However, in concentrating on the factors of mortality the results here indicated that predation was the major cause and not crippling loss as suspected by Holbrook and Vaughan (1985). Also, while management practices on industrial forests, such as hardwood "leave strips", are beneficial to turkeys and should be included in forests, other practices, such as clearcuts, which produce food and cover for small mammals, appear to keep predator populations high putting turkeys at greater risk. Populations of predators and their prey should be monitored and trapping of predators allowed to occur to reduce pressure on turkeys.

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Chapter 2: Fall trapping wild turkeys with 2 different dosages of alpha-chloralose

Investigations into the use of oral anesthetics to trap wild turkeys began in the mid 1950's. Tribromoethanol was first used experimentally on penned and wild turkeys (Mosby and Cantner 1956), and subsequently was used by other researchers to trap wild turkeys (Williams et al 1973, Evans et al. 1975). It is fast acting, with low drug related mortality (Williams et al. 1973, Evans et al. 1975), but the proportion of drugged turkeys captured can be as low as 50%, depending on dosage (Evans et al. 1975). Alpha-chloralose was first used in Europe for pest control (Ridpath et al. 1961, Murton et al. 1963), and later used in the U.S. to trap Canada geese (*Branta canadensis*) and several species of ducks (Crider and McDaniel 1967). Williams (1966) developed procedures, later adopted by others, for trapping wild turkeys with alpha-chloralose (Everett et al. 1980, Hopkins et al. 1980, Kennamer et al. 1980, Speake 1980, Exum et al. 1985, Holbrook and Vaughan 1985, Metzler and Speake 1985). Alpha-chloralose is a slower acting drug than tribromoethanol with longer recovery time and drug related mortality of approximately 10% (Williams et al. 1973). Methoxymol and trichloroethanol also have been used to trap turkeys. Methoxymol is safe and effective in trapping wild turkeys, but apparently is extremely distasteful to turkeys (Williams 1967). Mortality using trichloroethanol was 38% in studies in North Carolina and Michigan and its use for trapping turkeys was not recommended (Bailey and Doepker 1977).

A major drawback to using oral drugs is that dosage per turkey cannot be controlled. Since age class and sex of turkeys being trapped is not always known ahead of time a dosage specific to body weight cannot be used. Also, turkeys individually eat differing amounts of treated bait. Hens feeding with poults often watch more than eat and thus do not become narcotized as easily (Evans et al. 1975). Birds feeding later in the day may be more satiated and may not consume enough drug laced bait to become narcotized (Evans et al. 1975). Thus, average dosage rates have been established to trap the greatest number of turkeys with the least amount of drug related mortality.

Trapping of juvenile and adult wild turkeys was attempted in late summer and early fall using the standard dosage of alpha-chlorlose (2.0 g/0.25 liter bait) (Williams 1966). After experiencing high drug related mortality, particularly among juveniles, a reduced dosage was tried. This paper reports on the use of 2 different dosages for fall trapping of wild turkeys.

Study Area

The study was conducted on 2 tracts of land in Buckingham County, Virginia (Appendix Figs. 1 and 2). The first area was a 2700 ha tract of land owned and operated by Westvaco for short-rotation pine production. Over 60% of the land was in plantations of loblolly pine (*Pinus taeda*), ranging in age from 1-28 years and compartment size from 3-179 hectares. The remainder was mixed hardwoods left in large blocks on steep slopes or strips along drainages. The second area was a 1200 ha tract of privately owned land leased by a hunt club and maintained in typical Piedmont habitat with little active management.

Methods

Wild turkeys were trapped during late summer and early fall, 1986 and 1987. Several bait sites were established using cracked corn in sections of both study areas where turkey sign had been observed. When turkeys had visited a site on several consecutive days a trap attempt was made. Every effort was made to establish the sex, age, and number of turkeys using the site. This involved looking at scats, tracks, and the amount of prebaited corn consumed, and observing from blinds before attempting to trap.

Moistened cracked corn was mixed with alpha-chloralose in small increments 2-8 hrs prior to each trapping attempt. In fall 1986 alpha-chloralose was applied at a rate of 2.0 g/0.25 liter corn. In fall 1987 the rate was 1.8 g/0.25 liter corn. Drugged corn was placed at the bait site prior to sunrise in the same manner as the previous days. Trappers watched from previously established blinds as turkeys consumed the bait and moved through the 4 stages of narcosis (Williams et al. 1966). Trappers remained in blinds until all turkeys were to stage 3 (muscle coordination lost and can be captured by hand), or had wandered from the bait site. The time turkeys began feeding, how long they fed, and their reaction to the drug was noted for each trapping incident. Narcotized turkeys were picked up by hand or with the aid of a long handled dip net and placed in paraffin treated cardboard boxes. Corn was surgically removed from the crops of turkeys judged to have consumed an unusual amount of bait (Williams 1966).

National Weather Service data from Farmville, Virginia (approx. 30 km from the study area) on temperature and general weather conditions during trap days were recorded.

Turkeys were taken to a holding facility for recovery and processing, which included recording weight, sex and age, and tagging. Each bird was removed from the box approximately every 4 hrs to assess its recovery and elicit muscular movement. Survival under each dosage was noted as well as the time it took for recovery or death to occur.

Every surviving turkey was equipped with a Virginia Department of Game and Inland Fisheries (VDGIF) aluminum leg band (National Band Co., size 24) and a plastic patagial wing tag (Allflex cattle ear tags). Most turkeys weighing over 2.0 kg also were equipped with radio transmitters attached with nylon over-braided cable harnesses (Advanced Telemetry System, Bethel, MN). Turkeys were released within 200 m of the capture site early in the morning on the first day after recovery (1-5 days).

Results

During the 2 year study 71 wild turkeys came to alpha-chloralose treated bait (Table 15). Overall, 90% of these were captured, however, were captured (84 vs. 100%) on the reduced dosage used in 1987.

Turkeys captured using 2.0 g (N=27) of drug began entering narcosis approximately 30 min after feeding began, and over half were in general anesthesia within 90 min. All 27 were captured by hand within 50 m of the bait site and within 2 hrs after initiation of feeding. On the other hand, turkeys captured using 1.8 g (N=37) of drug began entering narcosis after approximately 45 min, and only 15% were in general anesthesia within 90 min. Only 30% were captured within 50 m of the bait site and 24% had to be captured with the aid of a net.

Nineteen percent of the 64 turkeys captured died from a drug overdose (Table 15). More died using the 2.0 g dosage due primarily to greater mortality in the juvenile age class.

In 1986 average weights for captured adult females and juveniles were 3.8 and 2.4 kg respectively. In 1987 trapping was intiated 2 weeks later than in 1986 in an attempt to capture larger birds and reduce drug related mortality. Average weights of adult females and juveniles increased in 1987 to 4.6 and 2.5 kg respectively, but only the former was significant ($P < 0.05$). Mean weights of juveniles captured in 1987 increased ($P < 0.05$) between September and October from 2.1 to 3.9 kg. Six adult males with an average weight of 7.4 kg also were captured in 1987.

Table 15. Disposition of turkeys attracted to bait treated with 2 different dosages of alpha-chloralose (grams/0.25 liter cracked corn), Buckingham County, Virginia, 1986-87.

	1.8 g				2.0 g				
	Adult males	Adult females	Juveniles	Total (%)	Adult males	Adult females	Juveniles	Total (%)	Grand total (%)
Came to bait	11	6	27	44	0	4	23	27	71
Fed on bait - not captured[a]	5	0	2	7 (16)	0	0	0	0	7 (10)
Captured[a]	6	6	25	37 (84)	0	4	23	27 (100)	64 (90)
Died from overdose[b]	1	1	2	4 (11)	0	1	7	8 (30)	12 (19)
Recovered[b]	5	5	23	33 (89)	0	3	16	19 (70)	52 (81)

[a]Percent of those captured and not captured calculated from total coming to bait
[b]Recovered and died calculated from total captured

Overall, average time until recovery or death was 43 and 15 hrs respectively (Table 16). Recovery time was not different between age classes in the 2.0 g dosage or between dosages within age classes, but in the 1.8 g dosage adults took longer to recover than juveniles ($P < 0.05$). There were no differences ($P > 0.05$) in time until death between dosages or age classes.

During the study, corn was surgically removed from the crops of 3 turkeys. Two were juveniles which had fed on the 2.0 g dosage; both recovered in 48 hrs. The other was a juvenile which had fed on the 1.8 g dosage and died 6 hrs after feeding (4 hrs after the corn was removed).

Temperature on trap days ranged from 0 to 27 C and temperature in the holding facility ranged from 16 to 20 C. Survival was better in 1987 when outdoor temperatures were lower.

Discussion

Williams et al. (1966) determined through field trials that 2.0 g of alpha-chloralose/0.25 liter of bait usually captured all turkeys coming to bait with a drug related mortality rate of not exceeding 10%. With lower dosages turkeys were often difficult, if not impossible, to capture. With higher dosages mortality exceeded 10% (Williams et al. 1966). Holbrook and Vaughan (1985) captured adult and juvenile turkeys in fall and winter using the same dosage (2.0 g/0.25 liter) with 5 and 0% mortality respectively.

In this study reducing the dosage from 2.0 to 1.8 g/0.25 liter corn reduced total mortality from 30 to 11% and juvenile mortality from 30 to 8%, but capture efficiency decreased. The reduction in capture efficiency appeared to be related to the wide variation in weights of birds involved, both between years and within a season. Fall trapping attracts adult males, adult females, and juveniles. In early fall the weight difference among these 3 age/sex groups was wide but narrowed as fall progressed.

Table 16. Mean (SE) time (hrs) until recovery or death of wild turkeys captured with bait treated with 2 different dosages of alpha-chloralose (grams/0.25 liter cracked corn), Buckingham County, Virginia, 1986-87.

	1.8 g			2.0 g			Total		
	Adults	Juveniles	Total	Adults	Juveniles	Total	Adults	Juveniles	Total
Recovery	53 (5)[a]	40 (2)[b]	44 (2)	38 (14)	41 (4)	40 (4)	50 (5)	40 (2)	43 (2)
N	10	23	33	3	16	19	13	39	52
Death	18 (6)	9 (3)	13 (4)	36 (0)	14 (4)	17 (4)	24 (7)	13 (3)	15 (3)
N	2	2	4	1	7	8	3	9	12

Values within rows followed by different letters are significantly different ($P < 0.05$, Wilcoxon rank sums)

Using 2.0 g alpha-chloralose/0.25 liter cracked corn all turkeys (4 adult females and 23 juveniles) attracted to bait were captured easily regardless of when during the fall they were trapped. The lower dosage, however, was most effective early in the season. All 22 turkeys (3 adult females and 19 juveniles) which fed on the reduced dosage in September were captured, most on or near the bait site. In October, most of the 22 turkeys (11 adult males, 3 adult females, and 8 juveniles) fed the reduced dosage wandered from the site. Seven of these (5 adult males and 2 juveniles) were not captured. Mean weight of the latter group was significantly greater than the former, implicating turkey weight as a key element in reduced capture efficiency at the reduced dosage.

With the 1.8 g/0.25 liter corn dosage survival increased but did not follow the same seasonal pattern as capture efficiency. Overall, 6 turkeys overdosed early in the season and 6 late. Three of the 4 turkeys that died on the 1.8 g/0.25 liter dosage, died later in the season (including an adult male that fed excessively). Weather did not appear to influence survival, particularly since the greatest survival occurred on colder days, and no trapping was conducted under extremely warm conditions.

That adults take longer than juveniles to recover has been reported in other studies with tribromoethanol (Williams et al. 1973, Evans et al. 1975) and alpha-chloralose (Holbrook and Vaughan 1985). It was therefore expected that recovery time for the lower dosage would be less for both adults and juveniles, but this was not the case. Individual metabolic rates and amount of drug ingested likely influenced recovery time.

In conclusion, body weight appears to be an important factor in how alpha-chloralose affects wild turkeys. Time of year, and sex and age of turkeys should be considered when choosing a dosage. When trapping adults or large juveniles 2.0 g/0.25 liter cracked corn appears to work well, however, early in the fall when poults are relatively small (< 3 kg) a lower dosage may be advisable.

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Chapter 3: Effect of radio transmitters on wild turkey roosting behavior

Radio telemetry has helped wildlife biologists obtain detailed information on several species including wild turkeys. The effect of transmitters on animals is often assumed negligible. Several studies on gallinaceous birds indicated no adverse effects from properly attached radios on sharp-tailed grouse (*Pedioecetes phasianellus*) in Montana (McEwen and Brown 1966), blue grouse (*Dendragapus obscurus*) in British Columbia (Lance 1970), or ruffed grouse (*Bonasa umbellus*) in Minnesota (Marshall and Kupa 1963). But radio transmitters have been suspected of increasing predation rates on pheasants (*Phasianus colchieus*) in Minnesota (Hessler et al. 1970), and reducing feeding and activity in red grouse (*Lagopus l. scaticus*) in Scotland (Boag 1972). Greenwood and Sargeant (1973) noted that radio-equipped ducks in North Dakota increased preening behavior and had an aversion to swimming. Such behavioral changes could be detrimental, possibly causing increased predation rates soon after release. Gilmer et al. (1974) noted that 60% of predation on radio-equipped mallards (*Anas platyrhynchos*) and wood ducks (*Aix sponsa*) in Minnesota occurred within 3 weeks of instrumentation.

Nenno and Healy (1979) concluded that wild turkeys in West Virginia were not affected permanently by transmitters, but they described a number of behavioral aberrations, as well as disintegration of the flock, stress-related sleeping, and trouble roosting. It is this last point in which we are most interested. After noting relatively high mortality rates soon (within 10 days) after release of radio-marked turkeys, a study was designed to determine if the transmitters were contributing to low survival. Thus, an attempt was made to assess the impact of back-pack radio transmitters on the ability of wild turkeys to fly and roost.

Study Area

The study was conducted on 2 tracts of land in Buckingham County, Virginia (Appendix Figs. 1 and 2). The first area was a 2700 ha tract of land owned and operated by Westvaco for short rotation pine production. Over 60% of the land was in plantations of loblolly pine (*Pinus taeda*), ranging in age from 1-28 years and compartment size from 3-179 hectares. The remainder was mixed hardwoods left in large blocks on steep slopes or strips along drainages. The second area was a 1200 ha tract of privately owned land leased by a hunt club and maintained in typical Piedmont habitat with little active management.

Methods

Wild turkeys were trapped using alpha-chloralose laced bait (Williams 1966, Williams et al. 1973) or a rocket net (Austin 1965, Bailey et al. 1980). All turkeys were tagged with a Virginia Department of Game and Inland Fisheries (VDGIF) aluminum leg band (National Band

Co., size 24) and a plastic patagial wing tag (Allflex cattle ear tags). Some also were equipped with radio transmitters attached with nylon over-braided cable harnesses (Advanced Telemetry System, Bethel, MN). Three different weight transmitters were used (approx. 50, 68, 104 g) and applied with respect to the weight of the bird. At maximum the transmitter was 3.7% of the bird's body weight. Turkeys captured with alpha-chloralose were released within 200 m of the capture site early in the morning on the first day after recovery (1-5 days). The only netted bird was released one hour after capture in the same field in which it was trapped. Flight behavior (flew vs. failed to fly) was noted upon release of each bird.

A randomly chosen sample of radio-equipped birds (stratified by flight behavior upon release) was located after dusk to determine where they were roosting with respect to the horizontal strata of the forest. This was done every other night beginning on the day of release and continuing for 1 week or until the bird was roosting in a position in a tree which would have required flight.

Results

During fall 1986 and fall 1987 45 wild turkeys were trapped and released, 30 were equipped with radio transmitters. Turkeys equipped with transmitters included 4 adult males, 7 adult females, and 19 juveniles, with average weights (SE) of 7.1 (0.11), 4.4 (0.18), and 2.8 (0.19) kg respectively. Turkeys released without transmitters included 2 adult males, 1 adult female, and 12 juveniles, with average weights (SE) of 7.0 (0.57), 3.9, and 1.9 (0.15) kg respectively. Every turkey released without a transmitter flew into the trees apparently with little trouble (Table 17). Only 40% of the birds equipped with a transmitter flew upon release. The others made no attempt to fly, or in most cases attempted but failed. No differences (χ^2 tests, $P > 0.05$) were detected in flight behavior with respect to age or sex, nor the weight of the transmitter.

Table 17. Flight behavior upon release of radio-equipped and non-equipped wild turkeys, Buckingham County, Virginia, 1986-87.

	Total Number of Birds Released	Number That Flew	Number That Did Not Fly
With Transmitters	30	12	18
Without Transmitters	15	15	0

Eighteen of the 30 radio-equipped turkeys were located at night; 8 which had flown when released and 10 which had not (Table 18). Six of the 8 turkeys that flew upon release roosted in trees on the first night and all roosted in trees by the third night, but only 3 of the 10 that failed to fly upon release roosted in trees by the end of one week. Of the remaining 7 which failed to fly upon release, 4 were killed by predators during the first week before they roosted in a tree, and 3 survived the week while roosting on or near the ground.

Of the 30 radio-equipped birds, 17% died in the first week, all as a result of predation. All of these birds failed to fly upon release and had not roosted in a tree.

Discussion

All 15 birds captured with alpha-chloralose and released without transmitters flew upon release, hence, the failure to fly upon release did not appear to be drug related. However, 18 of 30 captured with alpha-chloralose and released with a transmitter, and the 1 turkey captured by a rocket net and released with a transmitter, failed to fly upon release suggecting the transmitter and/or harness impaired flight. In Missouri, of the 80-100 turkeys radio-equipped annually, approximately 25% do not fly when released and about 10% die within 1 week (Kurzejeski pers. comm.). This is much lower than the 60% and 17%, respectively, observed in this study but indicates that the problem is not local.

Since turkeys normally roost in trees during the non-nesting season (Williams 1981), it is likely that a bird roosting on the ground was doing so because of a physical or behavioral inability to fly. Some radio-equipped birds attempted to roost off the ground and could be found on stumps, downed logs, and branches they could walk up. The 2 radio-equipped turkeys that flew upon release but did not roost in a tree the first night apparently were able to fly but were perhaps unable to balance on a limb. Behavioral aberrations, such as those described by Nenno and Healy (1979), could be enough to temporarily limit a turkey's ability

Table 18. Length of time after release before radio-equipped turkeys roosted in trees, Buckingham County, Virginia, 1986-87.

	Nights After Release				
Behavior Upon Release	1	3	5	7	>7
Flew (N=8)	6	2	0	0	0
Failed To Fly (N=10)*	0	2	0	1	3

*Four died from predation prior to roosting in a tree.

to roost on a tree limb. It appears that some birds need time to adjust to the transmitter/harness and that in a habitat with a low density of predators most birds may eventually resume normal flight and roosting behavior. Nenno and Healy (1979) and others, noted that after release an adjustment period is needed before data collection should begin. I believe, on the other hand, that location data on radio-equipped wild turkeys should be recorded immediately to monitor their movement and condition during these early critical days but, these data should be used with discretion.

Clark (1985), indicated that stress and an unstable social group among turkeys released in Ohio may have contributed to increased predation and higher mortality. Speake (pers. comm.), concluded that higher than usual mortality soon after release is to be expected. I believe that radio transmitters/harness stress fall-captured turkeys which may result in increased mortality. However, the significance of the transmitter related mortality observed is difficult to assess because mortality of non-radioed birds was unknown.

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General Conclusion

Virginia's Piedmont is approximately 62% forested, but the proportion of forested land owned by forest industry and in pine plantations is only 14 and 9% respectively (Brown 1985, 1986); suggesting relatively little impact on wild turkey (*Meleagris gallapavo*) populations at this time. However, the growth of forest industry and conversion to short-rotation pines in the Piedmont (increases of 37 and 159% respectively between 1965 and 1985) could eventually result in decreasing turkey densities at local levels.

Wild turkey survival on industrial forests in this study was extremely poor, similar to results reported by Holbrook and Vaughan (1985) from the same area. However in this study, predation was the major mortality factor, accounting for 80% of turkey deaths. Gray fox (*Urocyon cinereoargenteus*) populations may be high in these industrial forests due to high numbers of small mammals which likely occur due to an abundance of food and cover surrounding recently harvested sites. Fox predation on study area turkeys may have been high because hardwoods, used as feeding and travel areas by turkeys, were limited (half were narrow leave strips), thus compressing turkeys into small areas where foxes could more easily exploit them.

Data presented in chapters 2 and 3 suggested that the techniques used to trap and monitor turkeys contributed to mortality both before and shortly after release. The overall drug-related mortality rate of 12% was similar to other studies (Williams et al. 1966, 1973), however, the variability in mortality among years and the influence of turkey weight on survival raised questions about trapping juvenile turkeys with alpha-chloralose. The direct impact of the radio-transmitter package on turkey survival is unknown, however, observations of turkeys failing to fly at release or roost in trees for several days after release, and the high predator-related mortality shortly after release, indicates that some factor associated with the trapping and tagging procedures negatively influenced turkey survival.

Management implications

Since turkeys were present on the Gunstock tract each fall despite poor survival the previous winter, immigration likely was an important factor in the dynamics of this population. Immigration onto the area may have been high either because turkeys perceived Gunstock as preferred habitat compared to the surrounding areas or turkeys were forced into marginal habitat because of disturbance or an abundance of turkeys in surrounding areas. Habitat adjacent to Gunstock contained fewer pine stands but it also contained more agricultural areas, which although used by turkeys, are associated with residences and state roads, increasing the potential for disturbance from vehicles, humans, and dogs. Less disturbance in industrial forests, the presence of some hardwoods, the age structure of the loblolly, and/or the interspersion of habitats may have prompted turkeys to move onto the Gunstock tract. Alternatively, turkeys may have moved onto Gunstock only due to pressure from humans, predators, and/or other turkeys.

The 38% hardwood component on Gunstock as well as the interspersion of various age loblolly pines with hardwoods is probably greater than would be found on most industrial forests and may be indicative of the interest the owner of these tracts has in protecting watersheds and benefiting wildlife, as well as producing pines for industry. Since turkeys used most areas within Gunstock it is unlikely that the makeup of the tract restricted their use of the forest as a whole. However, their avoidance of loblolly 4-15 years old, which comprised 37% of Gunstock, suggests that use of an industrial forest by turkeys may diminish as the proportion of 4-15 year old loblolly increases. Maintenance of a self-sustaining turkey population within an industrial forest remains a questionable point. The poor turkey survival in this study and previously in Holbrook's study (1984) indicates that maintaining such a population is unlikely. However, before a final conclusion can be drawn, the impact of trapping and tagging procedures on survival must be ascertained.

The industrial forests in this study contained more roads/1000 ha than recommended for the maintenance of a viable turkey population (Bailey et al. 1980), however, this did not appear to affect turkey survival. Hunting and poaching losses were low and carcasses were not found closer to roads than random points. Roads were not used often outside of hunting season and gating more roads probably would not improve turkey survival in these areas.

Results from this study suggested that predation was the major turkey mortality factor. Trapping of predators is not allowed on the tracts studied except in special cases, eg; beaver damage (T. Hypes, Westvaco, pers. commun.). Intensive predator control is not recommended, but trapping on a permit basis may reduce predation rates on turkeys

Additional research needs

The results of this study indicate that further research is needed in 3 major areas: the use and effect of alpha-chloralose on wild turkeys, the effect of radio transmitter packages on turkeys and other birds, and the relationship among industrial forests, predators, and wild turkeys.

Although alpha-chloralose has been used to trap turkeys for over 20 years it's physiological effect on turkeys is not fully understood. Information is needed on how the drug effects body systems, the length of time birds are affected, and different dosages for various weight birds. Efforts to find alternative oral anesthetics with wider safety margins and/or antagonists should be increased.

Recently, greater attention has been given to the effect radio transmitters have on a bird's ability to fly (Pennychuick and Fuller 1987, Obrecht et al. 1988) including transmitter weight and placement, and harness attachment. More research is needed in this area and more studies should consider the impact of transmitter packages on birds when investigating movements and survival.

This research implied that industrial forests may support high densities of small mammals which attract predators that may prey on turkeys. Some research has been conducted on small mammal populations on industrial forests (Atkeson and Johnson 1979), but more information is needed on population size, diversity, and distribution of small mammals within industrial forests and typical Piedmont areas, along with studies of predator food habits in these areas. Last, research is needed on predator densities and distribution within industrial forests, and on interactions between foxes and turkeys.

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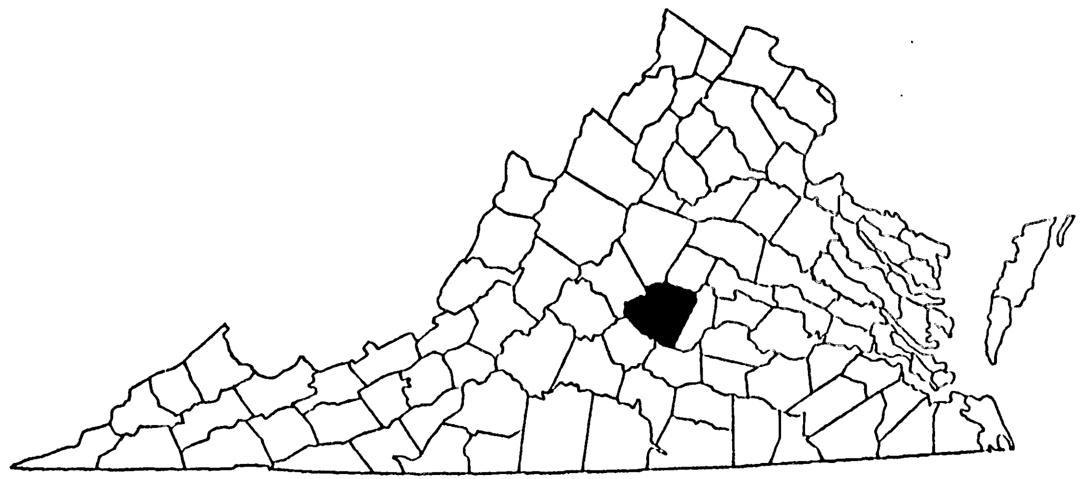
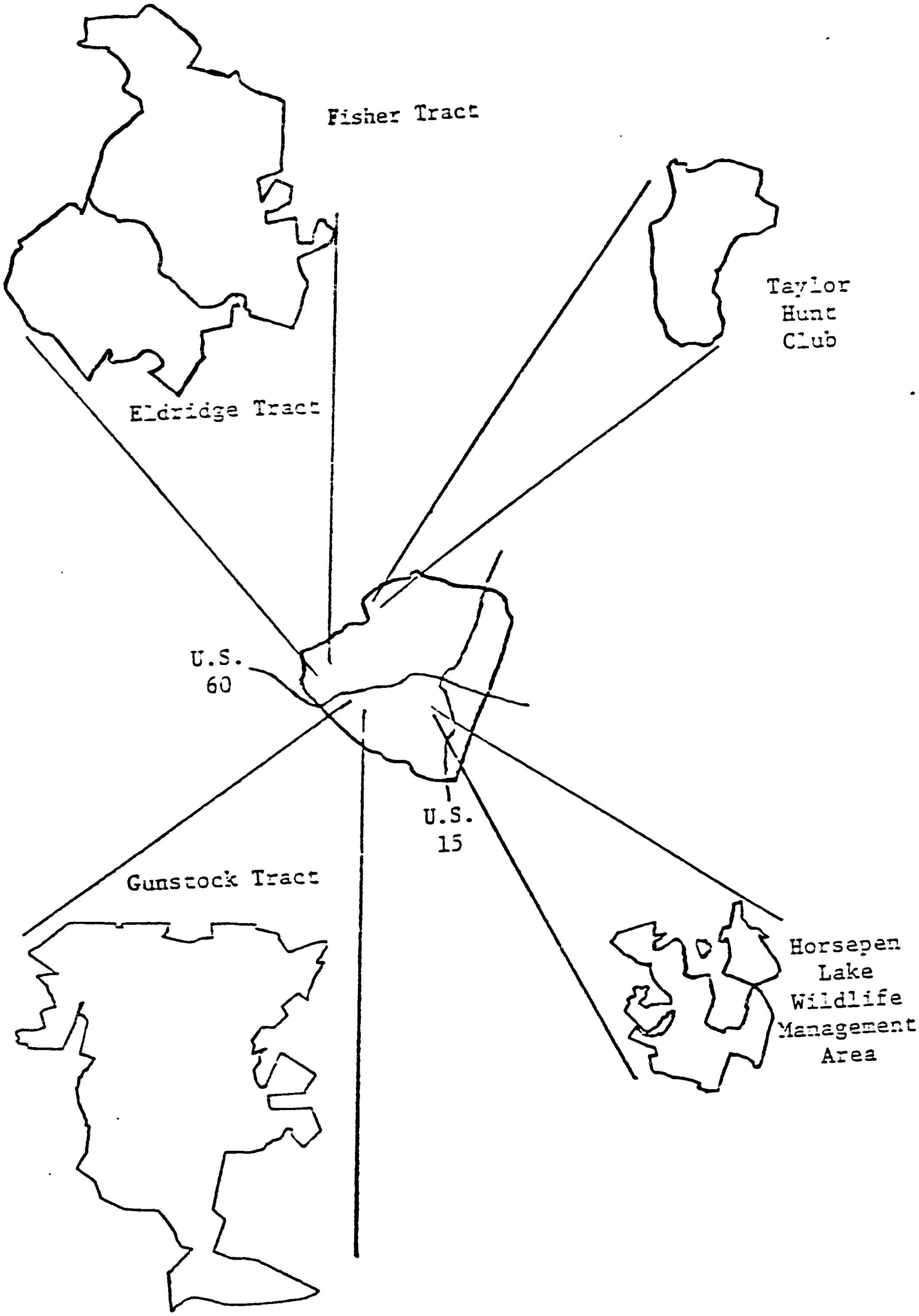
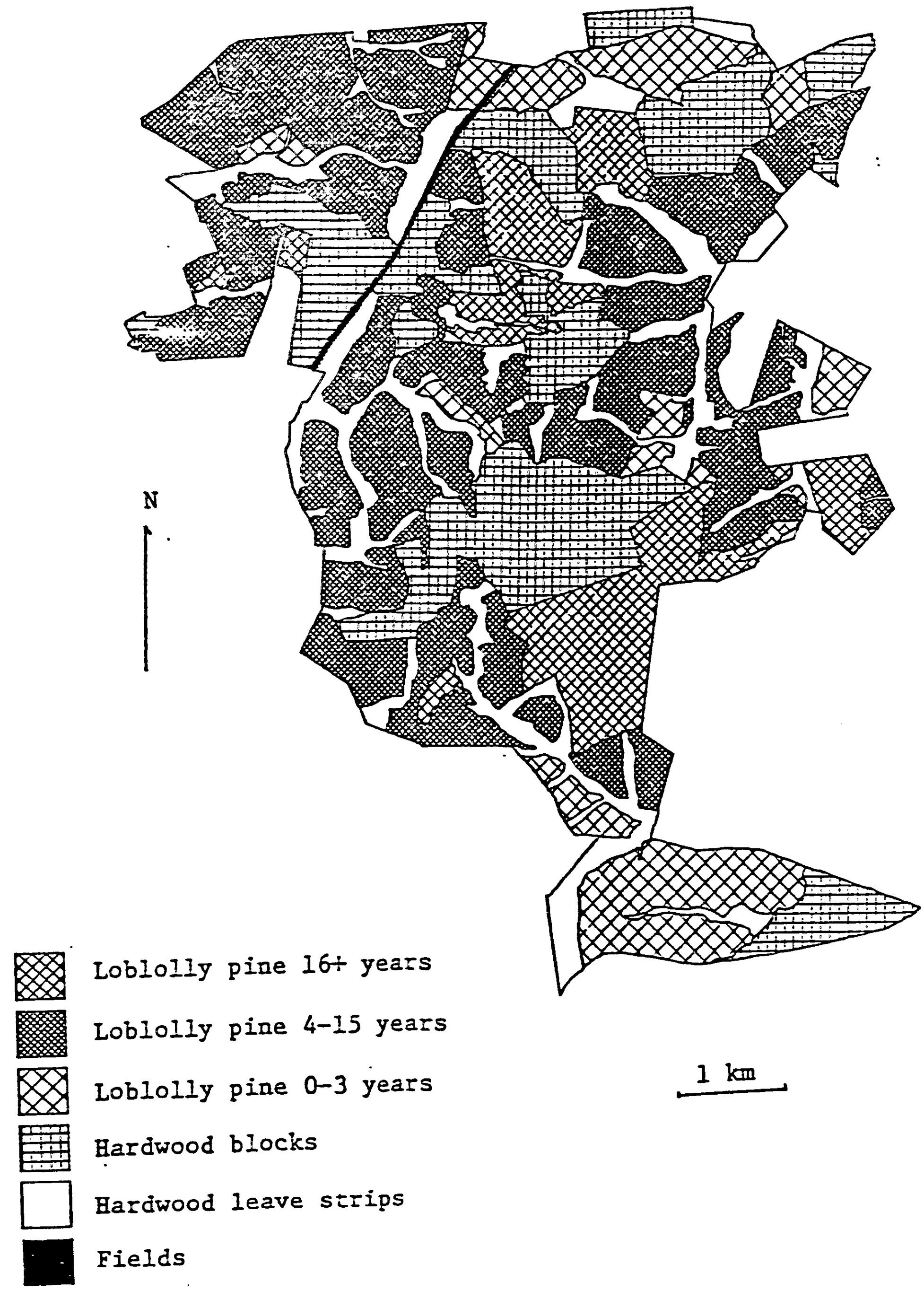
Appendices



Appendix Figure 1. Buckingham County, Virginia.



Appendix Figure 2. Five study areas in Buckingham County, Virginia.



Appendix Figure 3. Westvaco's Gunstock Tract, Buckingham County, Virginia.

Appendix Table 1. Wild turkey trapping, tagging, and release data from 5 tracts of land in Buckingham County, Virginia, 1985-1988.

Capture date (time)	Site	Capture number	Sex	Age	Weight (kg)	Band number	Wing tag	Transmitter frequency	Recovery time (hrs.)	Release date (time)	Release behavior
9/14/85 (NA)	Gunstock	T1	M	J	3.0	1501	1yl	150.011	NA	9/17 (NA)	NA
		T2	F	J	2.3	1502	2yl	150.586	NA	9/17 (NA)	NA
9/25/85 (1230)	Eldridge	T3	F	J	2.9	1503	3yl	150.143	48	9/28 (1200)	NA
		T4	F	A	4.0	1504	4yr	150.432	66	9/28 (1200)	NA
		T5	F	J	2.5	1505	5yl	150.259	48	9/27 (1430)	NA
		T6	F	A	4.2	1506	6yr	151.239	30	9/27 (1430)	NA
		T7	F	A	3.4	1507	7yr	151.128	66	9/28 (1200)	NA
		T8	F	A	3.8	1508	8yr	150.626	96	9/29 (1200)	NA
		T9	F	J	2.4	1509	9yl	150.766	30	9/27 (1430)	NA
		T10	F	J	2.8	1510	10yl	150.011	48	9/29 (1200)	NA
		T11[a]	M	J	3.4	-	-	-	60	-	-
		T12	M	J	3.3	1528	28wl	150.316	54	9/29 (1200)	NA
		T13	M	J	3.2	1529	29wl	150.464	42	9/29 (1200)	NA
		T13a[a]	M	J	NA	-	-	-	NA	-	
10/01/85 (1000)	Gunstock	T14	M	J	3.7	1530	30wl	150.850	72	10/04 (1300)	NA
		T15	F	J	2.8	1511	11yl	151.218	30	10/03 (1000)	NA
		T16	F	J	2.9	1512	12yl	150.354	36	10/03 (1000)	NA
		T17	F	A	3.8	1513	13yr	151.172	36	10/03 (1000)	NA
		T18	F	J	2.3	1514	14yl	150.394	36	10/03 (1000)	NA
		T2	F	J	2.3	1502	2yl	150.586	48	10/04 (1300)	NA
10/30/85 (NA)	Fisher	T19	F	J	3.3	1517	17yl	151.096	48	11/02 (0730)	NA
		T20	F	A	4.0	1518	18yr	150.818	48	11/02 (0730)	NA
		T21	M	J	4.5	1531	31wl	151.396	42	11/02 (0730)	NA
		T22	M	J	3.9	1532	32wl	151.592	54	11/02 (0730)	NA
		T23	M	J	4.5	1533	33wl	151.436	48	11/02 (0730)	NA
		T23a[b]	F	J	NA	-	-	-	-	-	-
10/31/85 (1200)	Horsepen	T24	M	J	4.8	1534	34wl	151.508	30	11/02 (1200)	NA
		T25	M	J	5.2	1535	35wl	151.264	24	11/02 (1200)	NA
		T26	M	J	4.4	1536	36wl	151.704	24	11/02 (1200)	NA
		T27	M	J	4.6	1537	37wl	150.882	30	11/02 (1200)	NA
		T28	F	J	3.8	1515	15yl	150.354	42	11/02 (1200)	NA
		T29	F	J	3.7	1516	16yl	150.934	54	11/03 (0800)	NA
		T30	F	J	2.9	1519	17yl	151.018	30	11/02 (1200)	NA
		T31	F	J	3.8	1520	20yl	151.850	30	11/02 (1200)	NA
		T32	F	J	3.6	1521	21yl	150.239	30	11/02 (1200)	NA
		T33	F	A	3.9	1522	22yr	150.011	30	11/02 (1200)	NA
		T34	F	A	3.9	1523	23yr	150.966	30	11/02 (1200)	NA

Appendix Table1. (continued).

Capture date (time)	Site	Capture number	Sex	Age	Weight (kg)	Band number	Wing tag	Transmitter frequency	Recovery time (hrs.)	Release date (time)	Release behavior
8/29/86 (0900)	Gunstock	1[b]	-	J	1.5	-	-	-	-	-	-
		2[b]	-	J	1.5	-	-	-	-	-	-
		3[b]	-	J	1.4	-	-	-	-	-	-
		4	-	J	1.4	1539	38wl	None	36	9/01 (1000)	Flew
		5	F	A	3.9	1540	40wr	151.396	66	9/01 (1000)	Flew
		6[b]	-	J	1.5	-	-	-	-	-	-
		7	-	J	2.0	1542	42wl	150.239	12	8/31 (0900)	Flew
		8	-	J	1.5	1541	41wl	None	36	9/01 (1000)	Flew
		9	F	A	3.6	1538	39wr	150.044	24	8/31 (0900)	Flew
9/19/86 (0900)	Gunstock	10[a]	M	J	3.1	-	-	-	48	-	-
		11[a]	F	J	2.8	-	-	-	48	-	-
		12	-	J	2.9	1544	44wl	150.850	36	9/21 (1200)	Failed to fly
		13[b]	-	J	3.2	-	-	-	-	-	-
		14	-	J	3.4	1545	45wl	150.094	42	9/21 (1200)	Failed to fly
		15[a]	M	J	2.1	-	-	-	54	-	-
		16	M	J	2.9	1543	43wl	150.506	36	9/21 (1200)	Failed to fly
10/10/86 (1300)	Gunstock	17[b]	F	J	2.9	-	-	-	-	-	-
		18[b]	M	J	3.0	-	-	-	-	-	-
		19[b]	F	A	3.9	-	-	-	-	-	-
		20[a]	M	J	2.3	-	-	-	30	-	-
		21	F	J	2.3	1553	53wl	150.966	30	10/13 (0930)	Flew
		22	F	A	3.9	1552	52wr	None	24	10/12 (1000)	Flew
		23	-	J	2.3	1551	51wl	None	66	10/13 (0930)	Flew
		24	-	J	2.8	1550	50wl	150.676	60	10/13 (0930)	Failed to fly
		25	-	J	2.2	1549	49wl	150.044	24	10/12 (1000)	Flew
		26	F	J	2.3	1548	56wl	150.432	30	10/12 (1000)	Failed to fly
		27	M	J	3.3	1546	76yl	None	60	10/13 (0930)	Flew
2/24/87 (1000)	Gunstock	28	M	A	7.3	1558	24yr	None	30	2/26 (1000)	Flew
9/11/87 (1000)	Gunstock	29	F	A	4.3	1566	61wr	151.470	36	9/13 (1000)	Failed to fly
		30	-	J	1.9	1568	65wl	None	36	9/13 (1000)	Failed to fly
		31[a]	-	J	1.9	-	-	-	36	-	-
		32	-	J	1.7	1567	62wl	None	30	9/13 (1000)	Flew
		33	-	J	2.1	1577	83yl	150.818	48	9/14 (1200)	Failed to fly
		34	-	J	1.9	1569	66wl	None	36	9/13 (1000)	Flew
		35	-	J	1.7	1570	67wl	None	30	9/13 (1000)	Flew
		36[a]	M	J	2.7	-	-	-	48	-	-
		37	F	J	3.2	1561	58wl	150.239	36	9/13 (1000)	Failed to fly

Appendix Table 1. (continued).

Capture date (time)	Site	Capture number	Sex	Age	Weight (kg)	Band number	Wing tag	Transmitter frequency	Recovery time (hrs.)	Release date (time)	Release behavior
		38	-	J	1.5	1571	68wl	None	36	9/13 (1000)	Flew
		39	-	J	1.7	1572	79yl	None	36	9/13 (1000)	Flew
		40	M	J	2.3	1560	78yl	150.934	48	9/14 (1200)	Failed to fly
		41	M	J	2.4	1574	80yl	150.044	36	9/14 (1200)	Failed to fly
		42[b]	-	J	2.2	-	-	-	-	-	-
		43	-	J	2.2	1575	82yl	150.316	48	9/14 (1200)	Failed to fly
		44	F	A	4.7	1565	60wr	151.348	60	9/14 (1200)	Failed to fly
		45	-	J	2.0	1564	59wl	150.128	36	9/13 (1000)	Flew
		46	-	J	2.1	1559	77yl	150.394	30	9/13 (1000)	Failed to fly
		47	-	J	1.9	1576	70wl	None	48	9/14 (1200)	Flew
		48	F	A	4.3	1563	64wr	151.592	36	9/13 (1000)	Flew
		49	-	J	1.9	1573	69wl	None	48	9/14 (1200)	Flew
		50[a]	M	J	2.3	-	-	-	60	-	-
10/10/87 (0900)	Gunstock	51	M	J	3.5	1578	86yl	150.394	36	10/12 (0900)	Failed to fly
		52[b]	F	A	4.4	-	-	-	-	-	-
		53[b]	M	J	3.2	-	-	-	-	-	-
10/16/87 (0900)	Gunstock	54[b]	M	A	8.8	-	-	-	-	-	-
		55	M	A	7.1	1579	87yl	None	48	10/19 (0900)	Flew
		56	M	A	6.4	1562	81yr	151.470	48	10/19 (0900)	Flew
		57	M	A	7.5	1581	90yr	None	42	10/19 (0900)	Flew
		58	M	A	7.1	1580	91yr	151.264	48	10/19 (0900)	Flew
10/16/87 (1000)	Gunstock	59[c]	F	J	3.2	-	-	-	48	-	-
		60	F	A	5.1	1583	72wr	150.239	72	10/20 (0730)	Flew
		61	F	J	3.8	1584	73wl	151.438	36	10/20 (0730)	Flew
		62	F	A	4.5	1582	71wr	150.546	84	10/20 (0730)	Flew
10/25/87 (1200)	Gunstock	63	M	J	4.9	1587	92yl	151.160	42	10/27 (0730)	Failed to fly
		64	M	J	4.4	1586	89yl	151.530	36	10/27 (0730)	Failed to fly
10/25/87 (1000)	Taylor	65	M	A	7.3	1588	95yr	151.348	60	10/28 (1000)	Failed to fly
*10/26/87 (0930)	Taylor	66	M	A	6.8	1585	75wl	151.312	0	10/26 (1200)	Failed to fly

Appendix Table1. (continued).

Capture date (time)	Site	Capture number	Sex	Age	Weight (kg)	Band number	Wing tag	Transmitter frequency	Recovery time (hrs.)	Release date (time)	Release behavior
2/05/88 (1100)	Gunstock	67	M	A	6.9	1589	94yr	150.239	42	2/07 (1000)	Flew
		68	M	A	6.9	1590	98yr	150.094	54	2/08 (0930)	Flew
		69	M	A	6.8	1591	97yr	150.464	42	2/07 (1000)	Failed to fly

NA-Data not available
[a]Died from leg disfunction co[illegible]tions
[b]Died from drug overdose
[c]Died from trapping related head injury
[*]Captured by rocket netting

Appendix Table 2. Wild turkey mortality data, Buckingham County, Virginia, 1985-1988.

Site	Band number	Date released	Date died (monitoring ceased)	Days elapsed	Cause of death
Gunstock	1501	9/17/85	9/23/85	6	Predation
	1502	9/17/85	11/19/85	63	Harvested
	1514	10/03/85	10/06/85	3	Predation
	1530	10/04/85	10/08/85	4	Predation
	1512	10/03/85	10/25/85	22	Predation
	1511	10/03/85	11/25/85	53	Predation
	1513	10/03/85	8/30/86	332	Predation
	1542	8/31/86	9/15/86	15	Predation
	1538	8/31/86	9/25/86	25	Predation
	1544[a]	9/21/86	9/25/86	4	-
	1543	9/21/86	10/02/86	11	Predation
	1548	10/12/86	10/23/86	11	Predation
	1545	9/21/86	10/26/86	35	Predation
	1549	10/12/86	11/19/86	38	Predation
	1550	10/12/86	11/25/86	43	Predation
	1553	10/12/86	12/01/86	50	Predation
	1540	9/01/86	1/02/87	123	Poached
	1565	9/14/87	9/15/87	1	Predation
	1561	9/13/87	9/15/87	2	Predation
	1574	9/14/87	9/18/87	4	Predation
	1564	9/13/87	9/22/87	9	Predation
	1563	9/13/87	9/27/87	14	Predation
	1559	9/13/87	9/28/87	15	Predation
	1560	9/14/87	10/01/87	17	Predation
	1577[a]	9/14/87	10/03/87	19	-
	1566	9/13/87	10/03/87	20	Poached
	1575	9/14/87	10/11/87	27	Predation
	1578	10/12/87	10/16/87	4	Predation
	1580[b]	10/19/87	10/23/87	4	-
	1562[b]	10/19/87	10/30/87	11	-
	1586	10/27/87	10/31/87	4	Predation
	1583	10/20/87	11/01/87	12	Predation
	1587	10/27/87	11/18/87	22	Predation
	1582	10/20/87	11/22/87	33	Predation
	1584	10/20/87	12/28/87	69	Predation
	1591	2/07/88	2/12/88	5	Predation
	1589	2/07/88	2/24/88	17	Predation
	1590[c]	2/08/88	5/31/88	112	-
Fisher	1518	11/02/85	11/18/85	16	Predation
	1531	11/02/85	11/25/85	23	Predation
	1533	11/02/85	12/01/85	29	Predation
	1532	11/02/85	1/07/86	66	Predation
	1517	11/02/85	11/03/86	367	Harvested
Eldridge	1510	9/29/85	9/30/85	1	Predation
	1506	9/27/85	10/02/85	5	Predation
	1529	9/29/85	10/03/85	4	Predation
	1505	9/27/85	10/04/85	7	Predation
	1528	9/29/85	10/21/85	22	Predation
	1503	9/28/85	11/04/85	37	Predation
	1504	9/28/85	11/25/85	58	Predation

Appendix Table 2. (continued).

Site	Band number	Date released	Date died (monitoring ceased)	Days elapsed	Cause of death
	1508	9/29/85	1/13/86	106	Poached
	1507	9/28/85	3/17/86	171	Predation
	1509[a]	NA	NA	-	-
Horsepen	1535	11/02/85	11/04/85	2	Predation
	1537	11/02/85	11/05/85	3	Harvested
	1521	11/02/35	11/05/85	3	Predation
	1536	11/02/85	11/06/85	4	Predation
	1523	11/02/85	11/06/85	4	Predation
	1520	11/02/85	11/09/85	7	Predation
	1522	11/02/85	11/10/85	8	Predation
	1534	11/02/85	11/20/85	18	Predation
	1519	11/02/85	11/21/85	19	Predation
	1515	11/02/85	11/30/85	28	Harvested
	1516	11/03/85	12/11/85	38	Predation
Taylor	1585	10/26/87	11/03/87	8	Predation
	1588[2]	10/28/87	11/05/87	8	-

[a]Lost contact - presumed dead
[b]Only transmitter recovered - presumed alive
[c]Still alive
NA-Data not available

Appendix Table 3. Details of turkey mortality for 20 birds dying on the Gunstock tract, 1986-1988.

Band number	Stand type	Stand number	Stand age	Distance to road (m)	Distance to water (m)	Distance to nearest leave strip (m)	Width of nearest leave strip(m)
1538	Leave strip	56	70	409	5	0	197
1543	Leave strip	44	70	195	10	0	55
1548	Loblolly	841	4	157	391	104	62
1545	Leave strip	50	75	15	10	0	79
1550	Block	999	50+	349	145	199	123
1553	Block	89	50+	452	2	125	40
1565	Loblolly	112	18	28	208	489	163
1561	Block	999	50+	343	133	545	58
1574	Block	999	50+	126	78	501	57
1564	Block	999	50+	111	33	529	63
1563	Leave strip	102	85	36	193	0	94
1560	Block	999	50+	59	53	618	261
1566	Loblolly	112	18	152	248	500	133
1578	Loblolly	112	18	98	164	416	66
1586	Block	52a	85	214	5	259	157
1583	Loblolly	112	18	122	270	373	181
1587	Loblolly	51	9	138	430	69	89
1582	Loblolly	112	18	166	0	686	177
1584	Block	999	25+	312	158	683	136
1591	Block	52a	85	66	0	481	107
$\bar{x}$				177	127[a]	329	115
Random				166	212[b]	211	114

Values within columns followed by different letters are different ($P < 0.05$, Wilcoxon rank sum)

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