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thesis entitled

HABITAT UTILIZATION, MOVEMENTS, AND
POPULATION CHARACTERISTICS OF
RESIDENT NORTHERN MICHIGAN TURKEYS

presented by

Thomas G. Kulowiec

has been accepted towards fulfillment
of the requirements for

Master of Science degree in Fisheries and Wildlife

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Major professor

Date September 30, 1986

O-7639

MSU is an Affirmative Action/Equal Opportunity Institution

HABITAT UTILIZATION, MOVEMENTS, AND POPULATION CHARACTERISTICS OF RESIDENT NORTHERN MICHIGAN TURKEYS

By

Thomas Gerard Kulowiec

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

1986

ABSTRACT

HABITAT UTILIZATION, MOVEMENTS, AND POPULATION CHARACTERISTICS OF RESIDENT NORTHERN MICHIGAN TURKEYS

by

Thomas Gerard Kulowiec

Forty-four eastern wild turkeys (*Meleagris gallopavo sylvestris*) were trapped and radio-tagged from 2 wintering sites in Michigan's northeastern Lower Peninsula. Annual and seasonal range sizes and movement patterns, seasonal and daily habitat use patterns, nesting chronology and nest site characteristics, and turkey mortality rates were determined.

The turkeys were found to use the same wintering and nesting sites each year. Age significantly influenced seasonal movements, with juvenile birds arriving earlier to and leaving later from their wintering grounds than adults.

Turkey habitat use was influenced primarily by the seasonal requirements of the bird, availability of vegetation types, and individual bird preferences. Selection of vegetation types was very diverse, based more on structural and functional characteristics than species composition.

Annual mortality averaged 34.4% for the flocks studied. Mammalian and avian predators were the primary mortality factors, followed by illegal kill.

Two peaks of nesting activity were noted, the first in early May, and the second during the first 2 weeks of June.

The results presented were used to formulate management recommendations for enhancing Michigan's northern turkey resource.

ACKNOWLEDGMENTS

This project was funded by the Michigan Department of Natural Resources, through the direct use of turkey hunter license fees. I would therefore life to thank the Michigan D.N.R. and all Michigan turkey hunters for making this project possible.

My deepest appreciation to my committee members, Dr. Donald L. Beaver, Dr. Harold H. Prince, Mr. Carl Bennett Jr., and Dr. Jonathan B. Haufler, for their time and professional expertise in the design, review, and evaluation of this project and thesis. A special thank-you to my major professor Dr. Jon Haufler for his professional advice and educational guidance.

Thanks to the people at the Mio office and the Houghton Lake Research Station, especially Dan Soults, Jerry Weinrich, and Elaine Carlson for their hard work in trapping and marking the project birds, their cooperation, help, and advice during the course of the project, their willingness to let me use the equipment I needed, and their friendly smiles. A special thanks to Mr. Ray Yoder, in Fairview, and Mr. and Mrs. Will Parent, in South Branch, for allowing birds to be trapped and marked on their property. Thanks also to all those students who did field work on the project; Laura Eaton, Laurie Winner, Jack Dingledine, Dave Luukkonen, Jerry

Cline, Terry Brown, and Jim Brown; folks, you made the project go! A warm thank-you to the Bowers and Parent families for making my time in the field feel more like home, and less like time in the field.

A big "Thanks" and "Take Care", to everyone in the M.S.U. Fisheries and Wildlife Department; to Shelli, Cindy, Jane, and Florence who always gave me service with a smile even when I was a pest; to my fellow graduate students: Dave Woodyard, Rique Campa, Dean Beyer, Tom Holechek, Jim Ruhl, Elena Seon,Bobbie Webber, Hiroko Kurita, Ani Pakpahan, Cheryl Connell, Dave Gorden, Earl Flegler, Brian Gray, Carolyn Mehl, Laura Grantham, Paul Padding, Larry Gigliotti, Tom Wessels, Becky Stout, Gayle Wescott, Dale Elshoff, Robin Ziegler, Will Gala, and Mark Sargent for all the good times and the helping hands. A special thanks to Laura Eaton for her help and friendship, without whom I would have had to appreciate a lot of bad movies alone.

To my relatives, the Karcz clan here in Michigan, and especially my family, Dave, Mom, and Dad back at home, I cannot begin to thank you enough for all you have done. Your encouragement, prayers, and support were always there when I needed them, for this I say "Thanks" and "I love you all very much".

Thank You dearest Lord for blessing me with all these wonderful people, without whom this work could not have been completed. Please reward them, twice over, for all the kindness and assistance they have given me.

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INTRODUCTION

The eastern wild turkey (Meleagris gallopavo silvestris) is endemic to the central-eastern United States (Hewitt 1967:3). The bird originally occurred from the Atlantic coast west to central Nebraska, Kansas, western Oklahoma, and southeastern Texas. It extended as far north as the southern regions of Maine, Ontario, Michigan, and South Dakota; and as far south as central eastern Texas, southern Louisiana, southern Mississippi, southern Alabama, northern Florida, and south-eastern South Carolina (Mosby 1949, Hewitt 1967:30-31). In Michigan, turkeys were plentiful throughout the southern Lower Peninsula, and extended possibly as far north as Oscoda county (44° 40' N. lat.) (Hewitt 1967:30). Scharger (1966) gives a precolumbian population estimate for Michigan at about 94,000 birds. However, excessive hunting pressure and habitat destruction following colonization caused a reduction in numbers, with the extinction of the wild turkey in Michigan occurring around 1900 (Hewitt 1967, Ignatoski 1973).

Although several reintroduction attempts were made during the early 1900's (Ruhl 1954 in Ignatoski 1973), the first successful reintroduction of turkeys into the state occurred in March of 1954, with the release of 50 birds in the Allegan State Forest. These birds, and an additional 400 eggs, were obtained from the Allegheny Wild Turkey Farm, Julian, Pennsylvania. This game farm stock originated from 3/4 wild hens serviced by wild toms. From 1954 through 1963, the Michigan Department of Natural Resources (MDNR) raised and released 882 turkeys at various locations across the state. By 1960, turkeys from the original Allegan flock were being trapped and released in other parts of the state (Ignatoski 1973). In the Mio area, turkey reintroduction occurred during the period of 1956-1957, when the MDNR released 148 game farm birds in Roscommon and Ogemaw counties. In addition, during the late 1950's and early 1960's, private hunting clubs made substantial releases of pen-reared turkeys, particularly in Alcona and Roscommon counties. By 1967, turkeys were well established in parts of Montmorency, Alpena, Alcona, Oscoda, Ogemaw, and Roscommon counties; with the bulk of these birds descending from private individual and club releases (Bronner 1983). In 1965, 11 years after the initial releases, Michigan's first turkey hunting season was opened in the Allegan area. Four hundred permits were issued for the hunt, and 82 turkeys were taken (Bronner 1983). Over the next 5 years, both fall and spring seasons were tried on different areas throughout the state as the individual turkey populations grew. The first hunt in the Mio area occurred in the fall of 1969, with a take of 29 birds. However, the state's turkey population was not expanding as rapidly as expected, so in 1970, the MDNR limited hunting to a spring season for bearded birds only (Bronner 1983). Approximately 4300 permits were issued for the May hunt, with a statewide harvest of 91 gobblers (Ignatoski 1973).

Since then, Michigan turkeys and turkey hunters have continued to expand in numbers and range. This is especially true in the northeastern section of the state. The Mio area has been divided into 8 zones to more evenly distribute the holders of the approximately 14,000 permits issued annually for the area. About 800 turkeys were taken in this area in 1981, with a total statewide harvest of 1,296 birds (Bronner 1983). In just 4 years, these figures increased to 1,393 and 2,016 turkeys harvested in the Mio area and statewide respectively in 1985. During that year, 11,982 permits, out of a total of 15,010 available, were distributed, by lottery, among 22,680 hunter applications (Urbain 1986).

From the above historical summary, it is clear that Michigan's turkey restoration program has been a success. However, strong public interest and an ever increasing hunter demand have raised questions about the future management of the state's turkey populations. Is all the best habitat filled to capacity, or can birds be transplanted and survive in what is now considered marginal habitat? Can trapping and transplanting activities shift the distribution of birds so more are available to hunters on public lands? How dependent are the turkeys on artificial feeding, especially during the winter? Is this dependency critical to the birds on the northern edge of their historic range, and if so, should the MDNR implement feeding on public lands? What are the primary vegetation types which the turkeys key in on during the course of a year? What management practices can be used to increase these important types? Can the current northern Michigan flock withstand an increase in the hunting pressure?

This 2 1/2 year study attempted to provide answers to some of these questions, and information toward the eventual resolution of the others.

OBJECTIVES

The objectives of this study were to:

1. determine turkey movement patterns on a seasonal and year round basis;
2. determine habitat utilization of turkeys on a seasonal basis;
3. evaluate the importance of winter feeding to the northern Lower Peninsula turkey flock;
4. estimate mortality rates and identify mortality factors impacting the turkeys in the Oscoda-Ogemaw County region;
5. determine the nesting chronology of the north-eastern Michigan flocks;
6. describe and quantify nesting site habitat parameters;
7. evaluate the effectiveness of different population censusing techniques to provide information useful in management of the northern Lower Peninsula turkey flock.

STUDY SITE DESCRIPTION

This study was conducted in Michigan's northern Lower Peninsula, primarily within Oscoda and Ogemaw Counties (Fig. 1). The area, approximately 40 to 50 km west of Lake Huron at an elevation of from 274 to 427 m above sea level, is characterized by a level to gently rolling topography to the north in Oscoda County, grading into a more varied relief in Ogemaw County to the south (Veatch et al. 1928,1931).

Oscoda County is primarily composed of high, dry gravel-sand plains of glacial origin. These plains, although occasionally broken by valleys, are relatively level, lacking any large local elevational differences. Level to undulating clay plains, and hilly areas with local elevational differences of up to 30.5 m (100 ft.) or more, do occur, but are not as prevalent. The principal soil types of the region are the Grayling, Rubicon, and Roselawn sand and gravelly-sand soil types. Because of the predominantly sand and gravel substrate, water is relatively scarce, with only 10% of the land being wet or swampy. The AuSable River bisects the county, running from east to west. The area has 122 lakes, concentrated mainly in the northern half of the county, comparatively few streams, and a small number of surface springs. Swamps are not frequent, occurring mostly

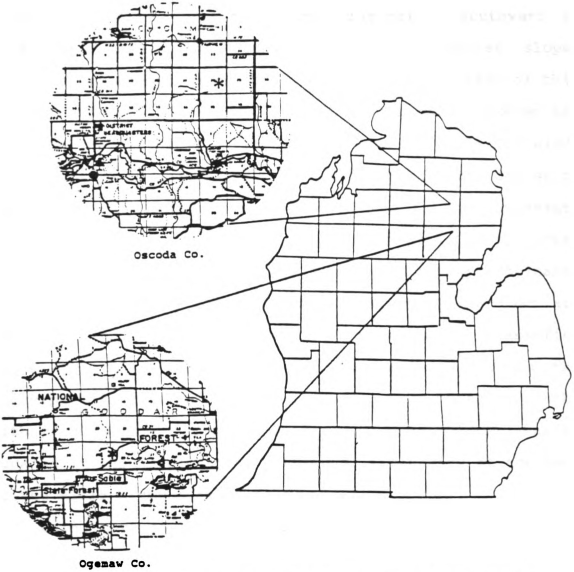

Fig. 1. Locations of the 2 study sites. Inserts show details of areas surrounding the trap sites. Trap sites marked by asterisks.

in the clay plain regions and in the basins of the more hilly terrain (Veatch et al. 1931).

The topography of the Ogemaw County area is more varied. A belt of hilly terrain extends diagonally, southwest to northeast, across the county, with the steepest slopes occurring at the northern end. To the south and east of this belt extend rolling plains. High, level sandy plains are found in the northwest portion of the county, while low sandy plains are found running north to south through the center of the region, interspersed with clay plates in the southeast. Loam and sand mixtures are the most common soils in the area, with the Nester, Grayling, and Roselawn types predominant. In the wet lowland areas, Lupton muck and Rifle peat are commonly found. Twenty percent of the county is classified as swampy or permanently wet. The Rifle River is the principal drainage for the area, flowing from north to south, with an extensive tributary system. A large swampy area is located in the northeastern portion of the county at the head of the Rifle River (Veatch et al. 1928).

Being more inland, the climate of this 2 county area is not significantly moderated by the Great Lakes. It is characterized by long, rigorous winters and short, mild summers with high humidity. The mean annual temperature is 6°C (43°F), ranging from winter lows of less than -29°C (-20°F) to summer highs exceeding 38°C (100°F). Precipitation annually averages from 63.6 cm to 76.3 cm, and is evenly distributed throughout the year. Snow can occur anytime from September to May, but November to March is the period of heaviest accumulations, with annual snowfall averaging more than 127 cm (Veatch et al. 1928,1931).

The entire area was originally densely wooded with 4 major forest types: Eastern hardwoods, dominated by sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and eastern hemlock (*Tsuga canadensis*), with secondary species such as American elm (*Ulmus americana*), ash (*Fraxinus* spp.), and red maple (*A. rubrum*); pine forests composed of white pine (*Pinus strobus*), red pine (*P. resinosa*), or red and jack pine (*P. banksiana*); mixed hardwood-conifer stands of the predominant hardwoods and pines along with hemlock; and swamp conifer stands made up of white cedar (*Thuja occidentalis*), black spruce (*Picea mariana*), white spruce (*P. glauca*), and larch (*Larix laricina*). Most of the area was cut over and frequently burned in the early 1900's. Some of the better land was settled for agriculture, but, because of the high sand component of the soil, much of the region was allowed to grow back to forest. Second growth hardwoods, such as aspen (*Populus* spp.), oak (*Quercus* spp.), and red and sugar maple are most commonly found in the wooded areas today. On sandy locations, scattered oak and jack pine occur with dense understories of blueberry (*Vaccinium* spp.), sweetfern (*Comptonia peregrina*), bracken fern (*Pteridium aquilinium*), and various grasses. Burned and disturbed bogs have regenerated dense covers of heath shrubs such as blueberry, leatherleaf (*Camaedaphne calyculata*), and Labrador tea (*Ledum groenlandicum*) (Veatch et al. 1928,1931).

The study was centered around 2 winter trapping sites, and included those areas which the telemetered turkeys occupied as they moved out from these winter concentration areas. The first trap site was located on the farm of Mr. R. Yoder (Sec. 26, T27N R3E) in the Fairview area (Comins Township) of Oscoda County. In the immediate vicinity of the trap site, and extending to the northeast corner of the county, is private land. The town of Fairview is approximately 2.5 km to the north. The private holdings in the central part of the county are primarily dairy farms, characterized by pasture and crop fields interspersed with oak-maple woodlots and small swampy areas composed of swamp hardwoods and conifers. The principal crops raised are alfalfa, rye, and corn. To the northeast, most of the land is in large holdings owned by individuals or private clubs. Most of this "club land" is uncultivated and is wooded or in natural openings. Two to 5 km to the east and south of the trap site is public forested land (Huron National Forest), and approximately 11-16 km to the west and northwest is another large tract of public land (AuSable State Forest).

The second trap site was on the property of Mr. and Mrs. W. Parent (Sec. 28, T24N R4E) in the South Branch area (Goodar Township) of Ogemaw County. Although small patches of private land, primarily homes and small farms, are in the area, the trap site was within the boundaries of the Huron National Forest which extends north and east to the county border. National forest land also extends from 2 to 4 km south and west of the trap site. Most of this land to the south is an extensive swamp composed primarily of cedar and mixed swamp hardwoods and conifers. The upland areas support stands of pure aspen, or stands of aspen along with white ash (*F. americana*), sugar maple, beech, and oak.

METHODS AND MATERIALS

TRAPPING AND MARKING

Wild turkeys were trapped and marked by personnel from the Michigan Department of Natural Resources (MDNR) during the months of February and March, 1983-84, at 2 winter concentration areas. The Fairview site was trapped over both years, while the South Branch site was trapped only in 1984. Turkeys were trapped using either a 3 mortar rocket net similar to that described by Day et al. (1980) or a slightly modified drop net technique described by Glazener et al. (1964). Trap sites were baited with corn for 1-2 weeks prior to trapping.

Trapped birds were immediately removed from the net, equipped with a transmitter, and released at the site. On the South Branch site, however, turkeys were trapped too late in the day to be released immediately. These birds were held overnight and released the following morning. All trapped turkeys were aged, as either juveniles or adults, and sexed using plumage characteristics (Lewis 1967), and marked with metal leg bands. Blackened radio transmitters (Telonics Inc., Mesa, Az.) were secured to the backs of selected birds using rubber tubing covered with a woven nylon sheath which was passed from the telemeter unit, around the base of the bird's wings, and was knotted back at the telemeter. The knots were further secured by applying a strong bonding glue. The telemeters were 80g transmitter-battery units with expected operational lives of 16.5 months. Each unit was set to emit a pulsed signal at a unique frequency.

TELEMETRIC MONITORING

Monitoring of movement and habitat use of the telemetered turkeys began the day after marking, and continued until an individual died, or contact was lost. Monitoring was conducted from March, 1983 through July, 1985. General locations were made using a truck mounted, omni-directional antenna. Once a general location was determined, an exact location was made, on foot, using a hand-held, directional, 2-element yagi antenna. In all cases, a portable Telonics TR-2 receiver (Telonics Inc., Mesa, Az.) was used.

Telemetered birds were located at least once every 2 days. Birds were monitored weekly from January to March, 1985 while they were on their wintering habitat. Locations were taken at random times from sunrise to sunset, to ensure that observations were made throughout the diurnal period for each bird. A location was considered completed when a bird was either observed, completely circled within a homogeneous vegetation type, or chased, without being seen, from a location (as evidenced by a consistently strong signal over an extended distance of tracking, or a signal which circled back to a previously checked location). In the latter case, the turkey was fixed at that position from which, as could best be determined, it was originally chased.

At the time of a location, the geographic position where a bird was found was determined to an accuracy of 4 ha (10 acres). The vegetation type in which the bird was found was described and recorded using the Michigan State Forest Operations Inventory classification system. In addition, the time, temperature, percent cloud cover, and presence and intensity of precipitation were recorded.

An effort was made to disturb the birds as little as possible during the study. The only time attempts were made to deliberately flush a bird was when identical positions were recorded for 3 consecutive locations. For hens during the nesting season, detailed searches were conducted only after no movements were recorded for more than 6 weeks.

MONITORING NESTING CHRONOLOGY AND MORTALITY FACTORS

Telemetered hens were closely monitored from the time of spring dispersal through mid-summer for nesting activity in 1984 and 1985. Date of nest initiation could not accurately be determined directly because of the relatively mobile behavior of the hens during laying, and the possibility of locating incubating hens while they were off the nest. From the telemetry data, the date a hen came off its nest was reliably recorded at least to within 2 days, and in most cases to the day. Using these dates, estimates of the starting dates of laying and incubation were determined by back-dating the commonly reported 28 day incubation period

(Dalke and Spencer 1946; Thornton 1955; Hoffman 1962; Anderson 1963; Bailey and Rinnell 1967, 1968; Williams 1972; Little and Varland 1981) and 14 day laying period (Hoffman 1962; Bailey and Rinnell 1967,1968).

Estimates of age and sex specific mortality rates, and potential mortality factors acting on the northern Michigan turkey flock were determined from mortality data collected from the telemetered birds. All recovered dead birds were sent to the MDNR wildlife pathology lab at the Rose Lake Wildlife Research Center for necropsy. Examination of each carcass and its surroundings in the field, along with the subsequent lab necropsy, provided evidence to identify mortality factors. Mode of kill and subsequent deposition of the carcass, hair and feathers on and around the carcass, tracks in the immediate area, and teeth and claw marks were used to attempt to identify possible predator species.

QUANTIFICATION OF NESTING HABITAT

Nest locations were determined from the telemetry work, as well as from information offered by local residents. As soon as a hen was permanently off a nest, the site was marked. To avoid any disturbance which could possibly influence poult survival, no work was done on a nest site until the hen and brood had moved out of the area.

Density of woody stems in 4 size classes was measured in 3 nested plots centered on the nest (Table 1). Vegetative cover at 3 height strata, as well as slash cover, (Table 1) was measured from 4, 30 m, line transects laid out from the

Table 1. Size classes and height strata for density and cover measurements taken around nests on the Fairview and South Branch study sites. Sizes of the sampling units are also given.

Parameter measured	Size class/ height strata	Sampling unit size
Stem Density	0.0 - 0.5m tall	6x6m plot
	>0.5m tall & <12.7cm DBH	12x12m plot
	12.7 - 25.3cm DBH	24x24m plot
	>25.3cm DBH	24x24m plot
Cover	<0.5m tall	30m lines
	0.5 - 1.0m tall	30m lines
	>1.0m tall	30m lines

nest in the 4 cardinal directions. Slash was defined as dead, woody material littering the ground. Cover was measured by the line intercept method as described by Gysel and Lyon (1980).

Distances to the nearest permanent water source and to natural and man-made edges were measured directly when possible or from aerial photographs. A water source was considered permanent if it was available to the nesting hen for the entirety of the nesting period. A natural edge was defined as that point were a discernable change in vegetation type occurred. Man-made edge was that point where a man-made structure; such as a house, road, 2-track, etc.; was encountered.

Nest length, width, and depth were recorded, in addition to construction material of the nest. The aspect and degree of slope on which the nest was situated were also measured.

EVALUATION OF POPULATION INDICES

Two population estimation techniques, road counts and breeding hen counts, were evaluated as to their feasibility, efficiency, and accuracy in providing information for management of the northern Michigan turkey flock. These techniques were also compared to the winter flock counts currently used to census Michigan's turkey population.

All turkey observations made from the road by project personal while working on the project were recorded as to flock size, composition, and general location. In addition, in July of 1984, all mail carriers of the 4 postal zones covering both study areas; Fairview, Mio, Rose City, and Lupton; were asked to note and record all turkey sightings made while on their daily routes. Forms (Appendix I) were distributed the first week of July, and were collected the last week of September.

A breeding hen census on the Fairview study site was conducted during the last 2 weeks of July, 1985. Tape recorded poult distress calls (Richard Kimmel, Minnesota Dept. of Conserv.) were played at intervals along censusing routes in an attempt to elicit responses from those hens which had nested earlier that year. Four, approximately 8.9 km (5.5 mi.) census routes were located along roads in the area (Fig. 2). Routes were picked to provide a variation in vegetation, human population, and disturbance conditions. All routes were located through areas where turkeys had been spotted earlier that summer. Twelve stations were positioned at 0.8 km (1/2 mi.) intervals along each route. A 15 minute interval at each station, followed a prescribed pattern. The sequence consisted of a 3 minute silent observation and listening period, 2 minute observation period while the distress calls were played, another 3 minute silent observation and listening period, a 3 minute observation and distress call period, and a final 4 minute silent observation and listening period. A 5 minute interval was scheduled between stations to allow for moving between stops and set up.

At each station, the start and stop times of the interval were recorded along with wind, temperature, and

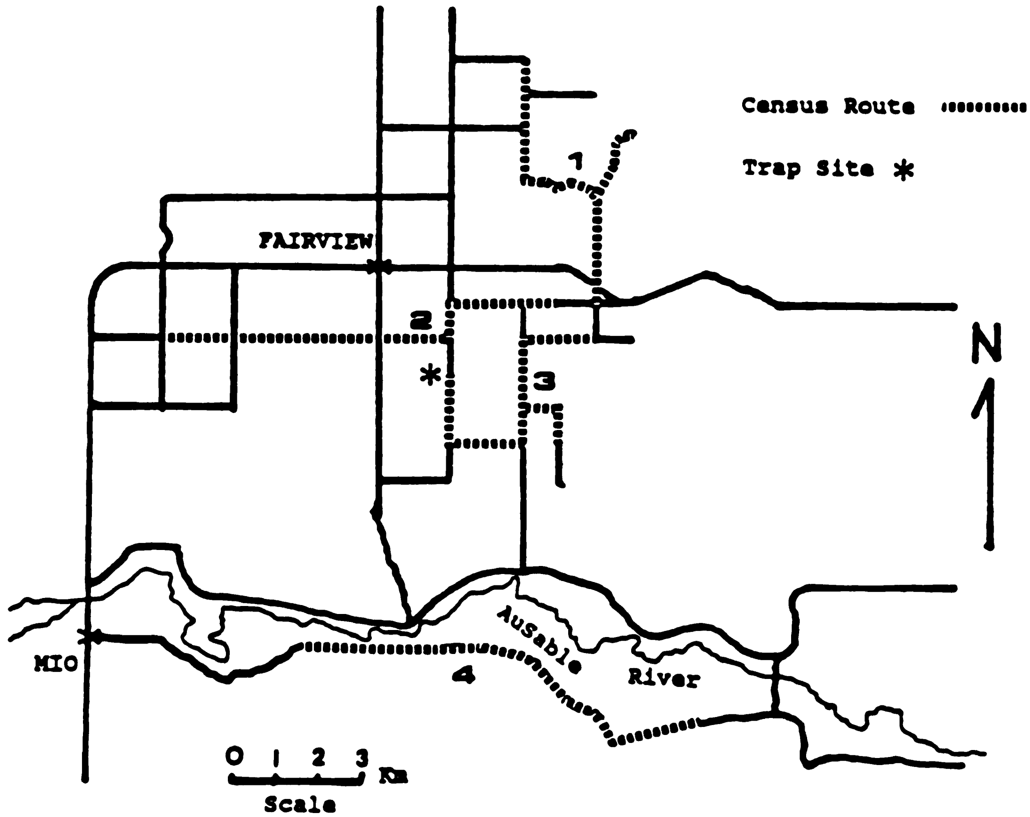

Fig. 2. The 4 census routes established on the Fairview study site to evaluate the summer road census method using poult distress calls.

general precipitation conditions. The number of turkey flocks observed and the observation period in which they were spotted were noted. Flock size and composition were recorded. Also, the number of disturbances during the station interval, such as cars passing, children, or stray dogs were noted.

Two 4 hour census routes were run each day, from sunrise through mid-morning, and mid-evening to sunset. All routes were run twice, once in the morning and once in the evening. An attempt was made to run the same route both morning and evening of the same day to reduce any biases resulting from weather or the movement of turkey flocks into or out of an area. The direction of the route was reversed between the morning and evening runs. Census runs were not conducted during heavy rainfall or high winds.

DATA ANALYSIS

Seasonal, annual, and overall range estimates were calculated from the telemetry data by the minimum area method (Mohr 1947) using the Telemetry Analysis Program (TAP) (Rabe 1983). Differences in annual and seasonal range sizes between study areas, years, and nesting and non-nesting hens were compared using the Mann Whitney U test (Seigel 1956). Seasonal range sizes were compared over all, and within specific sex and age groups using the non-parametric Kruskal-Wallis one way ANOVA (Seigel 1956). Seasonal and overall range sizes among the 4 sex-age groups were also compared using the Kruskal-Wallis one way ANOVA (Seigel 1956).

Significant differences were further analyzed using the non-parametric multiple range test described by Zar (1984).

Seasons were defined by individual bird behavior, with "spring" occurring from the time of winter flock break-up until a bird nested or noticeably restricted its movements. "Summer" extended from this point until a shift in range tending back toward a wintering area was noted anytime after early September. "Fall" was defined as the period of aggregation and movement back to a wintering range, with "winter" being delineated as the period in which a bird was located on its wintering range. Spearman ranks (Seigel 1956) were used to test for correlation between seasonal range size and length of observation period.

Dates of dispersal from the wintering range and spring dispersal distances were compared between age and sex groups using the Mann-Whitney U test (Seigel 1956). Spring dispersal distance was defined as the longest linear distance a bird was located from the center of its winter range before it nested or noticeably restricted its movements to a given area. Mean dispersal dates were calculated using Julian day transformations.

Differences in annual and seasonal habitat use were evaluated for age, sex, sex-age, and nesting - nonnesting groups using the non-parametric chi-square test (Seigel 1956). Daily habitat use patterns for the 4 sex-age groups and nesting-nonnesting hens were analyzed, within seasons, using chi-square analysis (Seigel 1956). For this purpose, habitat use observations were grouped into 5 time periods:

morning, mid-morning, noon, early-evening, and evening. Because of varying day length, each time period ranged from 1 to 3 hours in length depending on the time of year (Table 2). Seven general habitat use categories were defined, based on species composition and structural characteristics (Table 3).

Nest site characteristics such as volume, slope, distances to water and edge, woody stem density and species richness, and mean overall percent vegetative cover were tested between successful and unsuccessful nests using the Mann-Whitney U test (Seigel 1956). In addition, the cover data from each transect line were partitioned into 5, 6m, intervals moving out from the nest. The Kruskal-Wallis non-parametric one-way ANOVA (Seigel 1956) was used to determine if significant differences in cover, in each of the 4 height strata, occurred with increasing distance from the nest.

Mortality rates and nesting dates were tested between years and age classes with the Mann-Whitney U statistic (Seigel 1956).

All significance tests were two-tailed, with an alpha level of 0.05 or less used for rejection of the null hypothesis. All means are reported with their standard errors ($\bar{X} \pm$ S.E.).

Table 2. Time periods for the daily habitat use analyses. Four division patterns were used to compensate for variation in day length through the year. Time ranges given for the morning and mid-morning periods are in hours after sunrise. Time ranges for early-evening and evening periods are in hours before sunset. The noon time period ranged from the end of the mid-morning period, to the beginning of the early-evening period.

Division pattern	Dates	Time Periods M[a]	MM	N	EE	E
A	10/17 - 2/26	SR[b]- 2+	2+ - 4+	x	-4 - -2	-2 - SS
B	2/27 - 4/6	SR - 2+	2+ - 5+	x	-5 - -2	-2 - SS
C	4/7 - 9/6	SR - 3+	3+ - 6+	x	-6 - -3	-3 - SS
D	9/7 - 10/16	SR - 2+	2+ - 5+	x	-5 - -2	-2 - SS

[a]M=morning; MM=mid-morning; N=noon; EE=early-evening; E=evening
[b]SR=sunrise; SS=sunset; + means hours after; - means hours before

Table 3. Descriptions of the 7 vegetation types used in habitat use analysis.

Category	(Abbr.)	Description
Upland Hardwoods	(UH) -	Forested stands on dry soils. Woody, non-coniferous, vegetation dominates the system. Primary associations observed were oak, oak-aspen, oak-maple, aspen, beech maple, and maple. Understory vegetation ranged from upland brush to bare ground.
Lowland Hardwoods and Conifers	(LH-C) -	All forested lowland sites. Soils were permanently, semi-permanently, or seasonally wet. Primary associations observed were alder, alder-aspen-birch, cedar, fir, cedar-fir, cedar-spruce-fir, and spruce-fir. Understory ranged from lowland brush to bare ground hummocks amid standing water.
Upland Conifers and Plantations	(UC-P) -	Upland, well drained sites dominated by conifers,both naturally occurring and planted. Principal associations observed were white pine, red pine, jack pine, and jack pine-oak. Understory ranged from upland brush to grass.
Old Fields and Pastures	(OF-P) -	Open grassy fields and pastures. Herbaceous vegetation dominates the system, with little or no overstory cover. Old fields, fallow farm fields, open live-stock pastures, private lawns, and power line rights-of-ways were included in this category.

Table 3. Continued.

Category	(Abbr.)	Description
Farmland	(Fa) -	Farm fields and associated areas such as barn yards, and feed lots. Only those fields in production (i.e. planted, in standing crop, harvested within the past 4 months, or tilled for planting) were considered agricultural fields. Fields left fallow for more than 1 year were placed in the previous category.
Clear Cuts	(CC) -	All clear cut or heavily logged areas, cut no more than 5 years previous. Downed slash dominates the system.
Other	(Ot) -	Bare dirt, sand, or gravel roads and 2-tracks; construction sites; etc. were placed in this category.

RESULTS

TRAPPING AND MARKING

Forty-four eastern wild turkeys were trapped and radio-tagged on the 2 study areas over 3 trapping periods (Appendix II). An initial 18 birds (6 adult females (AF), 6 juvenile females (JF), 3 adult males (AM), and 3 juvenile males (JM)) were captured on the Fairview site in 1983. The following year an additional 8 hens (3 adults and 5 juveniles) were captured and marked on this site, while 18 turkeys (6 AF, 8 JF, and 4 JM) were radio-tagged on the South Branch study area.

Forty radio telemeters were used during the study (Appendix III). Twenty-six were recovered, usually as a result of the death of the bird before the telemeter ran down. Thirty percent (12) of the units failed during the 2 1/2 years of the study. One telemeter was known to have malfunctioned, while battery wear accounted for the remainder of the failures. The average life span of the 12 telemeters which failed was 15.7 $\pm$ 1.4 months, ranging from 3.4 to 21 months.

MOVEMENTS AND SEASONAL RANGES

Three distinct levels of turkey movements were noted during the study and subsequent analysis: large scale seasonal movements, described by the seasonal range telemetry data; intermediate dispersive movements from range to range, particularly those to and from the winter range; and small scale movements within the seasonal ranges, composed of diel movements and short term (2-14 day) wanderings.

Large scale movements

An overall mean annual range of 2455.5 $\pm$ 454.1 ha (6067.6 $\pm$ 1122.0 ac) was recorded for all the birds followed at least 1 complete year on both study sites. Annual ranges for the Fairview turkey flock are listed in Table 4. No significant differences ($P > 0.05$) were found between years. The 1984 mean annual range from the South Branch flock (Table 5) was significantly smaller ($P < 0.05$) than the 2-year mean for the Fairview flock. However, no significant difference was found between the 2 study sites when annual ranges were compared for 1984 alone. No differences were found in annual range sizes between males and females, or between adults and juveniles. Annual ranges could not be statistically analyzed between the sexes on the South Branch site because of an inadequate number of males.

Seasonal ranges did not differ significantly from year to year on the 2 study sites. The only exception was noted for the South Branch flock, where the 1984 winter range ($\bar{x}$=241.7 $\pm$ 32.0 ha, 597.3 $\pm$ 79.0 ac) was significantly smaller ($P < 0.01$) than that recorded for 1985 ($\bar{x}$=800.0 $\pm$ 116.2 ha, 1,976.9 $\pm$ 287.2 ac). Comparisons between study

Table 4. Annual ranges for 13 monitored turkeys over 2 years of study (1983 - 1984) on the Fairview site.

Year	Age	Sex	Annual Range Ha	Annual Range Ac
1983	J	M	9154.0	22620.0
	A	F	5582.6	13795.0
	J	F	4840.0	11960.0
	A	F	3848.6	9510.0
	A	M	2990.6	7390.0
	A	F	2559.6	6325.0
	J	M	2270.3	5610.0
	J	F	2161.0	5340.0
	J	M	1212.0	2995.0
	J	F	408.7	1010.0
	Mean range (1983):		3502.7 ± 799.0	8655.5 ± 1974.5
1984	J	F	1467.0	3625.0
	J	F	1378.0	3405.0
	J	F	1193.8	2950.0
	Mean range (1984):		1346.3 ± 80.4	3326.7 ± 198.8
	Overall mean range:		3005.1 ± 661.4	7425.7 ± 1634.2

Table 5. Annual ranges for 8 monitored turkeys on the South Branch study site.

			Annual Range	
Year	Age	Sex	Ha	Ac
1984	J	F	3638.1	8990.0
	J	F	2871.2	7095.0
	J	M	1185.7	2930.0
	A	F	1147.3	2835.0
	A	F	999.6	2470.0
	A	F	991.5	2450.0
	A	F	896.4	2215.0
	J	F	768.9	1900.0
			-------	-------
	Mean range (1984):		1562.3 ± 379.2	3860.6 ± 937.0

sites found significant differences ($P < 0.05$) for all seasonal ranges (Table 6). The Fairview flocks exhibited significantly larger spring, summer, and fall ranges, while the South Branch birds had larger winter ranges.

Overall on the Fairview site, winter ranges were found to be significantly smaller than those recorded in the other 3 seasons (Table 6). The largest seasonal ranges usually occurred in the spring. Range size then progressively declined through the summer, fall, and winter seasons. This progression of seasonal range sizes through the year generally persisted when ranges were analyzed between sex and age groups of turkeys.

A completely opposite trend was found on the South Branch site. Although much more variability was noted among the analyzed groups, spring ranges tended to be the smallest, with a general increase in size occurring from summer through winter (Tables 6). In all cases, the winter '85 ranges were found to be significantly larger ($P < 0.01$) than the mean spring and summer ranges. An extremely abundant beech mast crop in the Fall of '84 was observed to directly affect turkey movements in the winter of '84-85 on the South Branch site. The birds ranged over comparatively large tracts of upland woods feeding on the native forages, until snow accumulation in early January made this food source unavailable.

Summer ranges of hens with broods (Fair. $\bar{x}=545.6 \pm 113.9$ ha and S.B. $\bar{x}=139.2 \pm 24.7$ ha) and those without (Fair. $\bar{x}=1181.3 \pm 448.9$ ha and S.B. $\bar{x}=182.1 \pm 32.1$ ha) were not

Table 6. Mean seasonal ranges from both the Fairview and South Branch study sites. All comparisons within seasons between the 2 study areas were significantly different. Comparisons among seasons within each study area are also shown.

Season	Ranges (ha)	
	Fairview	South Branch
W ('84)	-----	241.7 ± 32.0[ad]
W ('85)	-----	800.0 ± 116.2[c]
W (overall)	229.8 ± 57.9[b]	435.9 ± 71.6[d]
SP	1020.4 ± 268.0[a]	84.8 ± 16.8[b]
SU	746.6 ± 142.2[a]	186.0 ± 29.4[ab]
F	529.2 ± 142.6[a]	203.7 ± 69.6[ab]

[abcd]All rows within a column with different letters are significantly different ($p < 0.05$).

significantly different on the Fairview or South Branch areas respectively. Fall ranges were also found not to differ significantly between brooding and non-brooding hens on both areas.

Intermediate scale movements

Over the 2 1/2 years of the study, winter flock formation was noted to occur anytime from early November to late December (Table 7). For the winter of '83-'84 on the Fairview site, mean date of arrival onto the winter range was November 29th. No significant differences in arrival time were found between sexes. Age was found to have a significant ($P < 0.01$) effect on time of arrival. The mean date of arrival for juveniles was November 18th compared to December 19th for adults. Only 3 juvenile hens were monitored on the Fairview site in winter '84-'85. All 3 arrived on the wintering ground on November 17th, 1984.

That same year, the mean arrival date for 9 monitored turkeys on the South Branch site was the 8th of November. On this site, telemetered birds moved onto their wintering ranges as early as November 3rd, while 1 juvenile female did not settle into a winter range until the 27th of November. Age did not significantly influence flocking dates on this site. The effects of sex on flocking chronology could not be determined due to the lack of males on the South Branch site.

In general, the monitored turkeys were found to consistently return to the same wintering areas from year to year. On the Fairview site, in the fall of 1983, 73% (8 of 11) of

Table 7. Mean arrival dates onto the wintering grounds over 2 years of observation (1983-1984) for both the Fairview and South Branch study sites.

Year	Area	Group	Arrival Date Mean	Earliest	Latest
1983-1984	Fairview	Overall	11/29	11/09	01/03
		Juveniles	11/18	11/09	11/30
		Adults	12/19	12/10	01/03
		Males	11/23	11/09	12/14
		Females	12/03	11/10	01/03
1984-1985	Fairview	Overall*	11/17	11/17	11/17
1984-1958	S.Branch	Overall	11/08	11/02	11/27
		Juveniles	11/12	11/02	11/27
		Adults	11/03	11/02	11/03
		Males	11/03	11/03	11/03
		Females	11/09	11/02	11/27

*Only juvenile females were monitored on this site in 1984-85.

the surviving birds returned to the original wintering area where they were trapped the previous year. In 1984 all 3 of the remaining birds again were found to return to the same location. All of the 3 birds in 1983 which did not return to their original wintering range had moved greater than 10 km (6.2 mi) from the original wintering area at some point during the preceding summer and fall. Similar behavior was noted for the South Branch flock.

Dispersal off the wintering areas was recorded as early as the 2nd week of March to as late as the 2nd week of May. However, on both study areas, the majority of the dispersal activity was observed in early to mid April (Table 8). Mean dispersal date in 1983 for the monitored Fairview flock was April 18th. Adult birds had a mean dispersal date of April 11th which was significantly ($P < 0.05$) earlier than the April 27th date recorded for the juveniles that year. Again in 1984 adults were found to disperse significantly ($P < 0.05$) earlier than juvenile birds on the Fairview site. Mean adult dispersal date was April 2nd while that calculated for the juveniles was April 14th. Overall 1984 mean dispersal date for the monitored Fairview flock was the 6th of April.

Mean dispersal distances from the wintering grounds were similar in 1983 and 1984 for birds on the Fairview site (Table 9). In 1983, 69% of the monitored birds dispersed to within a 10 km (6.2 mi) radius of the wintering area, and 50% remained within 8 km (5 mi). In 1984, an even greater proportion of monitored Fairview birds recorded short dispersal distances, with 86.7% remaining within 10 km and

Table 8. Mean dispersal dates off of the wintering grounds over the 3 years of observation on the Fairview study site.

Year	Group	Dispersal Date Mean	Dispersal Date Earliest	Dispersal Date Latest
1983	Overall	04/18	03/11	05/11
	Juveniles	04/27	04/06	05/11
	Adults	04/11	03/11	04/28
	Males	04/15	03/11	04/28
	Females	04/20	04/06	05/11
1984	Overall	04/06	03/02	04/21
	Juveniles	04/14	04/03	04/21
	Adults	04/02	03/02	04/15
	Males	03/30	03/02	04/15
	Females	04/08	03/26	04/21
1985	Overall	04/17	04/11	04/21
	Adults	04/17	04/11	04/21
	Females	04/17	04/11	04/21

Table 9. Dispersal distances from wintering areas for turkeys from the Fairview flock over 3 years of spring observations. Dispersal distance was defined as the longest linear distance a bird was located from the center of its winter range before it nested or noticeably restricted its movements to a given area.

Year	Age	Sex	Dispersal Distance Km	Dispersal Distance Mi
1983	A	F	18.00	11.18
	A	F	13.50	8.39
	J	F	12.70	7.89
	A	M	11.90	7.39
	A	F	10.30	6.40
	A	F	9.50	5.90
	A	F	8.90	5.53
	A	F	8.50	5.28
	A	M	7.60	4.72
	J	F	6.90	4.29
	J	M	6.90	4.29
	A	M	5.80	3.60
	J	M	5.30	3.29
	J	M	5.10	3.17
	J	F	5.00	3.11
	J	F	2.60	1.62
		Mean distance:	8.65 ± 0.98	5.37 ± 0.61
1984	A	F	25.40	15.79
	J	F	12.30	7.63
	A	M	9.20	5.74
	A	F	8.10	5.05
	J	F	6.60	4.11
	J	F	5.90	3.68
	A	F	5.80	3.63
	A	F	5.80	3.63
	A	F	5.80	3.63
	A	F	5.40	3.37
	A	F	4.60	2.84
	A	M	4.60	2.84
	J	F	4.50	2.79
	A	M	4.20	2.63
	J	F	4.10	2.53
		Mean distance:	7.49 ± 1.40	4.65 ± 0.87
1985	A	F	6.26	3.89
	A	F	4.32	2.68
	A	F	4.32	2.68
		Mean distance:	4.97 ± 0.65	3.08 ± 0.40

73% dispersing within 8 km of the center of the winter range. A further reduction in dispersal distance was found in 1985 (Table 9). However, it should be noted that the 1985 mean distance, 5.0 ± 0.7 km (3.1 ± 0.4 mi), was calculated from a sample size of only 3 adult hens. The longest spring dispersal move recorded during the study was for an adult female in 1984 which moved 25.4 km (15.8 mi) in approximately a 2 week period. The shortest distance moved during spring break-up was 1.6 km (0.6 mi) by a juvenile hen in 1983. In 1983 adults ($\bar{X}$=10.4 ± 1.2 km, 6.5 ± 0.8 mi) dispersed significantly ($P < 0.05$) farther than juveniles ($\bar{X}$=6.4 ± 1.2 km, 4.0 ± 0.7 mi). However this was not found in 1984. No significant differences in dispersal distances were observed between males and females in any of the years of the study.

Those turkeys monitored for more than 1 year, were found to disperse to, and make use of, the same general locations from year to year. In 1983, all but 1 bird dispersed to the north and east. In 1984, the pattern of dispersal was much more evenly distributed out from the wintering site. This resulted from the additional 8 hens trapped that year dispersing primarily to the south and west. All 7 of the turkeys remaining from the 1983 marking again dispersed to the north and east in 1984. All of the 4 hens and 1 of the 3 gobblers monitored for the second spring in 1984 used the same spring and summer locations they had frequented the previous year. Again, in 1985, the 3 remaining hens on the Fairview site were found to disperse to those areas they had used the spring before. Additionally a 3 year old tom, lost in 1984 due to telemeter failure, was legally harvested, during the 1985 gobbler season, from the same area it had frequented during the spring of 1984.

Dispersal behavior in the South Branch flock was distinctly different from that observed for the Fairview birds. No definite dispersal movements were noted. Seasonal ranges were not distinct, spatially separate areas connected by clearly directional, often extreme movements, as was observed on the Fairview site. South Branch turkeys were found to use specific parts of their comparatively large winter range through other seasons of the year. Because of this overlap of seasonal ranges, and the gradual "spreading out" from the wintering area as opposed to a distinct and rapid dispersal; dispersal dates and distances could not be accurately determined. However, as observed for the Fairview flock, these birds also exhibited a strong tendency to frequent the same general local from year to year.

Small scale movements

Although not specifically investigated, certain daily and short term movement patterns were noted during the course of this study. These movements within a season were the primary constituents of seasonal ranges.

Turkeys were found to follow very consistent daily movement patterns, particularly in the morning just after leaving the roost, and in the evening just prior to flying up to the roost. Within a season birds were noted to use from 1 to 3 roosts consistently. Rotation among the roosts was rarely regular, but roosts were generally used at least 3 to 4 consecutive days before movement to the next one. The birds generally followed 1 to 2 paths to feeding areas from the roost in the morning and to the roost from feeding areas in the evening. However, the morning and evening paths followed were not necessarily the same. Another pattern observed among several birds, especially during the summer season, was one in which a bird would establish a "home base" from which it would make several "trips" of from 2 to 5 days. The home base varied in size from 16 to 65 hectares (40 - 160 ac) and was always returned to for 2 to 3 days between trips.

These movement patterns were found to be strongly influenced by prevailing weather conditions. Under conditions of deep, powdery snow, birds tended to remain on the roost later into the day. When off the roost, smaller flocks tended to make extensive use of deer trails and snowmobile paths as travel lanes. Larger flocks, particularly those concentrated on private land, created their own trails, as all the birds tended to follow the same paths from place to place.

Rain also influenced small scale, diel, movement patterns. Turkeys tended to come out into openings during steady, moderate to heavy rain. However, during very heavy downpours, birds were noted to take cover in the wooded edges along open fields and pastures.

HABITAT USE

A total of 6969 habitat use observations were recorded over the duration of the study, 4033 on the Fairview site and 2936 on the South Branch site. Overall habitat use between the 2 study sites was found to be significantly different ($P < 0.01$). Greater use of farmland and upland conifers was observed on the Fairview site compared to the South Branch site. South Branch birds were found to use lowland vegetation types to a greater degree than their Fairview counterparts. No use of farmland was noted on the South Branch site. These overall differences in habitat use tended to reflect the general availabilities of the different vegetation categories between the 2 sites. Use of upland hardwoods was found to be consistently high on both sites (Fig. 3).

Sex and age were both found to significantly ($P < 0.01$) influence habitat use. Overall, on the Fairview site, toms and hens alike, were observed most frequently on upland hardwood, farmland, and old field-pasture sites. These 3 vegetation categories accounted for 91.5% of the male and 75.7% of the female sightings. Females differed from males in their greater use of lowland hardwood-conifer and upland conifer vegetation types. In addition, only females were noted using clear cuts on the Fairview site. Males were observed to make greater use of upland hardwood and old field vegetation types than females. Age differentiation resulted primarily from the greater use of lowlands and old fields and pastures by juveniles, as opposed to the greater use of farmland by adults. Comparison of habitat use over all

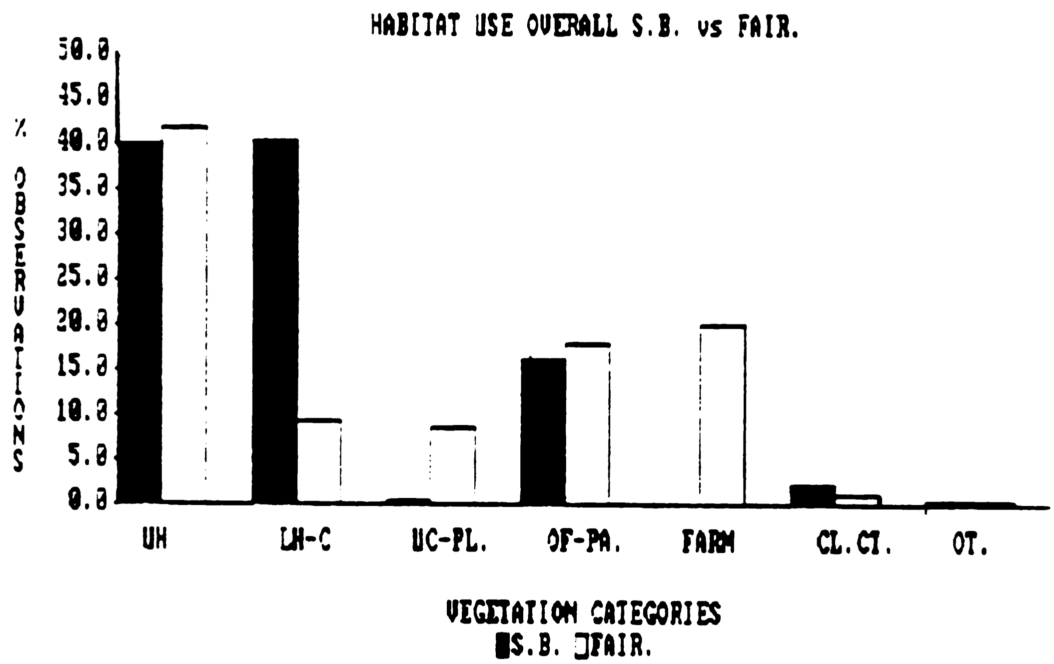

Fig. 3. Comparison of habitat use patterns between the Fairview and South Branch study sites. Habitat use measured as % of total observations of all monitored birds on a site which were in a specific vegetation category.

seasons among the 4 sex-age groups found highly significant differences ($P < 0.01$), and clearly summarized the trends outlined above (Fig. 4).

Contrary to that observed on the Fairview site, use of clear cuts was greater for males than females on the South Branch site. Females were observed more frequently in the old field-pasture vegetation type than males. However, both sexes in general concentrated the majority of their activities in upland hardwood and lowland hardwood-conifer vegetation types. These 2 categories composed 79.9% and 84.1% of the total number of sightings made on females and males respectively. Similar to those on the Fairview site, South Branch juveniles were found to make greater use of lowland hardwood-conifer and old field-pasture vegetation types than adults. Overall, the most utilized vegetation category by juveniles on this site was the lowland hardwood-conifer type (48.1%) followed by upland hardwoods (33.0%). Adults were observed in upland hardwood stands 47.5% of the time, in lowland vegetation types 33.3%, and in old fields and pastures 15.6% of the time. Significant differences ($P < 0.01$) in overall habitat use were also found among the 4 sex-age groups on this site (Fig. 5).

Within season comparisons found farmland comprising more than 50% of all winter observations made for all age-sex groups on the Fairview site (Fig. 6a). Farmland, upland hardwoods, and open fields and pastures comprised 97% and 93% respectively of the adult female and male winter observations on the Fairview site. Juvenile hens differed in their low

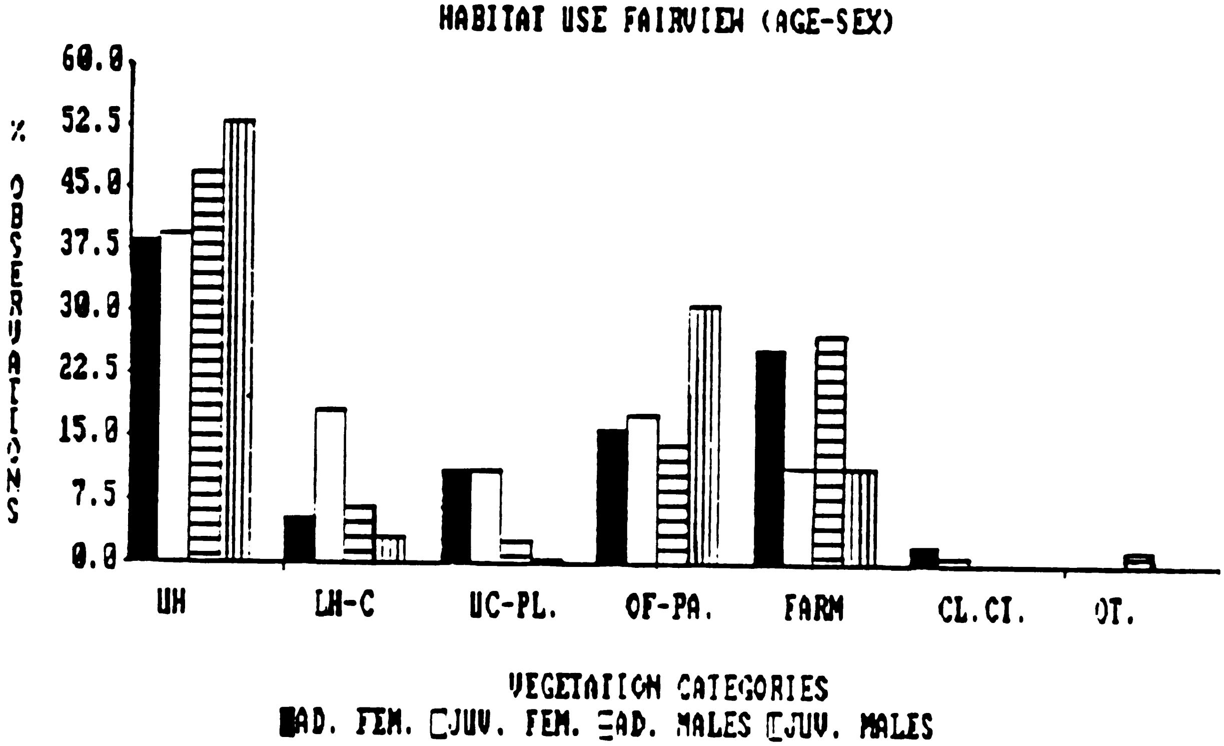

Fig. 4. Comparison of habitat use patterns among the 4 specific sex-age groups on the Fairview site.

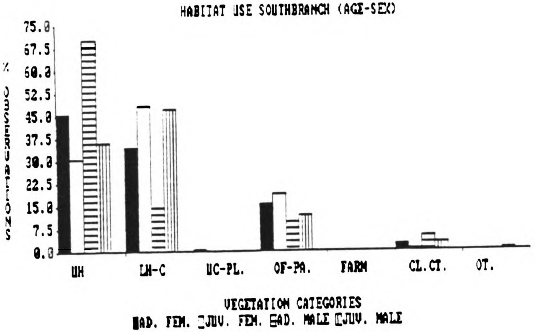

Fig. 5. Comparison of habitat use patterns among the 4 specific sex-age groups on the South Branch site.

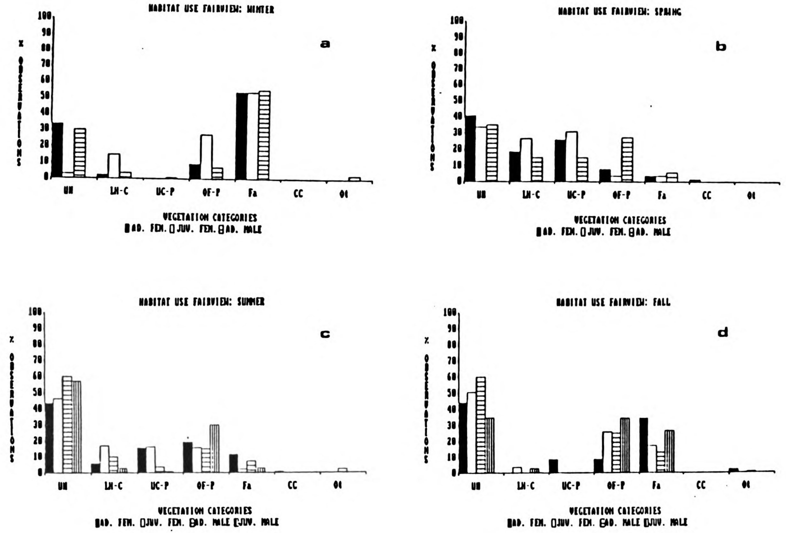

Fig. 6. Within season comparisons of habitat use for birds on the Fairview study site. a) winter, b) spring, c) summer, d) fall.

use of upland hardwoods and their concomitant higher use of lowland hardwoods and conifer stands.

From winter to spring, a substantial drop in the use of farmland was noted over all sex-age groups (Fig. 6b). Adult birds were still observed to make heavy (about 30%) use of upland hardwoods. Adult females were noted to shift use to the upland conifer-plantation and lowland hardwood-conifer categories. The adult males were observed more in old fields and pastures. Fairview juvenile females showed a large shift to use of the upland hardwood vegetation types (33.1%), bringing this group into close agreement with the adults. Like the female adults, juvenile hens increased their use of lowland vegetation types as well as upland conifers in the spring.

Even greater use of upland hardwoods was noted in the summer for all groups, with adult males making the most use (60.4%) followed by juvenile males (57.7%) (Fig. 6c). This category along with old fields and pastures accounted for 76.0% and 87.8% of the summer observations made for adult and juvenile males respectively. Juvenile males were noted to make the most use of old fields and pastures of any other age-sex group. Females continued to differ from males by their greater time spent in upland conifer vegetation types. Use tended to be much more spread out over a variety of vegetation types for the female birds. While still making up the greatest percentage of observations, upland hardwoods only comprised approximately 45% of the total female habitat use. In addition, adult hens were found to use the upland conifer-plantation, old field-pasture, and farmland vegetation categories from 10% to 15% of the time. Likewise, juvenile females made moderate use of the upland conifer--plantation, and old field-pasture categories; however use of lowland hardwoods and conifers was found to displace farmland.

A distinct shift to farmland and old fields occurred in the Fall (Fig. 6d). This shift did not diminish the persistently high use of upland hardwoods again noted for this season.

Similar trends and patterns were recorded for the South Branch flock (Fig. 7). Upland hardwoods were again found to be consistently used to a high degree by all sex- age groups. Males, particularly the adults, were again observed the most in this vegetation type. Lowland hardwood-conifer vegetation types again tended to be used more by juveniles than adults, although this type was observed to have greater overall use on the South Branch than on the Fairview site. This was observed most clearly during the winter (Fig. 7a). No use of farmland was noted at all. These shifts again reflect the differences in availability of these vegetation types between the 2 study sites. Upland hardwoods and lowland vegetation types accounted for approximately 90% of the winter observations over all 4 sex-age groups. Note that adults used the upland hardwood category more, while the juvenile birds made greater use of the lowland hardwood-conifer vegetation type. With spring, an even greater use of lowland vegetation types was noted (Fig. 7b).

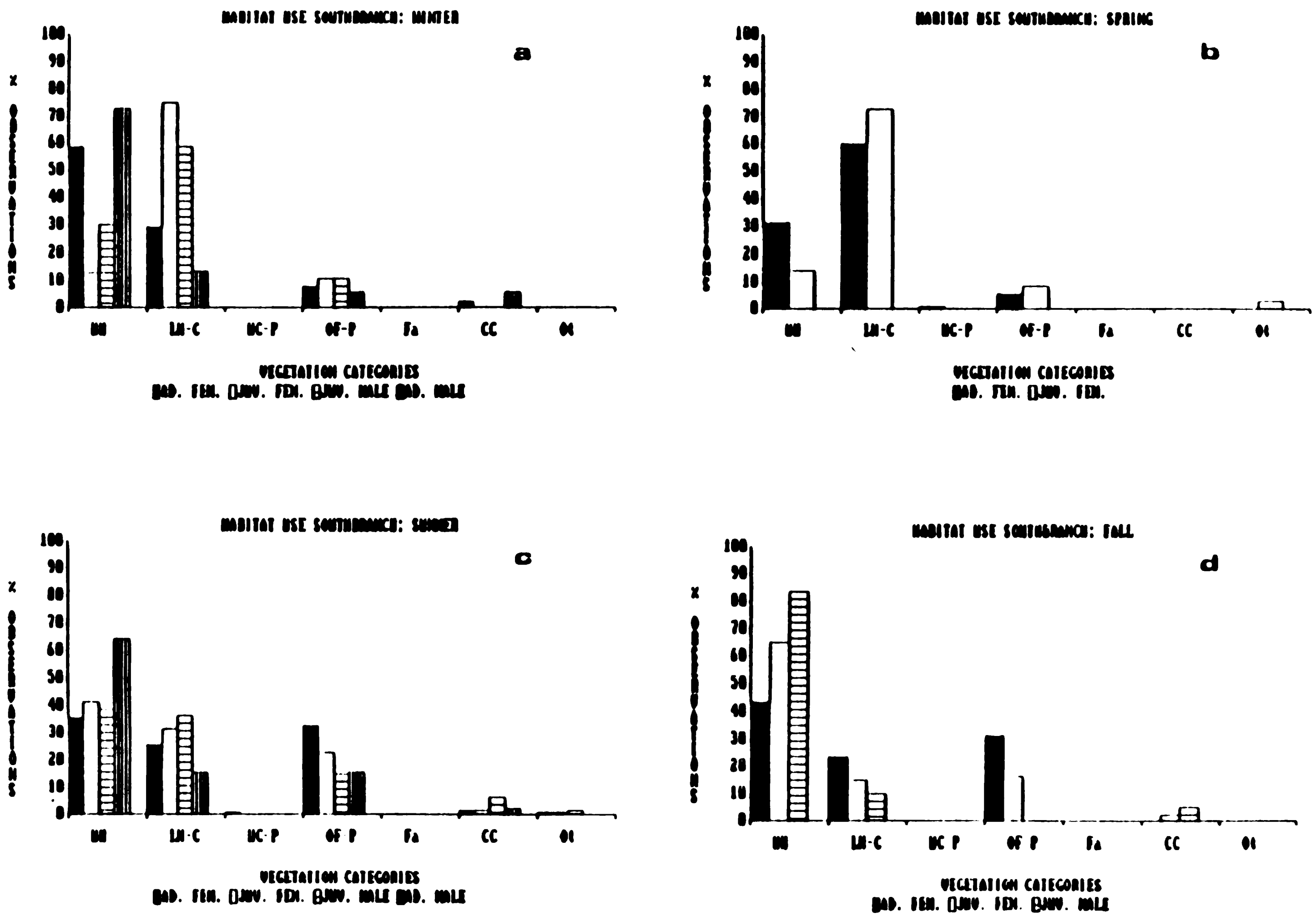

Fig. 7. Within season comparisons of habitat use for birds on the South Branch study site. a)winter, b)spring, c)summer, d)fall.

Use of old fields and pastures again was found to dramatically increase during the summer. However, on this study site, females made greater use of this vegetation type than males. Clear cuts, although not a dominant vegetation category, received highest use during the summer (Fig. 7c).

Increased use of old fields and pastures in the fall was recorded in South Branch as in Fairview (Fig. 7d). However, this shift was only noted for females. Hens made use of old fields and upland hardwood vegetation types. Juvenile males were found to make no use of the old field-pasture category at all. Upland hardwoods comprised 84.2% of the observations made on these turkeys in the fall (Fig. 7d).

Distinct daily habitat use patterns were recorded on both study sites in the fall, winter, and spring, with the strongest patterns noted during the winter.

On the Fairview site, highly significant ($P < 0.01$) use patterns were noted during the winter (Fig. 8a). Upland hardwoods tended to be used most during the morning and evening hours, with use declining toward mid-day. Farmland use generally peaked during the mid-morning and early-evening periods, as the birds fed just after coming down from and before flying up to the roost. Lowland hardwood-conifer and old field-pasture vegetation types tended to experience peak use during the inactive mid-day period. These birds also exhibited highly significant ($P < 0.01$) fall daily habitat use patterns (Fig. 8d). Old fields and pastures tended to be used most during the morning hours. However, use dropped off into mid-day and evening, while the use of upland hardwood

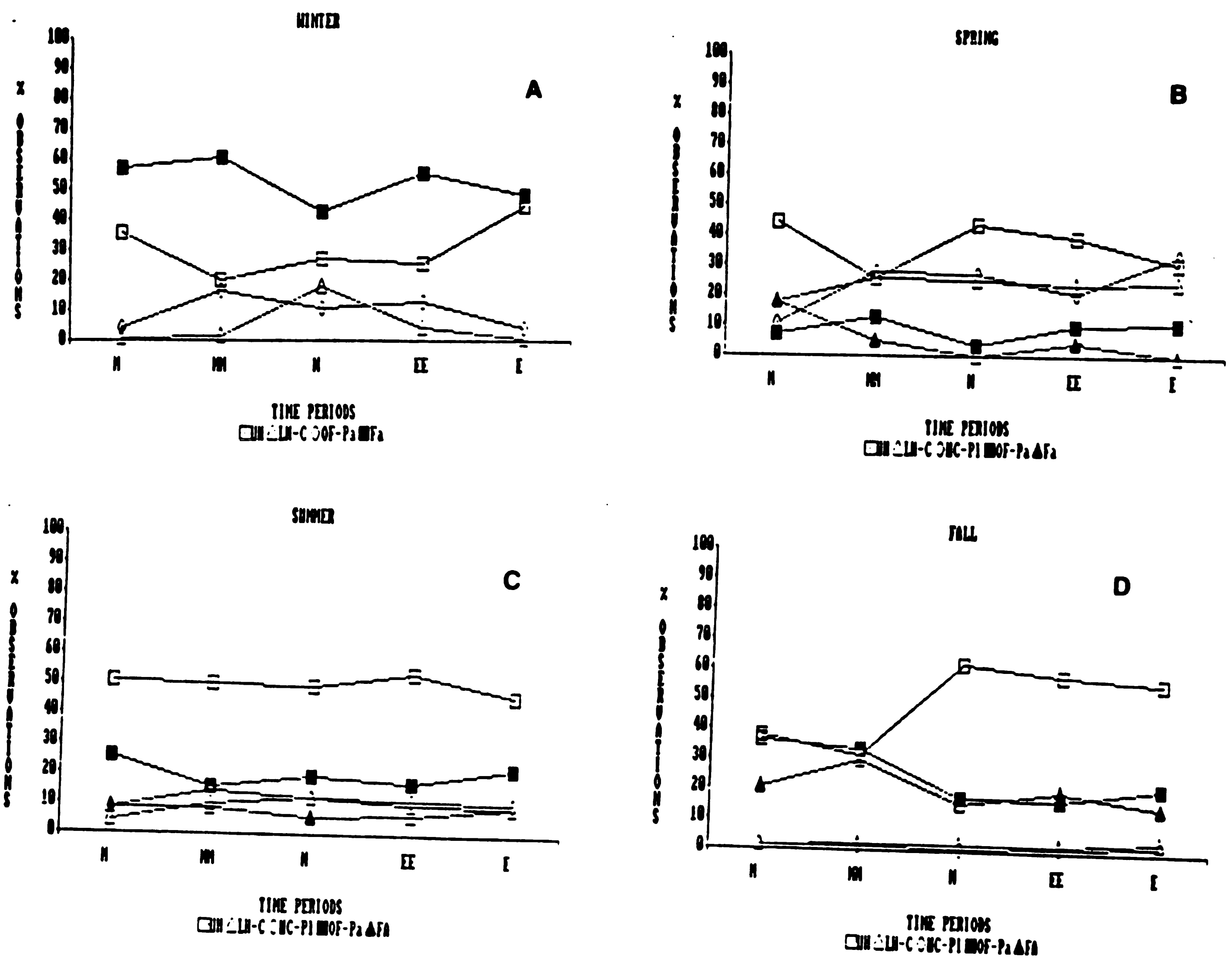

Fig. 8. Daily habitat use patterns observed for turkeys on the Fairview study site. a) winter, b) spring, c) summer, d) fall.

vegetation types increased. Farmland use peaked during the mid-morning period, and then also declined later into the day as upland hardwood use increased. Lowlands, and upland conifer stands were consistently used throughout the day at comparatively low levels. Spring daily habitat use patterns were not as distinct ($P < 0.05$) as those observed in the fall and winter. However,the tendency for peak use of farmland and old fields and pastures during the early and later parts of the day were still evident (Fig. 8b). No significantly different ($P > 0.05$) degrees of use were noted between the day time periods in the summer. Use of specific vegetation types was strikingly constant across the diurnal period (Fig. 8c). Here again, the extremely high use of the upland hardwood vegetation type is especially evident during the summer.

On the South Branch site, highly significant ($P < 0.01$) daily habitat use patterns were again noted during the winter, as well as in the spring. Wintering birds on this site exhibited a use pattern characterized by peak use of old field - pasture vegetation types in the morning and evening periods, with a gradual decline toward mid=day (Fig. 9a). Use of lowland vegetation types rose rapidly through the morning hours, and then gradually declined into the evening. Upland hardwood use exhibited the exact opposite pattern of that of the lowland types, declining from a peak in the morning and then gradually increasing from late mid-morning through the rest of the day. The use of open loafing cover, clear cuts in this case, received its highest use during the

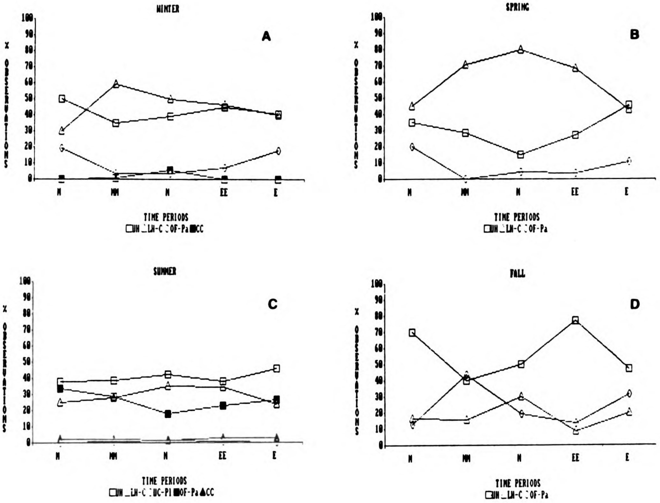

Fig. 9. Daily habitat use patterns observed for turkeys on the South Branch study site. a) winter, b) spring, c) summer, d) fall.

mid-day period. Spring use patterns basically followed the same trends observed in the winter (Fig. 9b). Uses of lowland and upland vegetation types were found to again oppose each other, with upland use peaking during the morning and evening hours, while the lowland hardwood-conifer vegetation type was used most through the mid-day period. Although both fall (Fig. 9d) and summer (Fig. 9c) daily habitat use patterns were found to be significant at the 0.05 level, no meaningful trends could be discerned. However, again note the extremely uniform use of each vegetation type throughout the day during the summer (Fig. 9c).

Because of its critical importance to turkey survival in northern Michigan, wintering range was specifically examined. It was noted over the course of the study that 3 distinct habitat components were present in close juxtaposition on every winter turkey range. First, good thermal cover was normally present. This was provided by upland hardwood and mixed hardwood-conifer stands, conifer plantations, and lowland forested stands. Second, an opening of some kind was needed to provide a loafing and feeding area during warmer, sunny days. Third, an easily accessible source of food was considered to be the most critical factor. Food was obtained in several different ways and in several different forms. Artificially obtained, non-native foods, such as corn, other grains, sugar beets, etc., were put out in feeders by local residents. Naturally obtained, non-native foods, such as waste corn and grain in harvested fields, or grain picked from manure in cattle feedlots, were frequently fed upon by wintering turkeys. Naturally obtained native foods, such as beech and oak mast and green vegetation from around streams and springs, were utilized by the turkeys when the abundance and availability of those foods was favorable.

Another characteristic observed was that nearly all wintering areas were located on private land. Of 68 known wintering areas recorded by the MDNR in Oscoda County from 1982 to 1986, only 3 were located on public land (Fig. 10).

Significant differences ($P < 0.01$) in habitat use between brooding and non-brooding hens were found, with non-brooding birds generally making greater use of wetter lowland areas than hens with broods. In the summer of 1984, brooding females on the Fairview site tended to make greater use of upland conifer stands and old fields, and less use of lowland vegetation types than non-brooding hens (Fig. 11). Significant differences were not found to persist into the fall of 1984 on this site. On the South Branch site, significant differences ($P < 0.01$) between brooding and non-brooding hens were also found in 1984. However, in summer 1985, no differences were found on this site. In the summer of 1984, brooding South Branch hens were observed with greater frequency in old fields and pastures, while non--brooding birds were found more in lowland vegetation (Fig. 12). This differential pattern of habitat use was maintained by South Branch hens into the fall of 1984, where a significant ($P < 0.01$) difference was found (Fig. 13).

These quantitative data support qualitative observations regarding brooding sites. For the first 7 to 10 days after

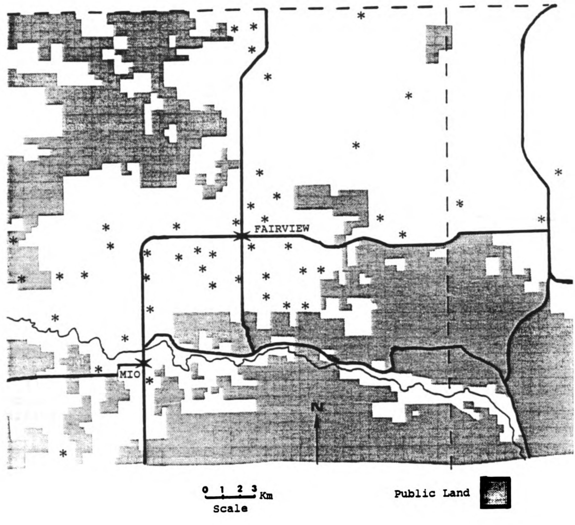

Fig. 10. Locations of known wintering concentrations of wild turkeys on the Fairview study site, Oscoda Co., Michigan over the winters of 1982 - 1986 (MDNR, unpubl. reports). Two of the 3 public land wintering areas are shown here.

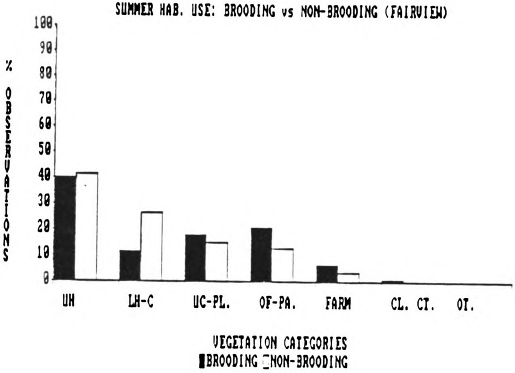

Fig. 11. Comparison of 1984 summer habitat use between brooding and non-brooding hens from the Fairview site. Comparisons found to be significantly different ($P < 0.01$).

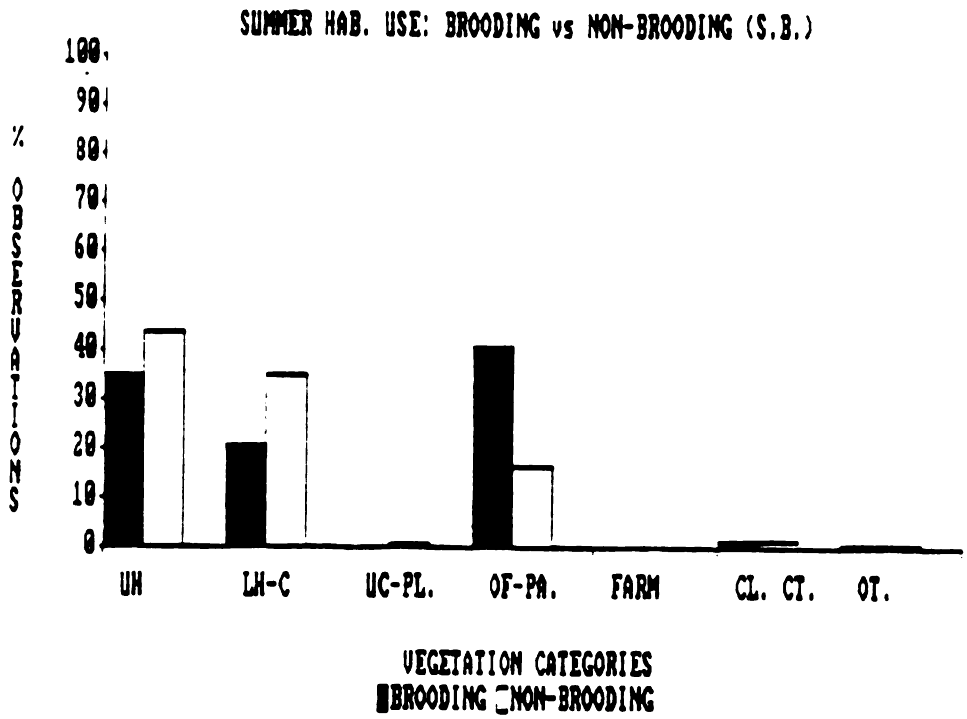

Fig. 12. Comparison of 1984 summer habitat use between brooding and non-brooding hens from the South Branch site. Comparisons found to be significantly different (P < 0.01).

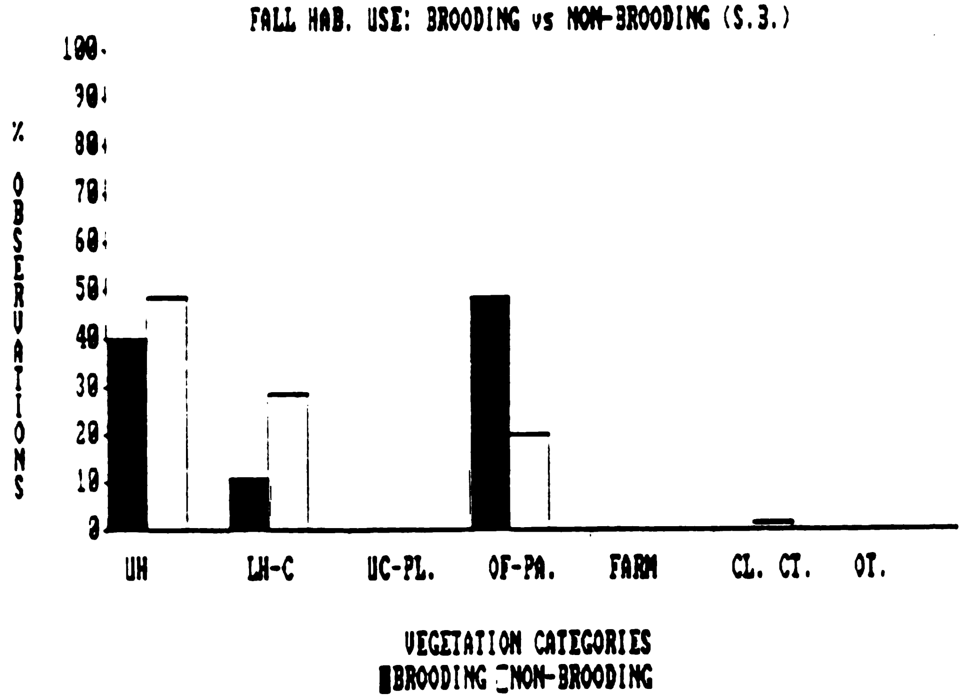

Fig. 13. Comparison of 1984 fall habitat use between brooding and non-brooding hens from the South Branch site. A significant ($P < 0.01$) difference between the 2 groups was noted in this season.

leaving the nest, hens were found to remain in dense brush or tall grass. As the brood got older, feeding in tall grassy old fields and pastures became the predominant activity. Most of this feeding was generally done along wooded edges, or in open savannah like wooded stands with heavy herbaceous ground cover. When available, mature alfalfa was a preferred brooding vegetation type. Wet lowland areas were generally avoided.

NESTING HABITAT

Of the 8 nest site parameters measured, none were found to differ significantly with hen nesting success or age.

Nests were generally oval in shape, being significantly ($P < 0.05$) longer ($\bar{x} = 36.2 \pm 2.1$ cm) than wide ($\bar{x} = 30.3 \pm 2.0$ cm). Depth was shallow, ranging from 0 to 7 cm, with a mean of 2.9 ± 0.4 cm. Construction was generally of the most prominent litter material, such as twigs, dried leaves and grass, and conifer needles. In most cases down and body feathers were also part of the nest structure. However, a few nests were just shallow, bare ground, bowls hollowed out in soft dirt or humus.

Twenty-seven percent (6 of 22) of the nests examined were on slopes of greater than 10%. Overall, nesting slope ranged from 0 to an upper extreme of 30%, with a mean of 6.1 ± 1.8%. No preference for a particular aspect was apparent. Nests were found facing into all 4 of the major directional quadrants.

Nests were generally within 1/4 mi of a permanent water source, and were never greater than 1/2 mi from water. Water sources ranged from cattle troughs and swales of standing water to the AuSable river. Mean distance to water was 213 $\pm$ 44.0 m (699 $\pm$ 144.3 ft) and ranged from 1 m (0.3 ft) to 723 m (2372 ft). Nests tended to be situated in close proximity to natural edges as well. Natural edge distance ranged from 4 m (13 ft) to 560 m (1837 ft), with a mean of 73.8 $\pm$ 24.4 m (242.1 $\pm$ 80.0 ft). Nests were found to be located significantly ($P < 0.05$) farther from man-made structures than natural changes in vegetation types. The mean man-made edge distance was 151.8 $\pm$ 31.7 m (498 $\pm$ 104.0 ft), and ranged from 5 m (16 ft) to 583 m (1912.7 ft).

Cover in the 4 height strata measured was not found to significantly differ between hens of different age or nesting success. In addition, cover was not found to significantly change with distance away from the nest. However, general observations noted that nests normally were situated in vegetation or slash which offered the most mid- and understory horizontal cover in the immediate vicinity. Mean percent cover for each of the 4 height strata measured are given in Table 10.

Stem densities, in 4 size classes, were also not found to differ significantly between successful and unsuccessful nests. Mean stem densities observed over 21 nests examined on both study sites are given in Table 11. Of a total of 31 woody species identified (Table 12), an average of 7.2 $\pm$ 0.8 woody species were found on a given nest site. Richness of

Table 10. Mean % cover for 4 height strata summarized from 23 nest sites examined on both the Fairview and South Branch study sites over 2 nesting seasons, 1984-85.

Height Stratum	Mean % Cover ± S.E.
< 0.5 m	73.36 ± 5.4
0.5 - 1 m	26.91 ± 5.1
> 1.0 m	62.46 ± 5.9
slash	22.29 ± 3.6

Table 11. Mean stem densities for 4 size classes of woody vegetation, measured on 23 nest sites, from both the Fairveiw and South Branch study sites over 2 nesting seasons, 1984-85.

Stem Size Class	Mean Density ± S.E. (stems/ha)
< 0.5 m tall	23152.1 ± 6864.5
> 0.5 m tall & < 12.7 cm DBH	6600.2 ± 1598.6
12.7 cm DBH - 25.3 cm DBH	249.1 ± 39.8
> 25.3 cm DBH	61.8 ± 16.6

Table 12. Frequency of occurrence of 31 woody species identified at 23 nesting sites examined on both the Fairview and South Branch study areas over 2 nesting seasons (1984-85).

Species	Frequency (%)
maple (*Acer* spp.)	60.9
oak (*Quercus* spp.)	60.9
aspen (*Populus* spp.)	47.8
white ash (*Fraxinus americana*)	43.5
birch (*Betula* spp.)	39.1
dogwood (*Cornus* spp.)	39.1
cherry (*Prunus* spp.)	34.8
hophornbeam (*Ostrya virginiana*)	30.4
serviceberry (*Amelanchier* spp.)	30.4
balsam fir (*Abies balsamea*)	26.1
Eastern white cedar (*Thuja occidetalis*)	26.1
alder (*Alnus* spp.)	21.7
balsam poplar (*Populus balsamifera*)	21.7
willow (*Salix* spp.)	21.7
basswood (*Tilia americana*)	17.4
American beech (*Fagus gradifolia*)	17.4
elm (*Ulmus* spp.)	17.4
Jack pine (*Pinus banksiana*)	17.4
tamarack larch (*Larix laricina*)	17.4
black spruce (*Picea mariana*)	13.0
white pine (*Pinus strobus*)	13.0
highbush blueberry (*Vaccinium corymbosum*)	8.7
ironwood (*Carpinus caroliniana*)	8.7
red pine (*Pinus resinosa*)	8.7
viburnum (*Viburnum* spp.)	8.7
American chestnut (*Castanea dentata*)	4.3
autumn olive (*Elaeagnus umbrellata*)	4.3
Eastern hemlock (*Tsuga canadensis*)	4.3
hawthorn (*Crataegus* spp.)	4.3
staghorn sumac (*Rhus typhina*)	4.3
witchhazel (*Hamamelis virginiana*)	4.3

woody species ranged from 0, for a nest located in an alfalfa field, to up to 13. Oaks, aspen, maple, and ash were found to be the most common tree species on the nest sites examined (Table 12). Nests were found in a variety of vegetation types. Lowland conifer swamps and willow swales were used, as well as northern hardwood stands and Jack pine plantations. Hens nested in open vegetation types, such as old fields and alfalfa fields, in addition to forested stands.

Hens were noted to nest in the same general local from year to year. For 7 monitored hens which attempted nests over 2 consecutive years, the mean distance between nest sites was 1.0 $\pm$ 0.45 km (0.62 $\pm$ 0.28 mi.), ranging from 0.29 km (.18 mi.) to 3.22 km (2.0 mi.). Only 1 hen, a juvenile the first year it nested, was found to establish nests on successive years more than 0.82 km (0.5 mi.) apart. Removing this outlier, the mean distance between 6 pairs of nests was 0.6 $\pm$ 0.1 km (0.3 $\pm$ 0.1 mi.).

NESTING AND MORTALITY

Two peaks of nesting activity were noted on both study sites for 2 of the 3 nesting seasons monitored (Table 13). Laying was found to begin as early as the second week of April. Hens generally began incubation during the first week of May, with young coming off the nest by late May or early June. The second peak of setting hens was noted during the first 2 weeks of June. This means laying activity peaked a second time during the last week of May or first week of June. Young from this second nesting period were noted by early July. Because of this bi-modal distribution of nesting activity, mean nesting dates are not truly representative. However, comparisons of mean dates between years point out the high variability of nesting peak (Table 13). Comparison of nesting dates between adult and juvenile hens found no significant differences.

Over both study areas, 52.3% of the telemetered turkeys died prior to telemeter failure or loss. Higher mortality rates were noted during the spring and summer months, with 78.3% of the deaths occurring during the 6 month periods from April to September (Table 14).

Over the 3 year period, annual mortality averaged 34.4% for the northern turkey flocks studied. A slight declining trend was noted, with a high of 38.9% occurring in 1983 and a low of 27.3% recorded in 1985. In general, males and females were found to experience the same mortality rate. Of the males, a mean of 37.3% died annually, compared to 34.4% of the females. Sex specific annual mortality rates were found to closely follow the overall population rates. Adults exhibited a higher annual mortality rate than 1 year old juveniles. The mean annual mortality rate for adults was 42.4%, while 25.8% for juvenile birds. Age specific annual mortality rates were not found to coincide as closely with the yearly overall population figures as the sex specific annual rates. Adults experienced consistently higher mortality, over the 3 years of observation, than the population as a whole.

Table 13. Nesting time table for the Fairview and South Branch study areas over the 3 years of the study.

Year	Study Area	Dates: Start of Laying[a]	Start of Incubation[a]	Date of Hatch
1983	FAIRVIEW	5/26	6/8	7/5
		5/26	6/8	7/5
		6/6	6/19	7/16
		6/9	6/22	7/19
	mean dates:	6/1	6/14	7/11
	SOUTH BRANCH	---	---	---
1984	FAIRVIEW	4/12	4/25	5/22
		4/16	4/29	5/27
		4/20	5/3	5/30
		4/24	5/7	6/3
		5/22	6/4	7/1
		5/22	6/4	7/1
	mean dates:	4/29	5/12	6/8
	SOUTH BRANCH	4/26	5/9	6/5
		4/26	5/9	6/5
		5/30	6/12	7/9
		5/30	6/12	7/9
		6/4	6/17	7/14
	mean dates:	5/17	5/30	6/26
1985	FAIRVIEW	4/24	5/7	6/3
		5/24	6/6	7/3
	mean dates:	4/9	5/22	6/18
	SOUTH BRANCH	4/20	5/3	5/30
		4/22	5/5	6/1
		4/22	5/5	6/1
		4/24	5/7	6/3
		5/7	5/20	6/16
	mean dates:	4/25	5/8	6/4

[a]These dates estimated by back-dating from end of incubation using 28 day incubation period and 14 day laying period.

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Table 14. Dates and causes of mortality for the 23 mortalities collected from the Fairview and South Branch study sites.

Sex	Age[1]	Date of Loss	Suspected Cause of Loss
		--------------Fairview--------------	
F	J	03/16/83	Avian Predator
F	J	04/05/83	Bacterial Enteritus
M	A	04/30/83	Legally Shot
F	A	04/30/83	Illegally Shot
F	A	05/14/83	Mammalian Predator
M	A	06/24/83	Mammalian Predator
F	A	10/13/83	Avian Predator
F	A	02/16/84	Avian Predator
F	J	04/20/84	Avian Predator
F	A	04/25/84	Legally Shot
M	A	05/21/84	Illegally Shot
F	A	07/24/84	Unknown Predator
F	J	08/05/84	Avian Predator
F	A	08/10/84	Illegally Shot
F	A	09/05/84	Illegally Shot
M	A	05/06/85	Legally Shot
F	A	07/08/85	Mammalian Predator
		------------South Branch-------------	
F	A	03/14/84	Mammalian Predator
M	J	04/21/84	Mammalian Predator
F	A	08/06/84	Unknown Predator
F	J	08/18/84	Avian Predator
F	J	11/16/84	Illegally Shot
F	A	05/17/85	Mammalian Predator

[1]Age at time of death

Adult males were found to have the highest mean annual mortality (50.0%) followed by adult females (39.6%) and juvenile females (32.1%). A mean mortality rate could not be meaningfully calculated for juvenile males because of small sample sizes. When death due to legal hunting was removed (assuming hunting to be completely additive in its effect) mean annual adult male mortality dropped to 33.3% compared to 37.4% for adult females.

At least 6 general mortality factors were identified to be operating on the northern Michigan turkey population. Mammalian and avian predators each took 26.1% of the monitored flock. Poaching accounted for 21.7% of the bird losses, while legal harvest accounted for 13.0%. Unknown predators accounted for 8.7% of the losses, while other miscellaneous factors, such as disease (specifically bacterial enteritus), removed 4.3% of the monitored flock.

CENSUS AND SURVEY RESULTS

Of the 4 census routes, only 3 1/2 could be completed because of weather and time restrictions. As a result, over a period of 14 days, 56.6 km (35 mi.) of census route were covered, using 25 man-hours. A total of 10 turkey sightings were made during this time.

Sixty percent of the observations were made during the morning runs. Of the 6 sightings made, only 1 occurred after 0800 hours (i.e. approximately 1 to 1 1/2 hours after sunrise). The 4 evening observations were distributed throughout the evening, from 1 to 4 hours before sunset. An average of 1.4 cars passed per station during the evening routes, compared to 0.8 cars per station in the morning.

Overall the tape recorded calls did not appear to improve the sensitivity of the census. Eighty percent of the sightings were made before the tape was played, or were made at distances too far to have been influenced by the calls. In the 2 cases where the taped distress calls did elicit responses,these responses were not very strong. In all cases, 1 or 2 hens in the flock would take an alert posture for a short time. However, the calls never invoked movement in the direction of the tape player. In 1 case, the distress calls may have stimulated a hen to call. However, the call was extremely soft and low in pitch, and would not have been audible if the hen had not been very close to the census station to begin with.

The mail-carrier road survey was received with varying degrees of cooperation. Usable data were collected at the end of the study. However, over the 3 month period, only 12 observations were recorded. One point worth noting is that most of the observations from any given carrier were all made around the same time of day, depending on the time they normally ran their route.

DISCUSSION

MOVEMENTS AND SEASONAL RANGES

The annual ranges reported here, especially those from the Fairview site, are as much as 3 times larger than reported elsewhere. Mean annual ranges given in the literature range from 300 ha to 1600 ha, with females generally having larger yearly ranges than males. Everett, Speake, and Maddox (1979), in Alabama, reported males and females to range over 1631 ha and 1439 ha respectively in a year. Barwick and Speake (1973), in another Alabama study, reported a smaller gobbler range of 398 ha. Hens in Iowa were noted to have an annual range of 385 ha (Little and Varland 1981). In Missouri, Ellis and Lewis (1967) reported a mean annual range for females of 829.6 ha and 447.6 ha for males. Turkeys transplanted onto Ohio farmland were found to cover 1567 ha in their first year.

One explanation given for this great variability in observed range sizes has been that annual and seasonal range size of wild turkeys is primarily a function of habitat quality. Birds on less productive ranges must travel farther to meet their needs than those turkeys in areas with abundant food sources and good interspersion of critical vegetation types (Ligon 1946, Korschgen 1967, Everett, Speake, and

Maddox 1976, and Brown 1980). In Pennsylvania, Hayden (1980) noted that the mean annual range size for hens using a woodland-pasture area (532 ha) was almost half that traveled by hens in an entirely forested area (1227 ha). He explained this difference by noting that the woodlot-pasture flock did not have to travel as far between critical seasonal ranges, such as winter and nesting habitats, as did the forest birds, because habitat components were adjacent to each other in the pasture-woodlot situation. In addition, the forest birds depended almost exclusively on hard mast as fall and winter food, and had to forage over large areas to obtain adequate quantities. Pasture-woodlot flocks had easy access to concentrated food sources, such as soft mast from shrub plantings, and waste grain picked from harvested fields and manure piles. If this same mechanism is working in the northern Michigan turkey flocks, the Fairview study area, although supporting one of the state's highest turkey densities, may be lower in quality than the South Branch site, as well as the majority of the turkey ranges studied in other states. However, it should be kept in mind that habitat quality is composed of 2 distinct properties: absolute quality of the required habitat components; and the spatial arrangement of those components for a particular species' use. Based on the data collected from this study, poor juxtaposition of spring and summer habitats, particularly nesting and brooding grounds, to wintering areas seems to be the primary reason for the larger overall Fairview annual ranges. This lack of optimum juxtaposition may also explain, in part, the more "migratory" behavior of the northern Michigan flocks. Weather patterns are so extreme and suitable seasonal habitats are so dispersed, that distinct seasonal movements have developed, especially preceding the winter months, as birds concentrate onto the few high quality winter ranges available. Additional observations which tend to support the idea of poor juxtaposition and interspersion of required vegetation types, rather than their poor absolute quality on the Fairview site, are the smaller winter and larger spring seasonal ranges noted for the Fairview flock as compared to the South Branch birds, and the differential dispersal behavior observed for turkeys from the 2 sites. These factors will be subsequently discussed in more detail.

It should be realized, however, that reliable movement data are only available for 1983. Other factors could have caused the abnormally large mean annual range observed on the Fairview site that year. The birds had been outfitted for the first time with radiotransmitter back packs, which may have altered their behavior and movement patterns. However, no behavior which could be considered abnormal was noted within 24 hours after birds were marked and released. Nenno and Healy (1979) did not find any permanent change in behavior due to transmitter backpacks. They noted that any obvious changes in behavior subsided within 2 days. In addition, turkeys which were monitored into a second year, generally ranged over the same areas they had the previous year. Finally, turkeys on the South Branch site did not show similarly inflated ranges after first being radio-marked.

Weather in 1983 could have potentially affected overall turkey movements. However, no noticeably aberrant weather patterns were recorded between the years of the study to account for the large 1983 ranges. Again, although not monitored for an entire second year, those birds originally marked in 1983 and monitored into 1984 gave early indications of following very similar ranges for the second year. Although the 1984 Fairview annual range figures appear more reasonable, it should be noted that only 3 birds, all of the same sex and age class (juvenile females), were monitored all the way through 1984. Thus the 1984 data are most likely not truly representative of the Fairview flock. This type of sampling error, due to small sample sizes, may also explain, in part, the abnormally large mean annual range observed in '83. Finally, it should also be kept in mind that the Fairview study site supports an extremely high turkey density. Competition for resources, such a space, nesting sites, and food, could also directly influence dispersive and seasonal movements. In addition, these high densities would also tend to magnify any habitat quality deficiencies. With these considerations noted, it would seem that the theory of poor spatial arrangement (i.e juxtaposition and interspersion) of critical vegetation types is still a possible, although not exclusive, explanation for the larger range sizes observed for the Fairview flock.

Seasonal range sizes reported elsewhere, vary between states and even between different regions of the same state. It has generally been observed that weather conditions, principally depth and consistency of snow-cover, and food abundance and availability directly affect winter home range size, especially in the northern most parts of the turkey's current range (Bortner and Bennett 1980, Hayden 1980). Leopold (1933) stated that annual variation in local acorn production caused turkeys to use different wintering areas. This is exactly what appears to have caused the unusually large 1985 winter range on the South Branch site. The fall of 1984 witnessed an abundant mast crop, particularly beech. The resulting high food availability combined with an unusually mild early winter, produced conditions where turkeys were widely ranging as they foraged through upland hardwood vegetation types. Sudden and prolonged snowfall in mid-January trapped the monitored South Branch flocks on the upland sites away from the thermal cover of the lowland conifer swamps and food supplied by local residents. With the formation of crusted snow-cover in mid to late February, access to mast and other natural foods became severely limited to the birds, while travel was facilitated over the hard surface. Movement onto lower private lands was noted for all the birds by late February. This scenario was not noted for the Fairview flock because of their dependence on farmland no matter what the prevailing weather conditions. Spring ranges have been found to be correlated with topography, with rougher terrain resulting in smaller ranges (Logan 1973). Speake et al. (1969) comment that the distribution of large openings appeared to influence the movement patterns of turkeys. in Minnesota, Porter (1977), hypothesized that the dispersion of food, water, and cover influenced summer gobbler movements, while female summer range sizes were a function of the abundance of resources, the requirements of the brood, and the ability of the brood to move. It thus becomes obvious that seasonal ranges are extremely dynamic and tend to be very sensitive to external, abiotic and biotic, factors. This should be kept in mind when viewing seasonal range data. The seasonal range sizes from the current 2 study areas, although appearing stable over 2 1/2 years of the study (i.e. no significant differences between years), could change substantially in response to changes in environmental conditions such as weather, mast crop, vegetation community structure, etc.

Winter ranges on the Fairview site were found to be much smaller than those noted for the South Branch flock. This suggests that the winter ranges on the Fairview site are as high, if not higher, in absolute quality than those on the South Branch site. Several studies (Glover 1948, Porter 1977, Hayden 1980, Porter et al. 1980, and Little and Varland 1981) have reported that turkeys generally tend to exhibit more erratic and wider ranging movements during mild winter periods, presumably looking for food; and that those birds near abundant, concentrated food sources tended to have the smallest winter ranges. Farmland, while clearly not an entirely natural winter habitat, provides a concentrated source of high quality food which can support a much higher density of birds on a small area than the natural foods supplied by the lowlands and hardwoods on the South Branch

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site. It should be noted, however, that both areas, for the number of birds they support and the quantity of thermal cover they provide, are adequate winter ranges as indicated by the low winter mortality rates observed on both sites.

Brood studies have found summer ranges of brooding hens to range from approximately 90 ha to 450 ha (Speake et al. 1975, Hayden 1979, 1980, and 1985, Pack et al. 1980, Porter 1980). The fact that the brooding ranges on the Fairview site tended to be larger than the reported range sizes, as well as those observed on the South Branch area, may again indicate poor juxtaposition of brooding habitat to nesting habitat on this site.

Numerous previous studies support the observation from this study that turkeys tend to return to the same wintering area year after year (Thomas et al. 1966 and 1973, Ellis and Lewis 1967, Speake et al. 1969, Hillestad 1973, Crockett 1973, Brown 1980, and Hayden 1980). However, in contrast to much of this earlier work, which reported only adults birds exhibited this behavior, a majority of the juveniles as well as the adults returned in this study. Consistent annual use of a given locale, not only during the winter, but during the spring and summer as well, as observed in this study, has also been documented in the literature. Little and Varland (1981) reported that adult gobblers dispersing in 1976, returned to the same summer ranges they used in 1975. In Oklahoma, Logan (1973), noted that patterns of spring dispersal were similar each year for Rio Grande turkeys (M.g. intermedia). And in Alabama, Speake et al. (1969) observed several marked birds using the same winter and summer ranges year after year. Ellis and Lewis (1967), in Missouri, reported that hens which had previously nested returned to the same nest area, but that males showed no such attachment to a particular location. Likewise, Ligon (1946) for Merriam's turkeys (M.g. merriami) and Hayden (1980) studying Eastern wild turkeys in Pennsylvania both noted that hens tended to return each spring to the same breeding and nesting range used the year before.

The mean dispersal distances observed on the Fairview site, especially in 1983 and 1984, tend to be slightly longer than those generally reported in the literature. Most other studies have found mean dispersal distances of from 2.0 km to 5.0 km (Ellis and Lewis 1967, Hillestad and Speake 1970, Barwick and Speake 1973, Davis 1973, Fleming and Webb 1974, Eaton et al. 1976, Hon et al. 1978, Hecklau et al. 1982, Vander-Haugen 1983). A few studies have reported dispersal distances comparable to the present findings. Miller et al. (1985), in west-central Indiana, reported dispersal distances ranging from 4.4 km to 14.3 km, with the mean distances for males and females being 9 km and 5.3 km respectively. Radio-telemetered gobblers were followed over a spring dispersal distance of 7.2 km by Proud (1969), and juvenile hens in Missouri had a mean dispersal distance of 7.4 km (Ellis and Lewis 1967). Brown (1980) gives a very good review of the turkey movement research.

The fact that the Fairview dispersal distances again tend to be longer than those normally observed gives further support to the theory of poor juxtaposition of critical habitat types, especially winter to nesting areas, on this site. In addition, the differential dispersal behavior noted between turkeys from the 2 study sites suggested better juxtaposition of habitat components on the South Branch site. Birds were found to disperse, on average, 8 km (5 mi.) from the wintering grounds on the Fairview site, while on the South Branch site, no distinct dispersal movements could be identified. It thus appeared that the Fairview birds had to move to distinctly different spring ranges, spatially removed from the wintering grounds, while the South Branch birds just had to shift their emphasis of use, in the spring, to a sub-section of their larger winter ranges. The differential turkey densities between the 2 wintering flocks should again be considered as well. On the South Branch site, flocks of only 20 to 40 birds tend to winter together, compared to 300 to 500 on the Fairview site. Birds tend to aggregate in from greater distances in the Fall and thus disperse out farther in the Spring on the Fairview site. In addition, the greater competition for nesting sites would tend to intensify any affects due inadequate amounts of quality nesting cover in close proximity to the wintering grounds.

The findings of this study that adults moved off the wintering grounds first and showed greater mobility than juvenile birds are different from previously reported results which generally have found juvenile females to be the most mobile sex-age group followed by juvenile males, adult females, and finally adult males (Ellis and Lewis 1967, Davis

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1973, Eaton et al. 1976, Fleming and Speake 1976, Hayden 1980, Little and Varland 1981, Clark 1985). Only Grettenberger (1979), in northwestern Michigan, found a similar pattern of adults moving greater distances during dispersal than juveniles. in their study, Speake et al. (1975) found no evidence that juveniles dispersed longer distances than adults.

One possible explanation for the unique dispersal pattern of adults before juvenile birds on the Fairview site may be that a learned stimulus-response mechanism is at work in the flock. Since the birds have been found to generally use the same wintering area from year to year, a majority of the wintering adults would be expected to have already spent at least 1 winter on Mr. Yoder's farm. Mr. Yoder annually rents out blinds on his property to turkey hunters during the spring hunt. As a result, a lot of scouting activity and calling by anticipating hunters goes on during the weeks just prior to the opening of the spring gobbler season. In both 1983 and 1984, the adult birds were noted to move off the wintering grounds, essentially all at once, within a 1 to 3 day period, 7 to 10 days before the opening of the turkey season. Presumably having already experienced a hunting season on Mr. Yoder's farm, the adults may key in on cues from the increased hunter activity, and move off the area. Such a learned response to external cues could be stabilized rather quickly since those males and some of the females which did not pick up on this behavior after the first 1 or 2 years would most likely be removed from the population.

Another possible explanation is that adult birds, generally being heavier (Lewis and Breitenbach 1966, and Speake et al. 1969) and thus most likely coming out of the winter in better physical condition with greater energy reserves (Glover 1948, Peterson and Richardson 1973, Porter et al. 1983, and Gray 1986), can leave the concentrated food source of the wintering grounds earlier in the spring. One would only expect to observe this behavior at the more northern extremes of the wild turkey range, where the harsh winter weather conditions would accentuate the advantage of this differential energy reserves between the age groups.

The design of the winter turkey trapping in this study provided an unexpected insight into the winter flock dynamics of the Fairview turkeys. Trapping was intended to obtain a random sample of individuals, representative of the turkeys in the Mio-Fairview area. However, most of the birds caught in 1 year were secured with only 1 or 2 drops of the net. Thus many of the birds were associated in the same feeding group when they were caught. No thought was given to this until it was noted that birds caught at the same time tended to disperse into the same areas (directions) during spring break-up. It thus appeared that subgroups of birds from the same general spring-summer-fall range existed within the large wintering aggregation. Researchers in Texas (Thomas et al. 1966), West Virginia (Bailey and Rinell 1968), and Oklahoma (Crockett 1973) have noted that turkeys form distinct social groupings, usually based on sex and age (i.e. adult males, juvenile males,and hens with young), during the

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winter. These groups usually fed and roosted together but remained separate from each other throughout the day. However, such a structured social organization did not appear to be occurring on the wintering sites in this study. Loose aggregates of turkeys termed "droves" by Dalke and Spencer (1946) and Ellis and Lewis (1967) are defined as temporary aggregations of 2 to 3 flocks which usually group together at common feeding areas. This structure seems to more accurately describe the social organization observed on the winter areas. One could consider the large wintering concentrations as 1 big drove, composed of many unique subgroupings of birds from distinct locales in the surrounding turkey range. This situation poses several questions for future research, especially concerning subgroup breeding interactions and possible restrictions to gene flow in the northern Michigan population. Because of this situation, it must be kept in mind for the purposes of this study, that the results reported here may not be entirely representative of the total range of behaviors and activities occurring within the northern Michigan turkey flocks.

Many of the daily movement patterns and behaviors noted in this study have been documented elsewhere. McMahon and Johnson (1980) noted that during spring dispersal, Minnesota turkeys undertook "trips" lasting from 2 to 6 days, out of the management area into previously unexplored areas. However, these trips always ended with the bird returning to the area from which it started. This is very similar to the cyclic summer movements noted for some of the monitored birds in this study.

HABITAT USE

During the initial years of turkey restoration in this country, the eastern wild turkey was considered a bird of the mature hardwood forests. It was generally felt that from 15,000 to 50,000 acres of relatively undisturbed mature upland forests (primarily oak-hickory, and beech-maple vegetation types), interspersed with at least 10% openings for brooding and nesting habitat, were required for successful reintroduction and management of the birds (Mosby and Handley 1943, Lantham 1956, Wilson and Lewis 1959, Anderson 1963, Bailey and Rinell 1968).

However, current habitat use research and successful introductions of turkeys into what was previously considered marginal habitat, have changed the thinking on what is "quality" turkey habitat. As stated by H.S. Mosby in his 1974 wild turkey status report at the third National Wild Turkey Symposium, "[The] turkey has proven to be a much more adaptable bird than was thought possible 25 years ago..." both in its habitat use patterns and its tolerance of human activity (Mosby 1974). Many studies have reported the establishment of viable, self-sustaining, turkey flocks in agricultural areas characterized by only 20% to 30% forested land, and intense human activity (Ellis and Lewis 1967, Hayden and Wunz 1975, Loomis 1978, Price et al. 1984, Wunz 1985). In fact, in the most northern states within the turkey's current range, such as Minnesota, Vermont, Maine, and New Hampshire, farmland has been found to be essential for successful turkey establishment (McMahon and Johnson 1980, Porter et al. 1980, Porter et al. 1983, Walski 1985). In a statement that would have been considered ludicrous 25 years ago, Walski (1985) reported that, "turkey restoration has been a tremendous success in Vermont [compared to New Hampshire and Maine] primarily because it has the most remaining dairy farms."

The turkey has been found to be extremely diverse in its habitat use, frequently using a wide variety of vegetation types to obtain its physiological and energetic needs for a given season. Donohoe and McKibben (1970), in Ohio, reported turkeys using everything from pure pine stands, through all ages of hardwoods, to both natural and man-made openings. Speake et al. (1975) quantified this diverse character of the birds' habitat use by pointing out that 79% of the observed hens in their study selected ranges containing 3 to 4 major cover types, while only 4% had ranges containing only 1 vegetation type. This flexibility, to be able to use such a wide array of vegetation types to meet its requirements, has no doubt been one of the major factors contributing to the turkey's successful reestablishment and expansion of its historic range. However, this characteristic has made it difficult for researchers to quantify "typical eastern wild turkey habitat." As stated by Covert and Michael (1975), "Optimum habitat is difficult to define for most animals, but it is almost impossible to write a description of optimal habitat that would apply to all areas where the eastern wild turkey presently exists. It is difficult, if not impossible, even to determine which single factor has the most influence on turkey distribution and density."

The birds observed in this study tended to follow habitat use patterns similar to those reported elsewhere, especially for birds in the northern states. However, specific vegetation type use was found to differ with other studies, as well as between sexes, ages, years, the 2 study areas, and individual birds observed within this study. One of the strongest patterns drawn from these data is that each turkey is an individual. Some birds were found to avoid lowlands, while others spent the majority of their time in swamps and swales. Certain hens brooded their young only in alfalfa fields, while others used old fields or horse pastures. Some gobblers used pastures and cut crop fields as display grounds, while others consistently used small openings in mature woods. For most of these individual differences no distinct patterns or trends could be determined. Each bird or flock tended to use a distinct combination of vegetation types to meet its needs for survival. This individuality among specific birds, although averaged out and masked when birds were grouped together for summarization and analysis, should be kept in mind when interpreting these results. One finding which does show the presence of these different individual use patterns is the significant differences in habitat use found between years. If all the turkeys generally used the same vegetation types in a given area, one would expect habitat use to remain fairly consistent from year to year, even if some birds under observation were lost and new birds were added between years. The yearly differences on the Fairview site were the result of the loss of old, and the addition of new, birds between 1983 and 1984, each of which had their own unique vegetation use patterns. The extreme variability between individuals becomes even more obvious when one considers that the significant differences between years on the South Branch site resulted from only the removal of individuals from the observed group. Individual differences were so great, that just removing a few individuals caused the "mean" vegetation use pattern to significantly shift.

The degree of this individual diversity of vegetation type use seems to decline during the winter period. On the Fairview site, seasonal differences between years were primarily noted during the summer. Possibly the extreme energy demands of the winter season force the birds to use that combination of vegetation types which will most efficiently provide their food and cover needs. This hypothesis is further supported by the fact that, in this study, significant mean daily habitat use patterns were observed primarily only in the winter. It would thus appear that the majority of the turkeys were using the same vegetation types at approximately the same times during the winter. Another explanation, however, for this greater conformity of winter habitat use could be that a majority of the telemetered birds were usually in the same large wintering flock. These

individuals would thus have tended to follow the same habitat use patterns followed by the flock as a whole. The significant yearly differences in winter habitat use on the South Branch site was the result of the abundant mast crop and subsequent mild weather during the latter part of 1984, as previously described.

The significant differences in habitat use between the 2 study areas was most likely the result of bird's using what was available to them. Extensive tracts of crop and pasture land were available in the Fairview area, while cedar swamp covered a significant proportion of the South Branch site. Note that between the 2 areas, especially during the winter months, the birds were able to concentrate on and extract their life requirements from 2 very different vegetation communities. It is also worth noting the consistently high use of the upland hardwood vegetation type throughout the year on both sites. This consistent use points out the extreme importance of upland hardwoods to the northern Michigan flocks. This vegetation type can be considered a base type in which the birds spend most of their time throughout the year, and from which use is extended to more seasonally critical vegetation types.

The differences in habitat use between the sexes most likely were due to the different vegetation types used by each in the process of courtship, nesting, and brooding. On both sites, female birds were found to make use of those vegetation types noted to be preferred for nesting (lowland hardwoods - conifers and clear cuts) and brooding (upland conifer - plantations and old fields and pastures). The high use of old fields and pastures by males on the Fairview site was observed in the spring, during the mating season. Use of open areas as displaying grounds by courting males has also been reported by Dalke and Spencer (1946), Barwick and Speake (1973), and Fleming and Webb (1974). No clear explanation could be found, neither in the field nor in the literature, for the greater use of clear cuts by South Branch males in the summer and fall.

One possible explanation for the consistently greater use of lowland vegetation types by juvenile birds compared to adults observed on both sites, may be that the thermal cover provided by these vegetation types (warmer in winter, cooler in summer) may reduce the energy demands of thermoregulation for the smaller, juvenile birds, which do not tend to have the energy reserves of the larger adults (Gray 1986).

Energetics probably has a strong influence in winter habitat selection. As already noted, most of the birds in a given area tended to follow similar patterns of vegetation use during the winter season more than in the other seasons, most likely in a attempt to utilize the available habitat in the most energy efficient way. The winter habitat use data, more than for any other season, suggests the versatility of the eastern wild turkey in meeting its seasonal energy demands. On the Fairview site, birds fed and loafed in harvested crop fields and pastures, while they roosted and sought thermal cover in hardwood woodlots and lowland conifer swales. This type of use pattern has been commonly observed fo

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for wintering flocks in many of the northeastern and north-central states. In New England, Walski (1985) reported wintering flocks of 30 to 50 birds concentrating on dairy farms and feeding on waste corn in manure spread on fields and grain from trench silos. Austin and DeGraff (1975), in New York, observed turkeys to prefer north-south running stream valleys with easy access to adjacent farmland and brushy south facing slopes. Peterson and Richardson (1973) noted that Merriam's turkeys in South Dakota frequented harvested crop fields, feeding on waste grain and grasshoppers during the early winter. They hypothesized that the birds tended to prefer this vegetation type because it was more likely to be blown free of snow cover than areas of higher natural food value. In Missouri, Dalke and Spencer (1946) and Kimmel and Kurzejeski (1985) report that during poor mast years, turkeys were found to concentrate in open bottomland corn fields. Porter and others have done extensive work in Minnesota with wintering turkeys. They have generally noted hardwood stands to be used for loafing and roosting, while fields of standing or waste corn are the primary feeding grounds (McMahon and Johnson 1980, Porter 1977).

On the South Branch site, the birds were found to use an extremely different combination of vegetation types to do the same thing, i.e. survive the winter. These birds loafed and sought thermal cover in cedar swamps. They also did some limited feeding in this vegetation type in snow free patches along streams and springs. The birds primarily fed on corn from feeders put out by landowners in the area. They roosted in aspen-beech woods in the vicinity of the feeding stations. Although extensive winter use of conifer swamps has not been reported in the literature, many workers have noted birds to make use of snow free seep and spring areas for feeding, especially during periods of heavy snow accumulation (Ellis and Lewis 1967, Logan 1973, Wunz and Hayden 1975, Healy 1977, Bortner and Bennett 1980, Goerndt et at. 1985). One observation of a Michigan turkey flock during a period of heavy snowfall noted that the birds centered their activity around lowland vegetation types (Lewis 1963).

From these data, it becomes obvious that the birds are not keying in on specific plant species communities. The structural and functional characteristics of a vegetation type or group of types is what is of primary concern. This is an important concept which can be observed to be at work not only in winter habitat selection, but also in the selection of nesting and brooding habitat as well. It is this concentration on the functional characteristics of a vegetation type based on its structural qualities, and not its species composition per se, that is the major cause for the great diversity of habitat use patterns observed for the wild turkey. It thus becomes obvious that habitat use studies must take a structural (i.e. stem density, canopy height, crown closure, etc.) and functional (loafing cover, thermal cover,etc.) approach rather than the traditional species composition approach. This approach has already been used for studying brooding and nesting habitat, however, it

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has yet to be used extensively for winter habitat analysis. In this study, both wintering sites, although composed of very different vegetation types, had the same 3 functional units: roosting and thermal cover; open loafing areas; and a readily accessible food source.

It should also be noted that even though the northern Michigan turkey flocks are dependent, for the most part, on man related food sources during normal Michigan winters, the birds will use natural food sources whenever they are available. This was especially evident in the early part of 1985 on the South Branch site. Instead of moving into the lowland areas and making use of feed stations as in the year before, all the monitored birds remained in the upland, aspen-beech hardwood vegetation type feeding on the abundant beechnut crop. Only after a heavy and prolonged snow storm in early January 1985, were the birds forced down into the lowland areas.

Another interesting observation is the lack of wintering sites on public land. This may be resulting from 2 conditions. First, the primary way wintering flocks are located in the D.N.R.'s winter census is through the observations and reports of local people (Weinrich et al. 1985). Thus flocks located on more secluded public land may be overlooked. The second possibility is that the current land management practices of the M.D.N.R. and U.S. Forest Service for northern Michigan are inadequate as far as providing for quality winter turkey habitat.

Habitat use patterns during the spring and summer appear to result primarily from breeding activity. It was already noted how the increased use of old fields and pastures by adult males during the spring coincided with the their courtship activity. Most researchers report a general shift to more open vegetation types through the spring into the summer (Bailey and Rinell 1968, Speake et al. 1969, Hillestad and Speake 1970, Hyde and Newsom 1973, Fleming and Webb 1974, Speake et al. 1975, Porter 1977). The only exception to this trend is reported by Grettenberger (1979) working in northwestern Michigan. He found turkeys to use mixed hardwoods and lowland brush vegetation types most frequently during the spring and summer months. In this study, only adult females were generally found to follow the trend toward more open vegetation types, while adult males and juveniles tended to concentrate their late spring and early summer activities in upland hardwoods and lowland vegetation types. The female summer habitat use information is another example of the bird's ability to use different vegetation types for the same functional purpose. Metzler and Speake (1985) noted that it is primarily the structural characteristics of herbaceous cover, vegetation height, and visibility profile that are important in discriminating between good and poor brooding habitat. The South Branch hens exhibited the traditional brooding habitat use patterns by frequenting the old field-pasture vegetation type (Hillestad and Speake 1970, Speake et al. 1975, Anderson and Samuel 1980, Healy 1985, and Walski 1985). The explanation given for preference of this vegetation type is that open, grass communities support a high biomass of insects upon which the poults feed. Martin and McGinnes (1975) found 25 times more insects in clearings than under forest canopy cover. However, several other studies have found that "savannah" type, semi-openings in forests, characterized by canopy closures of from 30% to 60% and a ground cover of grasses and ferns which are tall enough for concealment of the brood but sparse enough for easy movement, are also highly preferred by brooding hens (Bailey and Rinell 1968, Hayden 1979, and Nenno and Lindzey 1979). The increased use by Fairview adult hens, of the upland conifer vegetation type is consistent with these findings. The primarily red pine stands the birds were observed to frequent were generally widely spaced with an extensive grass understory. Grettenberger (1979) found that a mixture of conifers and grasses provided the necessary (structural) characteristics of heavy ground cover and high insect populations for successful brood rearing. Hayden (1979, 1980), in Pennsylvania, also noted broods to make frequent use of "savannah like" vegetation types. However, he found aspen savannahs to be the most utilized community type.

Note that juvenile hens also followed these trends, a greater percentage of the summer season observations were in lowland vegetation types. On the Fairview site, significantly fewer juvenile birds than adults were found to attempt nests. As a result, a greater number of the observed brood flocks contained adult hens, while broodless hens tended to be juveniles. It was also noted that broodless hens used lowland vegetation types significantly more than hens with broods. The combination of these findings may explain the higher summer use of lowland vegetation types by juvenile hens. It also points out another structural characteristic of brooding habitat, namely that brooding hens typically avoid wet, lowland sites.

Several different winter daily habitat use patterns were observed on the 2 sites. However, all the patterns can be explained by the same functional activity pattern. Many workers have noted that turkeys tend to exhibit a bimodal activity pattern, with peaks of feeding and movement occurring during the morning, soon after coming down from the roost, and late afternoon or evening, just before roosting (Hoffman 1962, Raybourne 1968, Palmer et al. 1969, Hillestad and Speake 1970, Logan 1973, Fleming and Webb 1974, and Eickholz and Marchinton 1975). Consistent with these reports, the turkeys observed in this study were generally found either in upland hardwood (roosting and feeding habitat), farmland (Fairview feeding habitat), or old field and pasture (the primary South Branch feeding habitat because yards containing feeding stations were placed in this category) vegetation types in the morning and evening hours. Use of thermal cover (lowland hardwoods and conifers) and loafing - sunning cover (old fields, pastures, and clear cuts) was found to peak during the birds' inactive mid-day hours.

Extreme variability in nesting habitat, as observed in this study, has generally been found to be the rule rather than the exception. Wilson and Lewis (1959), in southern Michigan, and Grettenberger (1979) in the northwestern part of the state, report nests found in mature stands of oak, aspen, and sugar maple, plantations of red, Jack, and white pine, orchards, alder swamps, pastures, and old fields. Dalke and Spencer (1946), in Missouri, reported nests located in a variety of vegetation types, with no preference found for any particular vegetation type. Northern Pennsylvania turkeys were recorded to nest in vegetation types ranging from densely forested ranges to dairy woodlots (Hayden 1980). Lazarus and Porter (1985) noted a distinct shift in nesting habitat with time during a single nesting season in Minnesota. Nests established in early April were primarily found in deciduous woodlands. As the season progressed and ground cover increased, hens shifted to more open - canopied vegetation types. All nests initiated in June were located in old fields and pastures.

Although extremely diverse in species composition, nest sites have generally been found to be consistent structurally, providing concealing surrounding and overstory vegetation without restricting visibility or escape from the nest (Bailey and Rinell 1968, and Logan 1973). Although these characteristics were qualitatively observed in this study, no quantitative differences could be found in cover as one moved out from the nest structure. A possible explanation for this lack of difference was put forth by Lazarus and Porter (1985). They found that the 0.5 ha locale around the nest site tended to be similar in vegetative structure to the specific nest site itself. It is possible that the 30 m lines use in this study did not extend far enough out from the nest to detect any significant differences in ground cover.

Most studies have contended that nests must be within close proximity to permanent water (Thornton 1955, Hoffman 1962, Cook 1972, and Grettenberger 1979). The mean distance to water of 213 m observed in this study is consistent with those distances reported from other studies. Grettenberger (1979) found water usually within 150 m of the nest of the nest, and never more than 1 km away. In Texas, Cook (1972) reported 84% of the observed nests were within 1/4 mile (402 m) of some water source. Although conforming well with the previous findings, water is most likely <u>not</u> a major factor influencing nest site selection by hens in northern Michigan. Generally during the late spring - early summer nesting season, ample water is available in the form of intermittent streams and lowland swales. In addition, several hens were observed on a number of occasions to use cattle troughs to drink. Also, vegetation during this period generally has a very high moisture content. As proposed by a few researchers, nesting hens and their broods may be able to get all their water requirements from their foods and morning dew (Williams 1972 and Exum et al. 1985). The tendency for nests to be located near edges, particularly ecotones between vegetation types, observed in this study, is also consistent with previous findings. Clark (1985), in Ohio, and Hayden (1980), in Pennsylvania, both found nests to be located an average of 50 m to 60 m from woodlot edges. In eastern Alabama, all the nests observed by Hillestad (1973) were situated from 100 to 400 yards from grazed areas; and 75% of the nests studied by Speake et al. (1975) were in openings or near opening edges.

NESTING AND MORTALITY

As would be expected, nest initiation tends to occur earlier in the spring as you move south. Reports from Florida, South Carolina, and Alabama place nest initiation in late March or early April (Powell 1965, Williams et al. 1968, Speake et al. 1969, Williams 1972, and Bevill 1975). From West Virginia (Bailey and Rinell 1968, and Healy 1985) northward, through Iowa (Little and Varland 1981) and Ohio (Donohoe and McKibben 1970), to Michigan and Minnesota (Wilson and Lewis 1959, Grettenberger 1979, Hecklau et al. 1982, and Porter et al. 1983) the date of peak nest initiation is reported consistently as mid-April, about 3 weeks later than reported in the south. Observations from this study agree with these findings from the northern states. Very little is reported in the literature of a bimodal pattern of nesting activity, as observed here. The pattern of these data can be partially explained by renesting efforts. However, most of the telemetered hens observed to nest during the second peaks were normally not noted to previously have attempted to nest. Although not specifically investigated in this study, work done in Minnesota and South Carolina (Bevill 1973, 1975, and Porter and Ludwig 1980) have noted bimodal patterns of gobbling activity. This second nesting peak may be the result, in part, of a second, later wave of breeding.

The 34.4% overall mean annual mortality rate observed in this study is much lower than observed by other researchers. Studies from Missouri (Lewis 1980, and Kimmel and Kurzejeski 1985), Minnesota (McMahon and Johnson 1980), and Oklahoma (Logan 1973) have reported mortality rates around 50%. Grettenberger (1979) observed an overall mortality rate of 68.6% for turkeys in northwestern Michigan. Only Everett et al. (1980) found a comparable annual mortality rate of 31%. Mortality during this study was found to peak during the spring and summer months. This has also been found in Minnesota (Hecklau et al. 1982, and Porter et al. 1983) and Alabama (Everett et al. 1980, and Speake 1980). Ignatoski (1973) commented that it appears turkeys have adapted well to Michigan's winters. He also reported light winter losses over the mid 1950's through the 1960's.However, work in Ohio by Clark (1985), in Missouri by Kimmel and Kurzejeski (1985), and again in Minnesota by McMahon and Johnson (1980) has found mortality to peak during the winter months. These studies point out that peak losses of turkeys are most likely extremely variable, and sight and time specific. Mortality is greatly influenced by the quality of the available habitat, and the climatic conditions over a given period of time. The consistency of Michigan's light winter turkey mortality may indicate that the winter habitat which is available is of very good quality.

Several studies, including this one, have found predation to be the primary mortality factor acting on a turkey population. Everett et al. (1980) reported 71% of the observed losses were due to predation. In Minnesota, mammalian and avian predators accounted for all the losses from an observed established flock, and 93% of the losses from a transplanted flock (Hecklau et al. 1982). Predators were only second to legal kill as the primary mortality factor in a New York study (Glidden 1977). However, several authors have indicated that predation does not appear to be an important factor governing turkey population dynamics (Dalke and Spencer 1946, and Uhlig and Bailey 1952). Porter et al. (1983) suggested that predation only becomes a significant factor when birds are under stress. The primary impact of predators has generally been found to be on nest success, and poult and juvenile survival (Glidden 1977, Everett et al. 1980, Speake 1980, Speake et al. 1985, and Yahner and Wright 1985). In fact, contrary to the findings of this study, 2 Alabama studies found animal predators to rarely kill adult birds, especially adult males (Everett et al. 1980, and Speake 1980).

The impact of poaching has frequently been suggested to be a major source of turkey mortality. However, because of the obvious difficulties in obtaining such information, very little quantitative documentation of illegal kill can be found in the literature. The 21.7% poaching loss in this study was second only to predator kill, and was greater than the effect due to legal hunting. In view of the extremely small sample sizes employed in this study, poaching may indeed be an extremely important factor influencing the size and distribution of Michigan's northern turkey flocks. In Alabama, Fleming and Speake (1976) noted that illegal kill was a major factor in loss of telemetered poults. In Missouri, mean annual hen mortality was almost cut in half when estimated illegal harvest was removed, falling from 47% to 25% (Kimmel and Kurzejeski 1985).

CENSUSING TECHNIQUES

A wide array of techniques have been developed to estimate turkey numbers. As pointed out by Zirkle (1982) the primary problem of censusing this bird is its extreme secretive nature and its wide ranging habits. Methods range from direct observation, such as road and air counts, through the surveying of sign such as gobbling counts and winter track counts, to landowner and hunter interviews (Bailey 1973, Cook 1973, and Wise 1973). Bailey (1980) has suggested that harvest data are probably more indicative of population trends than any of these population estimation techniques.

In northern Michigan, the observed annual concentration onto specific wintering areas provides a unique opportunity to completely census the northern turkey population every winter. This winter census, as described by Weinrich et al. (1985), was found to be very accurate under normal northern Michigan winter conditions, by cross checking census counts against known sizes of flocks containing telemetered birds. However, in milder winters, such as that of 1984-85, when the turkeys did not aggregate into highly visible groups on private land holdings, fairly large underestimations of total turkey numbers may occur. Note, however, only conservative underestimates are possible. Potentially harmful overestimation is really not possible with the way the census is carried out (Weinrich et al. 1985).

The winter northern turkey census is by far the most efficient and accurate method for censusing Michigan's turkey population. This census technique, based on information obtained from the public, has been tried in several other states as well. Wise (1973) found personal interviews about turkey sightings to be one of the most reliable population indices. Cook (1973) used landowners to locate roosting sites of Rio Grande turkeys. Several studies have used mapping of sighting reports from the public as population indices as well as means of locating flocks and monitoring range expansion (Zirkle 1982, Koechlein and Stumvoll 1983, and Backs et al. 1985). Such techniques not only provide usable information at fairly low monetary and man-power costs, but also provide for public involvement in managing the resource. Spring censuses, prior to the bearded bird hunt, such as gobbling counts or track counts are not accurate due to the fact that the birds still tend to be aggregated on the winter ranges, making identification of individual gobbling toms or unique sets of tracks impossible.

Summer road counts, if carried out specifically for and by themselves, are not efficient. Turkeys are not randomly distributed across the areas, but exist in distinct clumps, or flocks, which follow consistent, non-random, movement patterns. Thus a given group of birds will always be seen at a given time in a given field, but rarely will be out in the open at another given time. As a result, any road counts which are consistently repeated at the same time throughout the count period, such as along mail routes, will tend to underestimate the number of birds in the area. In addition, very little enthusiasm and cooperation was received from the mail carriers during the evaluation of this potential census method. Some sort of education-publicity program would have to be set up, in order to build enthusiasm and motivation, and maintain these attributes through the duration of the census. Thus, not only is the value of this census technique questionable, but department time and money would be needed to initiate and maintain such a project. Such observations could be more efficiently conducted by field personnel and conservation officers while conducting their normal field assignments. However, because of the fairly erratic, small scale, movements of turkeys within a season, an absolute count of birds within a given area would be difficult to obtain without a prohibitively large number of observations, and any population size estimated could rapidly change as wandering flocks move into and out of areas. A possible alternative could be the development of a "productivity index" based on a count of poults and hens for a given area over a given time period. Wunz and Shape (1980), in Pennsylvania, found poult and hen counts to be significantly correlated to fall harvest figures, and Healy and Nenno

(1985) found systematic summer brood counts to be the best way to evaluate productivity and estimate fall populations for management purposes. Note that this index is a total count of poults and hens, not a ratio. Glidden (1977) found poult to hen ratios tended to reflect trends but not actual magnitudes of net productivity fluctuations. Macdonald (1964), analyzing 4 sets of unrelated data, found poult to hen ratios to be very inaccurate estimates of poult production. With an extended,organized data base from several years, this survey of annual productivity could potentially be developed into a formal quantitative index of a given year's poult production.

The use of tape recorded poult distress calls was not found to be an effective censusing tool. All observations made, would have been made without the use of the tape. More time and funds should be concentrated on carrying out a thorough and well replicated brooding hen and poult road census before consideration is given to the use of such tape recorded calls. Note, however that Kimmel (1983) and Kimmel and Tizlowski (1986) found an encouraging 67% response rate of brooding hens to tape recorded lost calls. They reported that hen responses decreased with increasing poult age. It is thus possible that the test carried out in this study was run to late to elicit adequate responses. If further testing of this method should be carried out, Kimmel and Tizlowski's (1986) suggestion should be followed that tape call censuses be used early in the brood rearing season.

SUMMARY AND MANAGEMENT RECOMMENDATIONS

Speake et al. (1969) stated that a suitable range of 3,200 to 4,000 hectares (8,000 to 10,000 ac) can supply all the needs of a turkey population. Although aberrantly large relative to all other reported data, the 3000 ha (7413 ac) mean annual range for the Fairview flock is an adequate size to base turkey management units in northern Michigan. A particularly viable round figure would be a 12 section, 7680 acre (3108 ha) area.

The presented data suggest that on the Fairview site, and possibly other agricultural areas of northern Michigan, an increase in the juxtaposition and interspersion of wintering areas to spring and summer ranges might result in an increase in regional turkey density. As pointed out by Clark (1985), "It is likely that the arrangement of habitats influences use in a given area." He goes on to suggest that good turkey range should have a high degree of habitat diversity and interspersion. Based on the dispersal distances observed, maximization of the northern Michigan turkey population might be achieved by establishing wintering areas at 8 to 10 km intervals, interspersed with adequate spring nesting and summer brooding cover. Based on the habitat use data which showed high turkey use throughout the year, establishment of mast producing upland hardwood stands should be pursued whenever possible. A management plan for the Oak-Hickory forests of Missouri suggests an even aged management scheme, with 40% of each compartment in saw timber, 30% in poles, 20% in saplings, and 10% in early regeneration. Forty-four percent of each compartment should be in mast producing condition, with 1/3 of these fruiting trees in the white oak group (Dellinger 1973). In addition, alternative winter food sources; such as state planted or share cropped food plots, development and protection of lowland seeps, or direct feeding through actively maintained feeding stations; should be considered in every turkey management plan. Currently in New Hampshire, a program has been set up to provide farmers with fruiting trees and shrubs to plant along their field edges. In addition, farmers are paid to leave some standing corn for turkeys (Walski 1985). Patches of dense ground cover and/or heavy slash within hardwood or conifer types should be provided for nesting. In addition, the nesting habitat should be closely associated with open understory conifer stands or old fields and/or hay fields for brooding. Metzler and Speake (1985) provide the idea that thinning timber around clearing edges will increase herbaceous cover and height, thus improving brooding habitat. Hay fields, especially alfalfa, appeared to be preferred brooding cover. However, mowing should be avoided, or at least limited, from the first week of June through mid July. Hurst and Owen (1980) suggest leaving an unmowed buffer, at least 5 m wide around the edges of maintained openings.

Mowing should be done from the center outward, and 1/2 of the unmowed buffer strip should be mowed or burned annually in the late fall or early winter, to prevent hardwood encroachment (Hurt and Owen 1980).

However, it should be remembered that turkeys are extremely diverse and adaptable in their habitat use. This flexibility provides managers a lot of leeway in how they can best provide for the birds' needs, within the context of local habitat restrictions. Management should seek to duplicate the key structural characteristics identified for specific seasonal ranges using those vegetative communities most efficiently suited for a particular site.

An added benefit from such a management strategy may be a more evenly distributed turkey population. Currently, the combination of short dispersal distances and year to year fidelity to a given wintering location which can provide an adequate food supply has resulted in the observed concentrations of the northern turkey flock on private lands during the winter and early spring. This is of special concern during the spring gobbler season in late April through May, when the birds are just starting to move off of the wintering areas. Such circumstances tend to limit the access of the general public to the turkey resource. However, if winter concentrations of birds could be initiated on or near public land, this might make a greater number of birds available to the hunting public. In addition, the establishment of small, more dispersed, wintering flocks would decrease the currently high potential for an epizootic to eliminate a large sector of the population. A potential disadvantage of such a management system could be the potential for increased loss of birds due to poaching. While poaching only accounted for 21.7% of the bird losses overall in this study, considering the small fraction of the entire flock which was marked, this figure suggests a very serious poaching problem. It is felt that the potential impact of poaching is being suppressed by private landowners watching over "their turkeys." If suitable wintering areas are established on public land, a serious concern should be the potential of poaching to completely eliminate any flock using the sites. In addition, data from the Fairview flock indicate spring dispersal generally occurs during the second to the third week of April. If the spring season opening remains the third week of April, the potential exists for large flocks of birds to be caught while still on the wintering grounds. Without any type of regulation of the hunting pressure on these birds, as is currently done by the private landowners, this situation could further increase the potential for concentrated kills, as well as high hunter concentrations around wintering areas on public lands.

Examination of the dispersal and nesting chronology data seems to suggest a delayed opening of the spring gobbler season might be a conservative management strategy to consider. The first peak of laying hens was generally noted to occur during the second to the fourth week of April. If the spring season was delayed into the first week of May, the majority of these hens would be 1 to 2 weeks into laying and e

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early incubation. Such a shift would allow the hens to establish their nests before the season opened. Allowing the females to settle into a nest before the start of the hunt might avoid unnecessary disturbance of the hen. Hens generally tend to nest in vegetation types with dense herbaceous ground cover or slash. During the spring toms are generally not found in these vegetation types but prefer more open areas in which to attract mates. This can be seen from the comparison of spring habitat use on the Fairview site (Fig. 6b). Males tended to be observed most in upland hardwood stands and old fields and pastures, while hens generally were found in forested vegetation types of upland hardwoods, lowland hardwood-conifer, and upland conifers. Thus, once a female has settled into a nest, it is less likely that a hunter will disturb her than when she was originally searching for a suitable nest spot. In their study, Kimmel and Kurzejeski (1985) reported a related finding, that poaching of hens increased when the spring gobbler season coincided with the peak of breeding. They found a distinct decline in hen loss during the spring hunt, when the season was delayed until the majority of the hens were nesting. Furthermore, the concern that gobblers will "shut up" well before the end of a later hunt,is not supported by the data. Studies from several states have found gobbling to normally continue into early June (Bailey and Rinell 1968 (West Virginia), Donohoe and McKibben 1970 (Ohio), and Porter 1977 (Minnesota)). In addition, 2 studies by Bevill (1973,1975) in South Carolina, found that gobblers tended to exhibit 2 peaks of gobbling activity, one early in the spring when dominance hierarchies are established, and a second later in the spring when the bulk of the hens are incubating. This second peak generally occurred right before a second peak of nesting activity. If the same gobbling dynamics are working in northern Michigan, one would expect a second peak of gobbling to occur just prior to the second peak of laying activity from the third week in May to the first week in June.

From this analysis and discussion of the observed data, the following management recommendations are set forth:

1) Intensive management of the northern turkey population should begin with the establishment of turkey management units, approximately 3100 ha (7680 acres) or 12 sections in size.

2) Within each management unit, wintering areas of 250 - 300 ha (618 - 741 ac) should be situated at 8 to 10 km intervals.

3) Nesting and brooding habitat should be situated as close as possible to the wintering sites.

4) Wintering sites should include the 3 primary habitat components: thermal and roosting cover; open areas for loafing and feeding; and an easily accessible, concentrated food source.

5) Although the turkeys have shown they can and will use natural foods when these are available, this availability quickly declines as normal snow depths are reached. Provisions for alternative food sources are thus essential for maintenance and/or increase of the northern turkey population. Several options are available: a) management of natural food sources, such as mast producing hardwood stands or lowland seeps with high herbaceous productivity; b) development of cooperative agreements with land owners, to plant trees and shrubs that provide persistent fruits used by wintering turkeys; c) provision of non-natural foods, such as corn or other grains, in the form of planted food plots, waste in harvested fields, or directly put out at feeding stations; d) compensation to private land owners, either in cash or directly in corn or grain, for maintaining a MDNR sanctioned and supervised feeding program.

6) Maintain both upland and lowland vegetation types in dense understory and ground cover; such as slash, brambles, willow thickets, etc.; for use as nesting habitat.

7) Provide open field - pasture vegetation types for brooding areas close to nesting sites. Small narrow openings surrounded by forested or lowland brush cover are better than large fields. Open, grassy savannah-like vegetation types, such as open understory conifer plantations, are also ideal.

8) Upland hardwood stands, particularly those with high relative densities of mast producing species, should be maintained and, if possible, increased.

9) Delay of the spring gobbler season by 2 weeks, until the first week of May, should be considered.

10) A more organized and formal collection of annual brood and hen count information by field personnel should be initiated for the eventual development of a formal "productivity index."

11) The DNR's anti-poaching (R.A.P.) program and the reward program of the Michigan Wild Turkey Federation should be maintained and enhanced. Future programs should aim to educate the public to the seriousness of this problem and the potential impacts which poaching is having on the northern Michigan turkey flocks.

APPENDICES

APPENDIX I

Data sheet distributed to mail carriers during the 3 month evaluation of a mail-carrier, road census technique for estimating summer turkey numbers.

— July 1984 [illegible]

TURKEY OBSERVATION SHEET

Please record all turkey observations on this sheet. If you think you did not get a complete count, just put down the number you saw and write "incomplete" in the comments section. If you are not sure of the number of toms and hens in a group, just put the total number of birds in the group between the male and female spaces. Any information you give be very helpful. Thank you for your time and effort, without which this project would not be a success.

DATE /da/yr	TIME	# BIRDS OBSERVED males	females	young	LOCATION	COMMENTS
[illegible]-84						
[illegible]	10:[illegible]			1	[illegible]	[illegible]
[illegible]	[illegible]				[illegible]	[illegible] field
5-84	10:40		1	1	Deckerville Rd	in Road
2-84	10:30		2	6	2990 Heath Rd	walking
9-84	10:30		4	11	2990 Heath Rd	[illegible] in field
1-84	10:45			9	4040 Deckerville Rd	in road
11-84	10:45		1	4	2774 Croque Rd	

Thank you for your help

any question? call Tim Kulowiec 826-3047

APPENDIX II

Inventory of the 44 wild turkeys trapped over 2 winters on the 2 study sites.

STUDY AREA	FREQUENCY	SEX	AGE	DATE OF CAPTURE
Fairview	150.015	F	AHY	02/25/83
Fairview	150.025	F	HY	02/25/83
Fairview	150.035	M	HY	02/25/83
Fairview	150.066	F	AHY	02/25/83
Fairview	150.076	M	AHY	02/25/83
Fairview	150.081	F	HY	03/01/83
Fairview	150.085	M	HY	02/25/83
Fairview	150.0955	M	AHY	02/25/83
Fairview	150.101	F	AHY	03/01/83
Fairview	150.106	F	AHY	02/25/83
Fairview	150.115	M	AHY	02/25/83
Fairview	150.121	F	HY	03/10/83
Fairview	150.125	M	HY	02/25/83
Fairview	150.135	F	AHY	02/25/83
Fairview	150.140	F	AHY	03/10/83
Fairview	150.146	F	HY	02/25/83
Fairview	150.155	F	HY	03/10/83
Fairview	150.165	F	HY	03/10/83
Fairview	150.410	F	AHY	03/20/84
Fairview	150.450	F	AHY	03/20/84
Fairview	150.470	F	HY	03/20/84
Fairview	150.490	F	HY	03/20/84
Fairview	150.520	F	HY	03/20/84
Fairview	150.550	F	HY	03/20/84
Fairview	150.570	F	HY	03/22/84
Fairview	150.630	F	AHY	03/22/84
South Branch	150.080	F	AHY	02/25/84
South Branch	150.123	F	AHY	02/25/84
South Branch	150.140	F	AHY	02/25/84
South Branch	150.160	F	AHY	02/25/84
South Branch	150.190	F	HY	02/25/84
South Branch	150.370	F	HY	02/25/84
South Branch	150.390	F	HY	02/25/84
South Branch	150.410	F	AHY	02/25/84
South Branch	150.440	F	HY	02/25/84
South Branch	150.460	F	AHY	02/25/84
South Branch	150.480	F	HY	02/25/84
South Branch	150.500	F	HY	02/25/84
South Branch	150.520	F	HY	02/25/84
South Branch	150.540	F	HY	02/25/84
South Branch	150.560	M	HY	02/25/84
South Branch	150.620	M	HY	02/25/84
South Branch	150.640	M	HY	02/25/84
South Branch	150.770	M	HY	02/25/84

APPENDIX III

Inventory of the 39 radio-transmitters used during the project. Those telemeters indicated as "recovered" should be currently in the possession of the MDNR at either its Rose Lake or Houghton Lake research facilities.

TRANS. #	TRANS. FREQ	DAYS USE	MONTHS USE	RECOVERED
14487	150.015	109	3.6	YES
14488	150.025	594	19.8	NO
14489	150.035	365	12.2	NO
14490	150.066	630	21.0	NO
14491	150.076	451	15.0	YES
14492	150.085	572	19.1	NO
14493	150.0955	119	4.0	YES
14494	150.106	356	11.9	YES
14495	150.115	64	2.1	NO
14496	150.125	568	18.9	YES
14497	150.135	443	14.8	NO
14498	150.146	335	11.2	NO
14499	150.155	413	13.8	YES
14500	150.165	551	18.4	NO
14720	150.080	477	15.9	NO
14720	150.081	27	0.9	YES
14721	150.101	218	7.3	YES
14722	150.123	7	0.2	YES
14722	150.123	504	16.8	NO
14723	150.140	66	2.2	YES
14723	150.140	433	14.4	YES
14724	150.160	504	16.8	NO
14725	150.190	265	8.8	NO
16708	150.370	504	16.8	NO
16709	150.390	504	16.8	NO
16710	150.410	18	0.6	YES
16710	150.410	170	5.7	YES
16711	150.443	82	2.7	YES
16712	150.450	127	4.2	YES
16713	150.460	163	5.4	YES
16714	150.470	139	4.6	YES
16715	150.480	101	3.4	NO
16716	150.490	481	16.0	NO
16717	150.500	175	5.8	YES
16718	150.520	17	0.6	YES
16718	150.520	407	13.6	NO
16719	150.540	145	4.8	YES
16720	150.550	476	15.9	YES
16721	150.560	100	3.3	YES
16722	150.570	30	1.0	YES
16723	150.620	501	16.7	NO
16724	150.630	142	4.7	YES
16725	150.640	121	4.0	YES
16726	150.770	56	1.9	YES

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