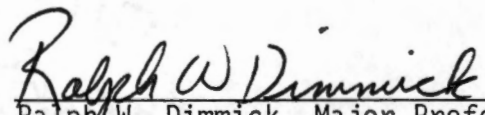
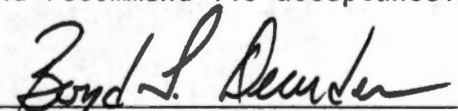
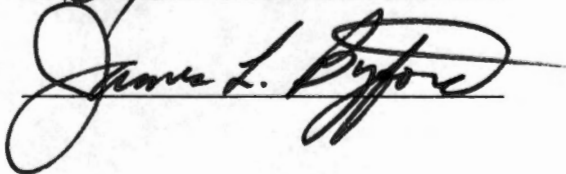


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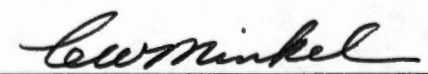
I am submitting herewith a thesis written by Mark J. Gudlin entitled "Evaluation of a Second Ruffed Grouse Restoration Attempt in Benton County, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.


Ralph W. Dimmick, Major Professor

We have read this thesis
and recommend its acceptance: .

. Accepted for the Council:


The Graduate School

EVALUATION OF A SECOND RUFFED GROUSE RESTORATION
ATTEMPT IN BENTON COUNTY, TENNESSEE

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Mark J. Gudlin

August 1984

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ABSTRACT

Eighty ruffed grouse trapped in southwestern Wisconsin were released on Nathan B. Forrest State Historical Area in Benton County, Tennessee in an effort to restore a population of the species to a portion of its historical range. Trapping, transporting and releasing were accomplished in late August and early September in 1981 and 1982. A total of 871 telemetry locations were made of 19 radio-equipped birds from September through December of both years. Seven of these birds were known to survive longer than 1 month after their release, including one which was alive at its last radio location almost 8 months later. Survival of the radio-equipped birds was probably adversely influenced by the transmitters. Maximum dispersal was 4.0 km. Home ranges for 10 grouse varied from 18.0 to 176.0 ha. Habitat utilized was subjectively classified into 1 of 6 categories based upon structural characteristics. The most intensively used habitats were dense stands of hardwood saplings, found principally on lower slopes and stream bottoms. Also frequented were huckleberry (Vaccinium arboreum) thickets on dry ridges beneath overstories of pine (Pinus spp.) or mature oak (Quercus spp.). Mature upland oak and bottomland hardwood forests offered suitable habitat mainly during early fall when herbaceous and viny thickets provided cover in the understory. Home range sizes, dispersal and daily movements were influenced by the quality of structural cover and seasonal changes within the cover types.

Two or more drumming males have been heard each spring since the 1981 release. Future restoration attempts should be conducted where forest management procedures can be targeted towards early successional stages.

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CHAPTER I

INTRODUCTION

Ruffed grouse (Bonasa umbellus) in Tennessee live near the southern extremity of a range which spans forested regions across the North American continent (Johnsgaard 1975). This range has changed little since primeval times, except where it has receded along the southern border (Aldrich 1963). During the early to mid-1900's, ruffed grouse were extirpated from all or portions of their range in several states including Arkansas, Illinois, Indiana, Missouri, and Tennessee. Ruffed grouse disappeared from these regions due to loss and fragmentation of habitat. Extensive clearing of forested areas, uncontrolled fires, and grazing of woodlands all contributed to habitat degradation. Grouse surviving in remaining coverts may have been vulnerable to external regulatory factors such as severe weather during the early brooding period or locally intense hunting pressure.

During the last 40 years, the range of the ruffed grouse in Tennessee has receded eastward (Figure 1). Present on the Western Highland Rim physiographic region (Fenneman 1938) as late as the 1940's, native populations are now found generally east of the western edge of the Cumberland Plateau (White and Dimmick 1979a). However, many areas of the Western Highland Rim may once again be suitable for habitation by ruffed grouse, as marginal farmland

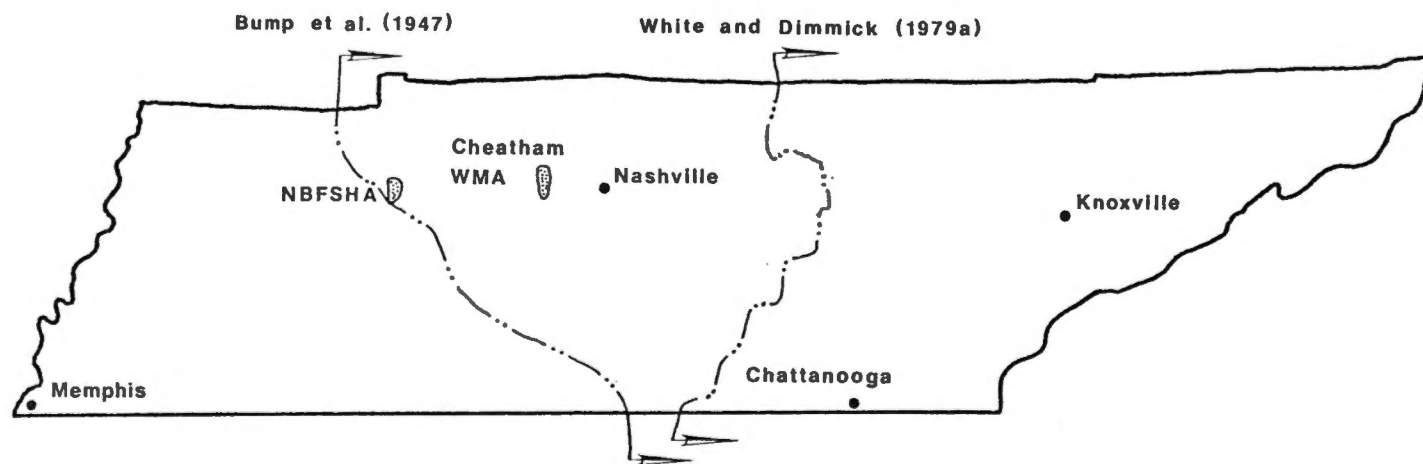


Figure 1. Western range limits of ruffed grouse and location of restoration sites in Tennessee.

has been allowed to reconvert to early successional forests, a habitat type critical to ruffed grouse.

The success of Missouri's restocking program (Lewis et al. 1968, Hunyadi in press) and the rising popularity of the ruffed grouse as a game bird in the southeastern United States have inspired several states to reintroduce ruffed grouse. Tennessee has had very limited success with 2 releases on the Western Highland Rim. Eighteen birds trapped in Tennessee were released in Cheatham County in 1975 and 1976 (Jones 1979). In 1976 and 1977, 60 Michigan and Wisconsin grouse were released on Nathan B. Forrest State Historical Area (NBFSHA) in Benton County (White 1978). Although clear evidence of reproduction has not been observed, grouse were present on both areas as long as 2 years following the last release.

This thesis reports on a second restoration attempt on NBFSHA, a release of 80 Wisconsin grouse during the late summers of 1981 and 1982. Telemetry techniques were employed to monitor the fate and movements of 19 of these grouse which carried radio transmitters. Special attention was given to determining home range sizes, dispersal patterns and habitat selection of the transmitted birds. Factors influencing these parameters and prospects for future restoration are discussed.

CHAPTER II

MATERIALS AND METHODS

I. TRAPPING, TRANSPORT AND RELEASE

A total of 80 grouse (40 each year in 1981 and 1982) was captured and transplanted to NBFSHA within a period of 2 to 3 weeks each year. Original efforts to trap grouse from East Tennessee's scattered population met with limited success (Jones 1979). Subsequent high trapping success of Michigan and Wisconsin grouse for the first restoration attempt on NBFSHA (White 1978) prompted us to concentrate our trapping efforts on the Fort McCoy Military Installation, Monroe County, Wisconsin. Grouse were trapped during 23 August - 8 September 1981 and 17 August - 2 September 1982. U.S. Army Wildlife and Forestry personnel provided valuable help in locating suitable trapping areas on Fort McCoy.

Located at 44°N latitude, Fort McCoy is situated at the interface of the Conifer-Hardwood Forest and the Southern Hardwood Forest (Curtis 1959). Topography varies from flat sandy lowlands to moderately dissected uplands. Elevation varies from 79 m to 135 m.

Trapping efforts were concentrated in 3 habitat types: upland hardwoods, bottomland hardwoods, and alder swamps. Upland hardwood sites were dominated by aspen (Populus tremuloides and P. grandidentata) and oak (Quercus spp.) overstories, and had shrub

layers comprised principally of hazelnut (Coryla cornuta), gray dogwood (Cornus racemosa), and blackberries and raspberries (Rubus spp.). Bottomland hardwood dominants included oaks, sugar maple (Acer saccharum), red maple (A. rubrum), basswood (Tilia americana), white ash (Fraxinus americana), and elms (Ulmus spp.). Alder swamps typically bordered small streams and were comprised of paper birch (Betula papyrifera) and speckled alder (Alnus rugosa), with dense ground cover consisting mainly of cinnamon and interrupted ferns (Osmunda cinnamomea and O. claytonia).

Grouse were captured in unbaited interception traps (Gullion 1965) consisting of 2 to 4 catch boxes (1 m² by 70 cm high) linked by poultry wire leads (80 cm high) 10-30 m in length. Traps were set after broods had been located in habitat suitable to the interception technique. Most broods were found by a line of men passing through promising coverts on foot, usually with the aid of a pointing bird dog. Each trap was checked twice daily, in late morning and at dusk.

After capture, the birds were held in pens contained in a wooden utility shed. The pens were fashioned from burlap-lined trap catch boxes (1981) or stacked straw bales covered by nylon netting (1982). The latter proved superior in convenience and safety to the birds. All birds were supplied with water and locally available wild fruits, particularly gray dogwood, American elderberries (Sambucus canadensis), and wild grapes (Vitis spp.). In 1982 the birds were also supplied with commercial game bird food

pellets. Pen floors were covered with wood shavings or excelsior to absorb droppings. The shed was dimly lit and the grouse were handled as little as possible to limit stress.

The birds were leg-banded, sexed according to rump-feather pattern (Roussel and Ouellet 1975) and completeness of tail band (Davis 1969), and aged according to completeness of retrice growth and tip contour of the outer two primaries (Hale et al. 1954). Weight and color phase were also recorded for birds trapped in 1982. Scalp wounds incurred during trapping were treated with antiseptic ointment.

Within a week of their capture, the grouse were either air shipped (20 birds) or driven (60 birds) to NBFSHA for prompt release. In preparation for transport, the birds were placed into excelsior-lined cardboard poultry cartons (4 to a box, each bird in its own partitioned compartment). The cartons were then sealed with tape and string. A supply of berries was provided to help sustain the birds during their 1000 km trip.

Upon arrival at NBFSHA, the birds were released as soon as possible at sites near suitable refuge cover. In 1981, 25 birds were released at the Pilot Knob Ridge site and 15 birds at the Bethel site (Figure 2). In 1982 all 40 birds were released at the Bethel site, as the habitat near that site appeared to be favored by the birds released in 1981. Birds not having radio transmitters attached to them were released without the unnecessary stress of added handling by simply cutting their holding cartons and allowing them to walk or fly free.

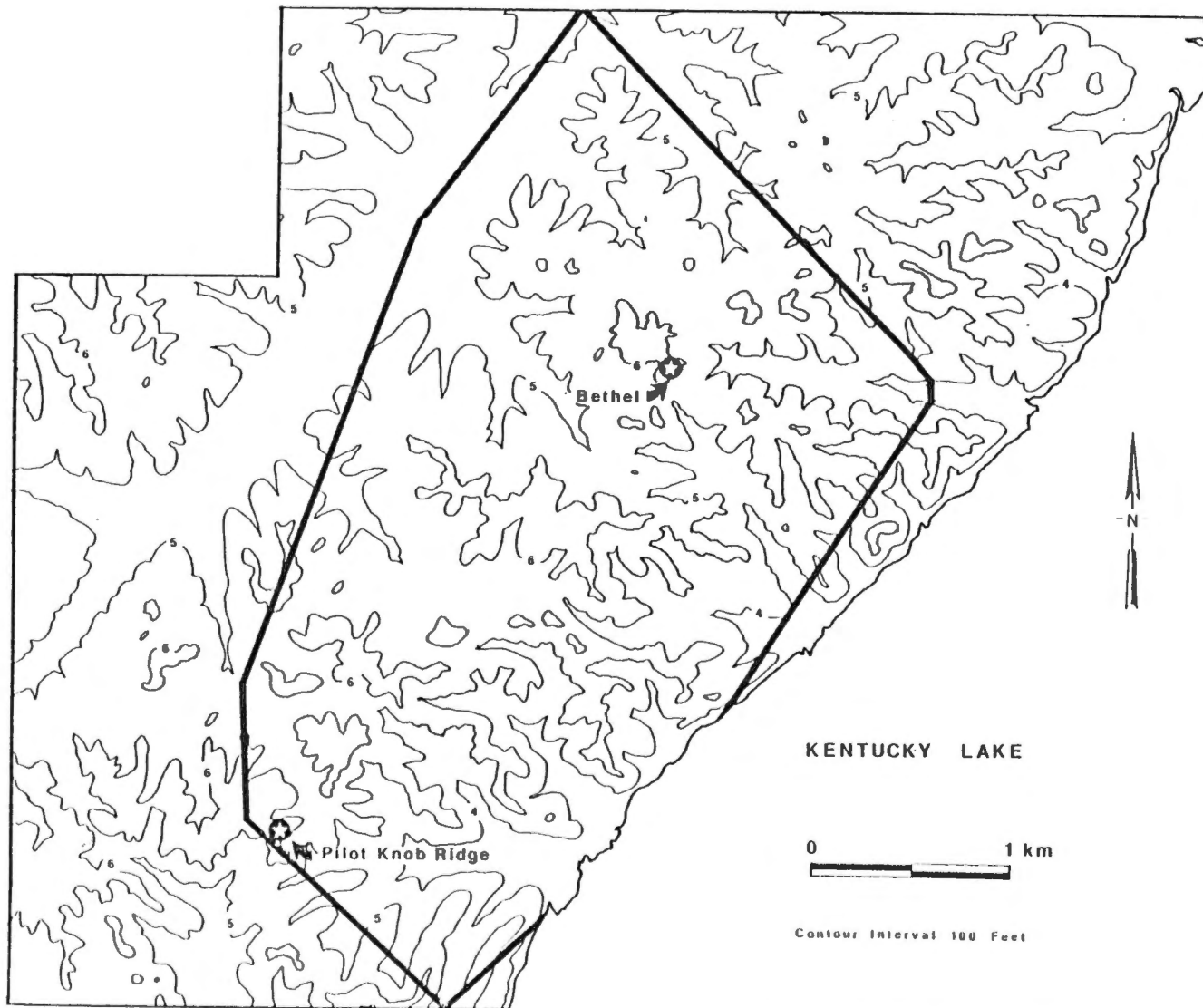


Figure 2. Location of study area and grouse release sites on NBFSHA, Benton County, Tennessee.

II. DESCRIPTION OF STUDY AREA

Nathan B. Forrest State Historical Area in Benton County was chosen as the site for this reintroduction. NBFSHA was originally chosen as a restoration site because the area: 1) contained habitats similar to those supporting grouse populations in East Tennessee, 2) offered relatively good faunal protection, and 3) allowed easy access for daily field work (White 1978). Encouraging results from the previous release of ruffed grouse on NBFSHA in 1976 and 1977 (White and Dimmick 1979b) influenced us to attempt a second reintroduction, as most successful reintroductions involve several releases in subsequent years on the same area.

Located some 200 km west of the present westernmost ruffed grouse populations, NBFSHA occupies 1448 ha along the hills and bluffs overlooking the western shore of Kentucky Lake. It is part of a narrow portion of the Western Highland Rim physiographic province (Fenneman 1938) extending west of Kentucky Lake. A few kilometers to the west begins the flat, largely deforested Coastal Plain.

Topography of the area ranges from undulating stream terraces and uplands to steep, narrow-ridged hills with reliefs of up to 90 m. Elevation varies from 109 m to 203 m. Soils in the hilly areas (Bodine and Mountview series) are well to excessively well drained, cherty, weakly developed, leached and very acidic (Odum

et al. 1953). Richer colluvial and alluvial soils (Greendale and Humphreys series) in the valleys and hollows are limited in extent.

The vegetation is a mosaic of successional stages resulting from a history of repeated timber cutting and clearing of most level tracts for agriculture (White and Dimmick 1979b). Most of the area is wooded uplands dominated by oaks and hickories including chestnut oak (Q. prinus), blackjack oak (Q. marilandica), white oak (Q. alba), post oak (Q. stellata), and shagbark hickory (Carya ovata). Ground layer vegetation in the uplands is characteristically sparse, but tangles of muscadine grape (Vitis sp.) often provide cover from spring through early fall. Thickets of farkleberry (Vaccinium arboreum) are regularly found on the ridges and upper slopes. Bands of mountain laurel (Kalmia latifolia) often border the lower edge of farkleberry thickets on some of the steep south and east facing slopes.

The moister bottomlands and hollows are mainly comprised of tulip poplar (Liriodendron tulipifera), sweetgum (Liquidambar styraciflua), tupelo gum (Nyssa uniflora), maples, beech (Fagus grandifolia), mockernut hickory (C. tomentosa), and river birch (B. nigra). Flowering dogwood (C. florida), serviceberry (Amelanchier arborea), hop hornbeam (Ostrya virginiana), and winged elm (U. alata) are frequent in the understory. Shrub and ground layer vegetation are typically denser and more diverse in the bottomlands than in the uplands. Pines (Pinus echinata, P. virginiana, P. strobus) are interspersed throughout the area but

are only dominant in one small portion of the park. Red cedars (Juniperus virginiana) are also scattered through NBFSHA but are rarely, if ever, dominant.

Six cover types were identified on the study area for the purpose of analyzing ruffed grouse habitat use. They were subjectively classified according to their structural characteristics. The resulting classification varied slightly from that presented by White and Dimmick (1979b) because different areas of the park were used by grouse and habitat changes have occurred since their study was conducted. The study area itself was determined by the bird's movements, and included 323 ha outside of NBFSHA boundaries.

The 6 cover types are: 1) hardwood saplings: dense stands of saplings (< 10 cm dbh), found mainly on lower slopes and hollows, 2) upland oaks: mature oak or oak-hickory woodlands with a poorly developed understory, 3) bottomland hardwoods: mature, diversified mesic-site trees with shrubby and herbaceous understories varying from sparse to dense, 4) farkleberry-laurel: mature upland forest with dense shrubby understories of farkleberry and/or mountain laurel, 5) farkleberry-pine: mature pine overstory with a dense shrubby understory of farkleberry, 6) fields: pasture, old fields, and fields annually planted in corn (Zea maize) or soybeans (Glycine max).

The cover types were available in varying degrees of both quantity (Table 1) and location (Figure 3) throughout the study area. Upland oaks was the predominant cover type; hardwood saplings,

Table 1. Cover type utilization and preference of 10 introduced ruffed grouse on NBFSHA, Benton Co., Tennessee, based on number and percentage of radio locations in each of 6 cover types.

Cover Type	% Availability	No. Locs. Observed	% Utilization ^a	P_i ^b	99% Confidence Interval	Preference ^c
Hardwood saplings	9.3	445	56.3	.093	$.603 \leq P_i \leq .523$	+
Upland oaks	70.3	210	26.6	.703	$.301 \leq P_i \leq .231$	-
Bottomland hardwoods	7.6	61	7.7	.076	$.099 \leq P_i \leq .055$	0
Farkleberry-laurel	5.3	28	3.5	.053	$.050 \leq P_i \leq .020$	-
Farkleberry-pine	2.5	33	4.2	.025	$.058 \leq P_i \leq .026$	+
Fields	5.0	13	1.7	.050	$.027 \leq P_i \leq .007$	-

^aBased on percentage of total locations (N=790).

^bTheoretical proportion of occurrence (Neu et al. 1974).

^c0 = used in proportion to the availability of the cover type on the area, + = used in greater proportion than its availability, - = used in lesser proportion than its availability.

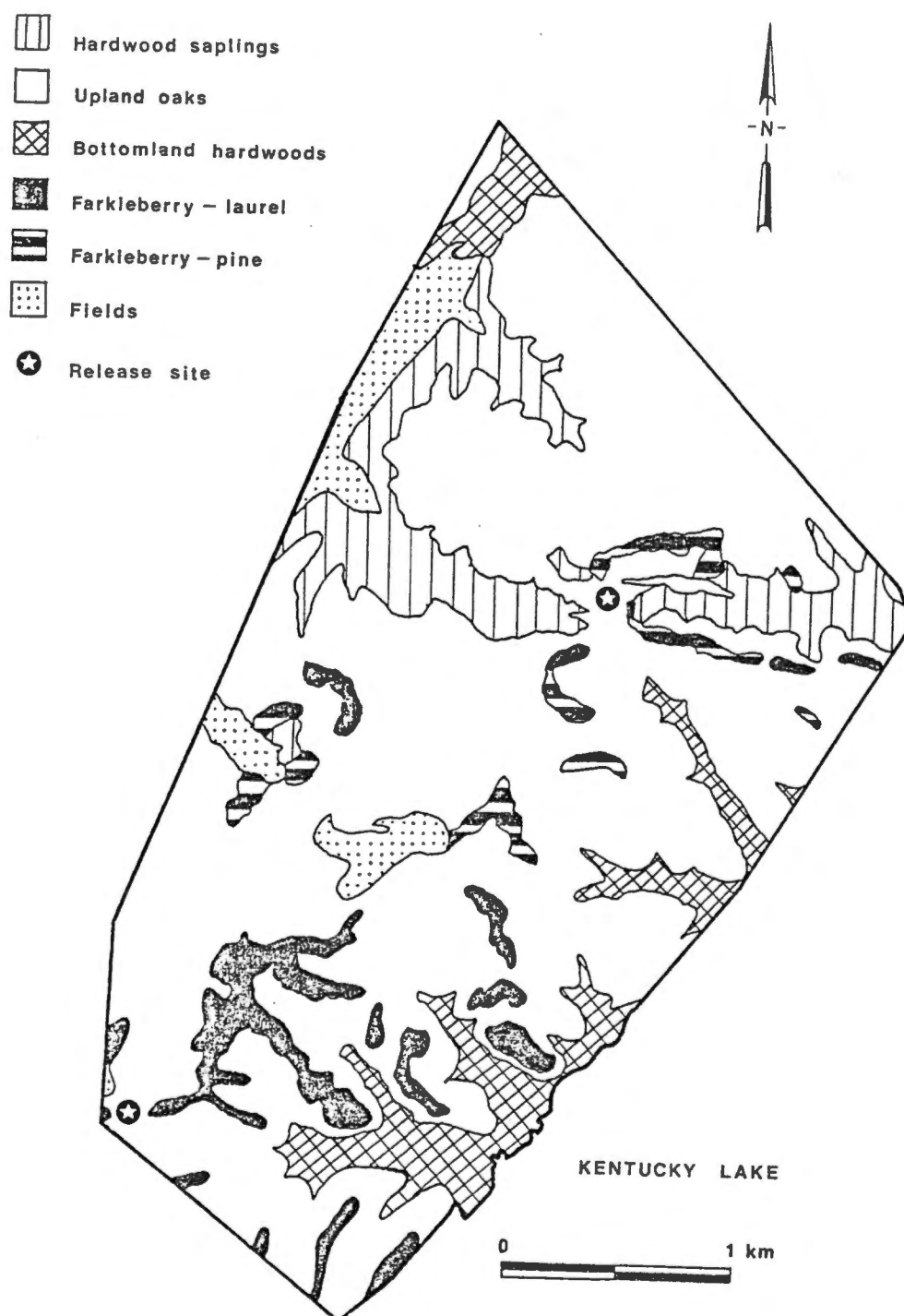


Figure 3. Location of habitat types on the study area.

bottomland hardwoods, farkleberry-laurel thickets, farkleberry-pine, and fields were increasingly less common.

III. RADIO TRACKING

This restoration attempt was evaluated using data collected by locating radio-equipped grouse. Identical tracking techniques and equipment were used on both releases. Nineteen grouse (10 in 1981 and 9 in 1982) were fitted with battery-powered, brass-encased radio transmitters (built by Telonics, Inc., Mesa, AZ). Identical transmitters were used both years, but those used in 1982 were spray-coated with a flat brown paint to make the brass exterior less conspicuous to predators.

Transmitters were harnessed on the birds using 1/8" wide elastic strap, so that the transmitter rode on the back with the antenna wire facing forward. An attempt was made in 1982 to orient the transmitters with the antennas facing the tail, as used by White (1978). Also the elastic strap was replaced with nonelastic strap as recommended by Telonics, Inc. However, birds equipped in this manner displayed great difficulty in flying. They were recaptured by hand and their transmitters readjusted in the former manner.

All transmitters broadcast between 36 and 42 signal pulses per minute on individual frequencies in the 150.73-151.38 Mhz. range. Extended battery life of up to 9 months was expected.

The weight of the transmitter package (30.0 g) exceeded the standard 4% of body weight recommended by Brander and Cochran

(1971). Implications of this aspect as related to mortality will be discussed later.

A portable telemetry receiver and a 2 element "H" design hand-held directional antenna were used for daily location of radio-marked birds. To minimize error, readings for each location were taken during the shortest period possible, usually 10-20 minutes.

Locations were determined by triangulation. Azimuths were determined from signal intensity peaks with a pocket compass, and transferred to a 1:24,000 scale U.S. Geological Survey (USGS) topographical map. Dissected topography combined with low output of the transmitters caused deflection of some signals; therefore, some azimuths had to be interpreted subjectively when plotted on the USGS map. Birds were flushed in 22% of the locations in order to uncover triangulation errors, and to monitor survival and habitat utilization more accurately.

IV. ANALYSIS

Each time the position of a radio-equipped grouse was determined by telemetry or by flushing the bird, its location was recorded on a 1:24,000 scale USGS topographic map and was translated into grid coordinates (100 x 100 m grid size). Date, time, and means of location were also recorded. The cover type associated with the location was determined by habitat description after the birds had been flushed or by transferring the location to a habitat map constructed from observations gathered during extensive hours

traversing the study area on foot. Topographic parameters (slope aspect, slope angle, and relative position on the slope) were determined from map positions. Locational data were used to evaluate several aspects of grouse mobility and behavior, including dispersal, home range, daily movements, and habitat utilization. Maximum dispersal was defined as the straight-line distance between the release site and the location farthest from that site.

Home Range

Two methods of determining home range were used. The convex polygon involves drawing the least-sided polygon which contains all the location points for a bird. The minimum polygon is similar except the requirement that the polygon be convex is dropped. The area of the home range was determined by a mathematical formula utilizing the grid coordinates of the outermost locations (Jennrich and Turner 1969).

Daily Movement

Daily movement was defined as the straight-line distance (net position change) between 2 locations. Distance was measured in 24 m segments. Sampling intervals less than 4 hours or greater than 27 hours apart were deleted from analysis.

Sampling intervals were divided into 2 categories. Same Day Locations (SDLs) included a sampling interval of 4-11 hours occurring on the same day. Consecutive Day Locations (CDLs) included a sampling interval of 12-27 hours separated by nightfall.

Habitat Utilization

A chi-square test of utilization-availability data was used to determine preference or avoidance of the 6 cover types (Neu et al. 1974).

CHAPTER III

RESULTS AND DISCUSSION

I. TRAPPING, TRANSPORT AND RELEASE

A total of 92 grouse was captured (51 in 1981 and 41 in 1982) during a 17-day period each year at Fort McCoy, Wisconsin. In 1982 Fort McCoy personnel also graciously donated 2 grouse captured during their trapping experiment. From these, 80 birds were ultimately released at NBFSHA (40 each year).

Overall trapping success was 1 bird per 3.7 trap days (Table 2). Despite greater familiarity with the area, an increase in the number of traps used, and a 37% increase in the number of trap days, trapping success in 1982 was lower than in 1981 (1 bird per 4.8 and 2.8 trap days, respectively). This difference is attributed to a sharp decrease in Wisconsin's grouse population in 1982, estimated at about 50% at Fort McCoy (Kim Mello, personal communication). However, trapping success for both years was high compared with success rates reported by others using the interception technique (Table 3). We believe our relatively high trap success was due to our locating broods and trapping specifically for those broods. By contrast, most interception trapping is done by placing traps in habitat believed to be good brood habitat, but without previous location of broods.

Table 2. Individual trap success at Fort McCoy, Monroe County, Wisconsin.

Trap ^a	17 August - 2 September 1982		23 August - 8 September 1982	
	Number	Number	Number	Number
	Days Set	Birds Captured	Days Set	Birds Captured
1	16	9	16	1
2	9	1	15	1
3	15.5	7	8	0
4	6	0	14.5	1
5	15	8	10	10
6	9.5	1	13	0
7	6	1	13	5
8	4	1	9	0
9	5.5	5	13	5
10	11.5	6	13	1
11	10.5	1	12	6
12	10	9	9.5	2
13	9	2	9	0
14	7.5	0	8	2
15	7	0	7	2
16			7.5	2
17			8	0
18			5	0
19			4.5	3
Total	142.0	51	195.0	41
Success	2.8 trap days per bird		4.8 trap days per bird	
Overall success	3.7 trap days per bird			

^aTraps were numbered in the order that they were set.

Table 3. Reported ruffed grouse trapping success rates using the interception (lily-pad type) trap method.

Researcher	Location	Dates	No. Birds	No. Trap Days	Trap Days Per Bird
White 1978	Vernon Co., WI Missaukee & Roscommon Counties, MI	Aug. 1977	35	79	2.3
		Aug.-Sept. 1976	37	106	2.9
Gudlin (this study)	Fort McCoy, Monroe County, WI	Aug.-Sept. 1981&1982	51 41	142 195	2.8 4.8
Gullion 1961	Cloquet Forest Res. Center, MN	Fall/Winter 1959-60	104 49	297 154	2.8 3.1
		Fall 1960			
Rusch & Keith 1971	Rochester, Alberta, Canada	Aug.-Nov. 1966&1967	550	2389	4.3
King (as reported in Gillion 1961)	Cloquet Forest Res. Center, MN	Fall 1931- Spring 1934	809	3673	4.5
Chambers & Sharp 1958	Centre County, PA	July-Oct. 1955	104	882	8.5
Little & Sheets 1982	Yellow River SF, Allamakee Co., IA	Aug.-Nov. 1971&1972	106	1113	10.5
Harris 1981	Union County, GA	April-July 1978, March- July 1979	76 30	907.5 1626	11.9 54.2
Chaney & Widner (unpub. data)	Cumberland Gap NHP, VA	Oct.-Nov. 1981	56	1586	28.3
Schulz 1978	Wakopa Game Mgmt. Area, ND	Oct.-Nov. 1977	7	387	55.3
Jones 1979	Catoosa WMA, Fall Creek Falls SP, TN	July 1975- May 1976	18	1078	59.8

In both years alder swamp was the most productive trapping habitat, accounting for 47% of the captured grouse (Table 4). Traps set in alder swamps were twice as successful as those set in either upland or bottomland hardwoods. In addition to being attractive both floristically and structurally, the typically narrow, linear shape and streamside location of the alder swamps enhanced the effectiveness of interception trapping. By placing one end of the trapline at the stream and running the leads perpendicular to the edge of the swamp, the trap would effectively intercept the line of travel of grouse moving along that side of the stream.

Seventy percent of all birds were taken in multiple captures. The largest captures were 1 of 8 birds and 2 of 5 birds. Most (92%) of the birds captured were juveniles, ranging up to about 16 weeks old. Eight birds had juvenile tails characteristic of grouse 8-10 weeks old. The average capture weight of 1982 juveniles was 475 g.

One raccoon (Procyon lotor) and 1 skunk (Mephitis mephitis) were captured in the traps. Also on several occasions it appeared that raccoons had entered or tried to enter catch boxes but had failed or escaped.

The sex ratio of the 1981 birds was 1:1, and 1.5 males:1 female in 1982 (Table 5). Color phase of the 1982 birds was 2 red:1 gray (color phase was not recorded in 1981). Only 7 of the 92 grouse were adults, accountable by the greater wariness of adult birds and a preponderance of juveniles in the population at this time of year.

Table 4. Trapping success by habitat type, Fort McCoy, Monroe County, Wisconsin.

Habitat Type/Year	No. of Traps	No. of Traps Successful	No. of Trap Days	No. of Birds Captured (% Total)	Success: Trap Days Per Bird
Upland hardwoods					
1981	6	5	55.5	18	3.1
1982	8	5	80.5	12	6.7
Total	14	10	136.0	30 (32)	4.5
Bottomland hardwoods					
1981	4	2	41.0	10	4.1
1982	5	4	60.5	9	6.7
Total	9	6	101.5	19 (21)	5.3
Alder swamps					
1981	5	5	45.5	23	2.0
1982	6	4	54.0	20	2.7
Total	11	9	99.5	43 (47)	2.3

Table 5. Demographic characteristics of ruffed grouse captured at Fort McCoy, Monroe County, Wisconsin, 1981 and 1982.

	Sex			Age		Color Phase		
	Male	Female	Unknown	Adult	Juvenile	Red	Gray	Unknown
1981 ^a	20	20	1	1	50	-	-	-
1982	24	16	1	6	35	26	13	2
Total	44	36	2	7	85	26	13	2
Percent of total	55	45		8	92	67	33	

^aColor phase was not recorded for 1981 birds.

Eleven birds died prior to release in 1981 and 3 in 1982. Two deaths occurred as a result of predation in the trap (1 by a raccoon, 1 by a skunk), and 3 deaths as a result of injuries incurred during trapping or captivity. The 9 other deaths were apparently due to stress of trapping, handling, and confinement. Almost half the birds were mildly to severely scalped from pushing their heads against the wire mesh of the catch boxes, but these superficial injuries are common and do not appear to be fatal (Gullion 1965, Chaney and Widner, unpublished data). Scalp injuries were treated with an antiseptic ointment.

Shorter captivity time and better holding facilities were probably responsible for the lower captivity mortality in 1982. Grouse were captive up to 12 days in 1981 but only up to 7 days in 1982. The captive grouse remained calmer in the straw bale holding pen as it better shielded the birds from outside movement, and the soft straw and nylon mesh netting were less likely to cause injury than the wire mesh holding pens.

The average capture weight of all the 1982 birds was 488 g. Weights recorded at the time of release for 16 of these birds revealed changes ranging from a gain of 20.6 g to a loss of 87.1 g while in captivity from 1 to 7 days. Two birds gained weight, 1 maintained, and 13 lost weight. The average weight change was a loss of 38.7 g. Similar weight changes for captive wild-trapped grouse were reported by Chaney and Widner (unpublished data), Little and Sheets (1982), and Woolf et al. (in press).

All grouse in 1981 were transported to NBFSHA by car. In 1982 20 birds were transported by airplane and 20 by car. Only 1 death (1981) occurred during transport. Upon arriving at NBFSHA, the birds were released as soon as possible. In 1981 one-half of the birds were released at Pilot Knob Ridge and the other half at the Bethel site. In 1982 all birds were released at the Bethel site, because the habitat appeared to be favored by birds in the 1981 release.

II. RADIO-TRACKING

Nineteen radio-equipped ruffed grouse were located a total of 871 times during 860 known grouse days (Table 6). Grouse were radio-tracked from 30 August - 14 December 1981 and 6 September - 14 December 1982. Several days were also spent on the study area in late March and April each year following release in attempt to locate surviving birds and to listen for drumming activity.

Despite a shorter tracking period and one less radio-equipped bird, 32% more locations were obtained in 1982 as a result of greater familiarity with the telemetry technique, study area, and movements of the birds. Two locations for a single bird (1 morning and 1 afternoon or evening) were made on 60.4% of the location days (days when a successful location was made) in 1982 in contrast to only 21.2% in 1981. Locations were obtained generally either in early morning (35.3% between 0700-0959 CDT) or late afternoon (36.6% between 1500-1759 CDT).

Table 6. Radio location success of transmittered grouse.

Bird No.	Days Known Survived	Number of Days Locations Made	Successful Locations	Flushes
81	≤ 9	6	6	1
82	≤ 86	71	86	28
83	≤ 15	12	12	1
84	≤ 22	16	16	1
85	≤ 92	70	96	28
86	≤ 22	16	16	1
87	≤ 15	13	13	1
88	≤ 11	8	8	1
89	≤ 11	9	9	1
90	> 234	86	114	38
1981 total	517	307	376	101
127	≤ 11	11	16	3
129	≤ 44	40	64	13
130	≤ 69	63	101	12
132	≤ 4	5	7	3
135	≤ 25	22	37	5
137	≤ 4	4	5	1
140	87	82	129	22
144	≤ 2	2	3	1
145	≤ 97	79	133	27
1982 total	343	308	495	87
Total	860	615	871	188
Mean	45.3	32.3	45.8	9.9

The transmitters were harnessed longitudinally on the middle of the birds' backs by means of a 1/8" wide elastic strap which ran underneath the birds' wings at the shoulder. The elastic strap allowed the transmitter to be snugly attached but allowed for flexibility of wing movement during flight. Two birds (1981) lost their transmitter.

The transmitters had antennas made from 39 cm of flexible, bare, twisted wire with 4.5 cm of rubber casing at the base. Even though none of the antennas became frayed as reported by White (1978), the antennas were still apt to become bent. Two of them became entangled in vegetation, immobilizing both birds and subsequently contributing to their deaths.

Signal transmission from the transmitters was very reliable. All transmitters were recovered pursuant to each bird's death, including one which still emitted a weak pulse 3 months after the brass casing had been punctured by a predator's tooth.

Transmitted birds were flushed 87 times. On 21 of these flushes (24%) 1 or more non-transmitted grouse were flushed in the company of a transmitted bird. This occurred only 4 times after 16 October, all in the company of Bird #90. Only twice were 2 transmitted birds located in very close proximity to each other.

III. SURVIVAL AND MORTALITY

Transmitted Birds

Survival rate of transmitted birds was low. Ten grouse (53%) died within the first month. One survived longer than 4 months, and was last located almost 8 months after the release. Two other birds survived past their last location; however, they both had lost their transmitters 15 days or less after release. No significant difference was detected in survival rates according to age, sex, color phase, or year released. Spray-painting the transmitters to camouflage them did not increase survival of the birds.

Specific or approximate causes of death were determined for 16 of the radio-equipped birds (Table 7). Experimental methods contributed to 4 of these deaths. Two birds died from shock within 4 days after release, one bird was taken by a predator after its antenna became entangled in vegetation, and another died from self-inflicted injuries and/or exhaustion when its antenna became entangled in vegetation. The 12 other deaths were attributed to predation: 3 avian, 4 mammalian, and 5 unknown.

Predation did not appear to be habitat-specific. Predation deaths occurred in all habitat types except farkleberry-pine, and occurred most often in upland oaks (5) and hardwood saplings (4). Based upon the theory that habitats offering dense cover should provide more security to grouse from predators than would

Table 7. Survival and terminal disposition of 19 radio-equipped grouse released in 1981 and 1982, ranked in order of known survival times.

Bird	Released (D/M/Y)	Sex	Age	Color Phase	Survival (Days)	Terminal Disposition
90	8/30/81	M	J	-	234	Alive when last located
145	9/09/82	M	A	Gray	97	Dead - predator unknown
85	8/30/81	M	J	-	92	Dead - predation, harness contributed
140	9/09/82	F	J	Red	87	Dead - predator mammalian
82	8/30/81	F	J	-	86	Dead - predator avian
130	9/07/82	M	J	Red	69	Dead - predator unknown
129	9/07/82	M	A	Red	44	Dead - predator mammalian
135	9/09/82	F	J	Red	25	Dead - predator unknown
84	8/30/81	M	J	-	22	Dead - predator mammalian
86	8/30/81	F	J	-	22	Dead - predator unknown
83	8/30/81	M	J	-	15	Dead - predator mammalian
87	8/30/81	F	J	-	15	Alive - transmitter lost
88	8/30/81	F	J	-	11	Dead - predator avian
89	8/30/81	F	J	-	11	Dead - predator unknown
127	9/07/82	F	J	Red	11	Dead - predator avian
81	8/30/81	M	J	-	9	Alive - transmitter lost
132	9/07/82	M	J	Gray	4	Dead - shock death
137	9/09/82	M	J	Gray	4	Dead - trauma, harness contributed
144	9/09/82	M	A	Red	2	Dead - shock death

more open habitats, it might appear that there would be a larger discrepancy between the number of predation deaths in hardwood saplings versus upland oaks. However, radio-equipped birds frequented hardwood saplings more than twice as often as they did upland oaks and it appeared that dense vegetation may have proved a hindrance to radio-equipped birds, as evidenced by the 2 birds whose antennas became entangled in vegetation, leading to their demise.

For the purpose of projecting post-release mortality rates of non-transmitted birds, White (1978) and others have assumed that survival rates of transmitted grouse were equal to those of non-transmitted grouse. I believe that, at least regarding the transmitters we used, that assumption is false. Mortality rates for transmitted birds likely are significantly higher. Both the weight and design of these transmitters increased the likelihood of mortality. One problem is that the antenna wires may become entangled in vegetation, exposing the bird to predation or trauma (White 1978, this study). The "backpack" style of harnessing also has drawbacks. Even when using elastic materials to attach the transmitter to the bird, it appears that there is a fine line between having the harness just right or being either too loose or too tight. Harness failure occurred in 17% of the radio-equipped grouse in the 3 Tennessee reintroductions (White 1978, Jones 1979, this study). Having the harness drawn too tight may cause the bird to be reluctant to fly, may cause difficulty

in flying, or provoke friction wounds at the base of the wings, increasing the possibility of infection or disease.

The weight of the transmitter package (30.0 g) equalled 4.5-7.0% of the body weight of the transmitted birds, exceeding the standard 4.0% of body weight recommended by Brander and Cochran (1971). Even though a grouse may appear to fly normally upon release, a slight reduction in flight speed would be difficult to detect. Lance and Watson (1977) observed that red grouse (Lagopus l. scoticus) harnessed with transmitters weighing only 4% of body weight displayed a tendency to be the last bird of the flock to flush and to gain speed less easily than the non-transmitted birds. A reluctance to flush and loss of speed would increase susceptibility to predation.

In any experiment such as this, careful consideration must be taken to weigh the advantages of a larger, heavier, longer-lived transmitter (longer potential data-gathering period) versus the possible disadvantages (increased mortality risk) compared to a lighter, smaller, shorter-lived transmitter. When the primary goal is to have the transplanted birds survive and reproduce, and where a significant proportion of the birds are transmitted, it may be advantageous to use a smaller, lighter transmitter. Some survival data were obtained in the spring by non-telemetric methods (drumming and flush surveys). Woolf et al. (in press) using solar-powered poncho transmitters, reported no lost transmitters, no transmitter-related deaths, and no deaths within the first 3 months.

Non-transmitted Birds

The fate of several non-transmitted birds was determined. In 1981, one bird appeared to be in very poor condition when released. The next morning it was found dead, the death attributed to stress. The legband of another bird was found in November 1981. In March 1983 the remains of another banded bird were found. The extent of retrice growth since the time of release indicated that this bird died approximately 3-6 weeks after release.

Non-transmitted birds were often flushed while conducting fieldwork during the fall. On 21 occasions non-transmitted birds were flushed with transmitted birds, 15 times in 1981 and 6 times in 1982. Non-transmitted birds were also flushed separate from transmitted birds. In 1981 only 1 bird was flushed separately, but in 1982 non-transmitted birds were flushed separately 18 times (Figure 4).

One grouse observed at close range in September 1982 appeared not to bear a red legband, which should have been easily visible at that distance. Since the loss of a legband is highly unlikely, this unbanded bird may have been the progeny of introduced birds.

Spring Searches

Several days were spent on the study area in late March and April to locate surviving grouse. Transects were walked during the early mornings and late afternoons to listen for drumming males. Preferred habitat was coursed by several men in a line to flush

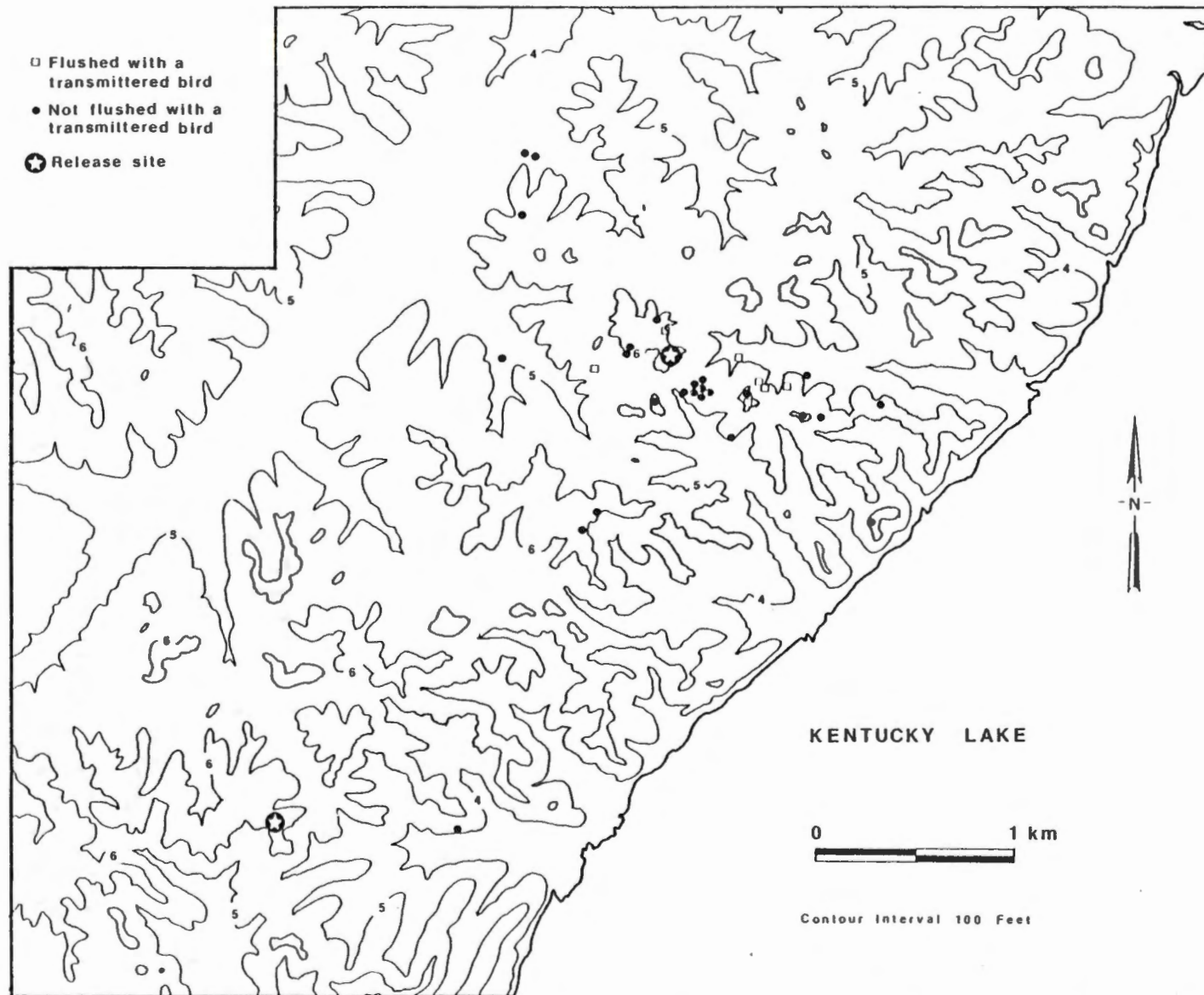


Figure 4. Locations of non-transmitted grouse flushed on NBFSHA, September 1981 - May 1983.

grouse. TWRA and NBFSHA personnel also provided information about birds flushed or heard drumming.

In the spring of 1982 Bird #90, a male, was located 3 times by radio telemetry. One non-transmitted grouse was flushed in its company on 16 March. It was last located on 18 April, and was not heard drumming during this search. Two drummers were heard on 18 April, and a bird which may represent a third drummer was heard during March and April by TWRA personnel. Three to 5 other birds were also flushed on the study area. In the spring of 1983 2 drummers were heard, and one of them was flushed from its drumming log. No other birds were flushed. In March 1984 a grouse was flushed near the known drumming log and droppings were found on the log. Two, possibly 3, drummers were heard in May 1984 and another drumming log was located approximately 100 m from the first log. Both logs were most likely being used by the same drummer.

All drumming grouse were heard in the hardwood saplings area in the northeast section of the study area (Figure 5). Drumming was heard as early as 27 March and as late as 9 May.

Drumming Log #1 was a decaying oak tree (9 m long, 33 cm dbh) which lay parallel to the contour near the bottom of an east-facing slope. The drumming stage was approximately 4 m from a small creek. The log was located in dense hardwood saplings. Drumming Log #2 was a decaying oak (4 m long, 20 cm dbh) which lay parallel to the contour near the top of a north-facing ridge. The drumming stage was 1 m from the sawed butt end of the log. The cover surrounding this log was medium in density compared to the cover by Log #1.

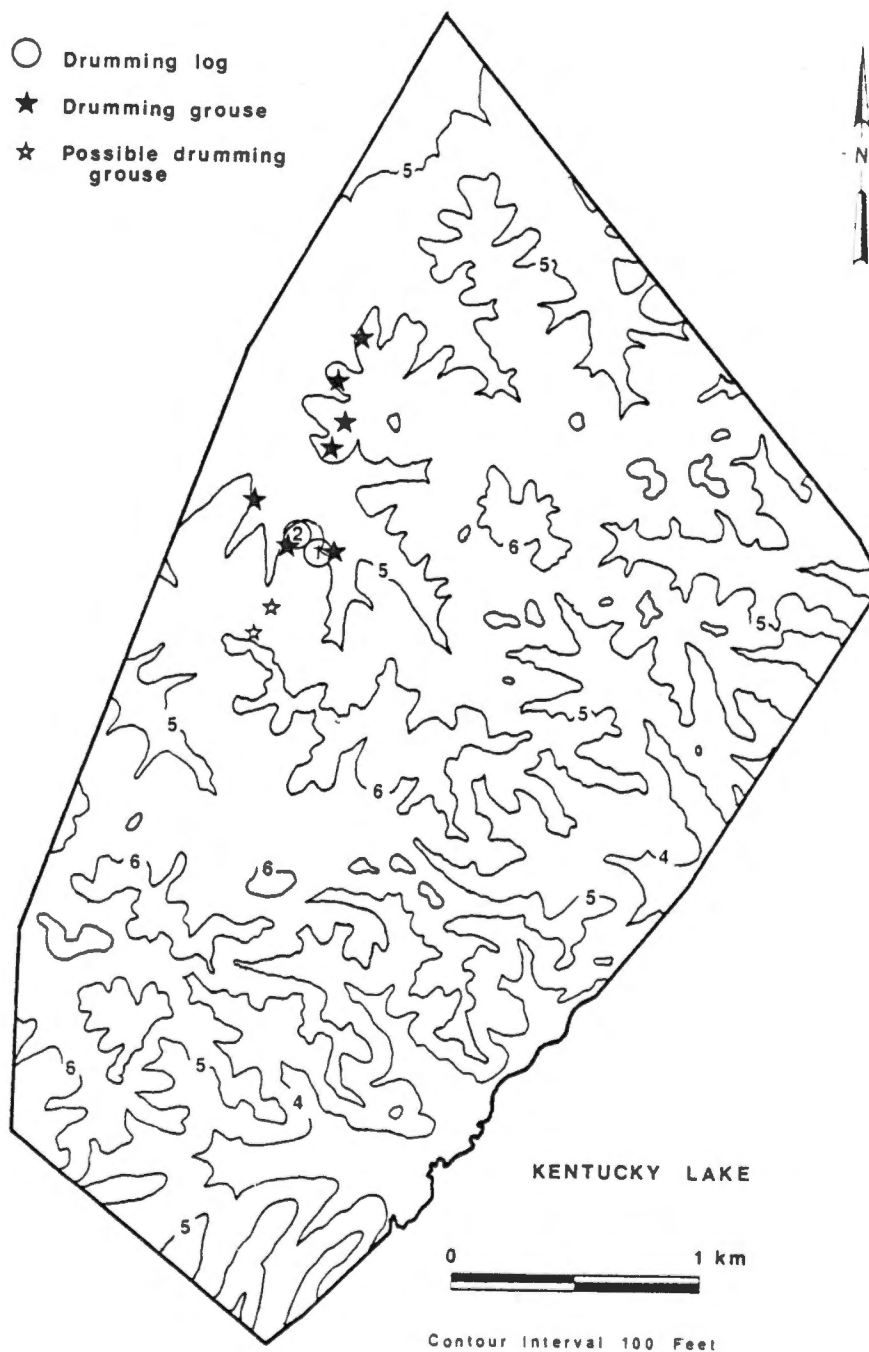


Figure 5. Drumming males and drumming logs located during spring searches 1982-1984.

Recapture Attempts

Attempts were made to capture grouse on the study area to aid in determination of survival of non-transmitted birds and to document reproduction. Three interception traps were set during the fall of 1982 (Figure 6). No grouse were captured during a total of 60 trap days. However, the traps were not set in preferred locations as they would have been too remote to check daily or too near radio-equipped grouse.

A mirror trap was set on Drumming Log #1 from May 7-10 and May 14-17, 1983, for a total of 7 trap days. The grouse was not captured although it was heard drumming during this time.

IV. LOCATIONAL DATA ANALYSIS

Ten radio-equipped birds provided sufficient locations for habitat utilization, home range, and daily movements. These 10 birds each had 16 or more radio-locations and survived a minimum of 22 days, yielding a combined total of 790 locations. The remaining birds were omitted because they were not monitored long enough to display meaningful movement or habitat use patterns.

Dispersal

Radio-equipped birds showed a strong affinity for the release site. Maximum dispersal was 4.0 km, well within limits reported for native northern grouse (Chambers and Sharp 1958, Gullion and Marshall 1960, Hale and Dorney 1963, Godfrey and

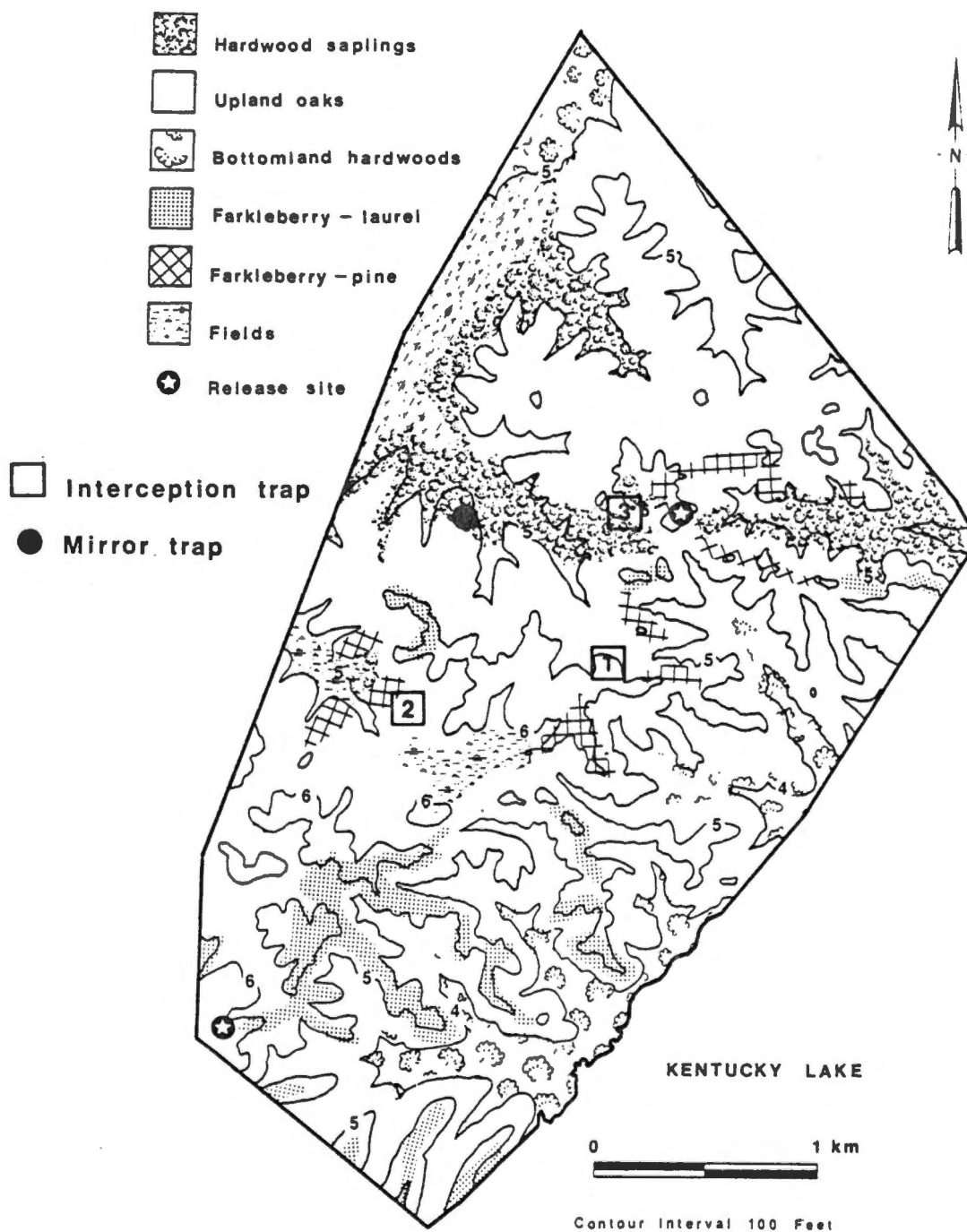


Figure 6. Location of interception traps and mirror trap set on study area.

Marshall 1969, Rodgers 1980, Gullion 1982). Maximum dispersal for all but 3 birds was less than 2.0 km. Similar movements of introduced birds have been reported by Lewis et al. (1968), Jones (1979), White and Dimmick (1979b) and Woolf et al. (in press).

Three dispersal modes were observed among the 10 radio-equipped grouse surviving a sufficient period of time to establish home ranges. Three birds (#130, #140, #145) had very short initial movements following release and occupied home ranges immediately adjacent to the release site. Four birds (#84, #86, #129, #135) displayed initial long and short "wandering" movements the first several days, then settled into home ranges 400-1000 m from the release point and remained there until their demise. The 3 other birds (#82, #85, #90) displayed exaggerated dispersal movements travelling from one area to another. Bird #82 initially occupied a large home range before dispersing northward on 1 November 1981 and establishing a much smaller home range approximately 1400 m away. Bird #90 also occupied a very large home range before dispersing northward on 27 September 1981 and establishing a much smaller home range approximately 2000 m away. Bird #90 presumably continued to use this second area through early March 1982, but was subsequently located in a third area on 17 April 1982 some 2200 m west of its last location on 16 March. Bird #85 initially occupied one area then dispersed to an adjacent drainage. Bird #85 returned to its initial area of use for several days at the end of October.

Habitat Utilization

Although comprising only 9.3% of the study area, hardwood saplings were the most frequented cover type, accounting for 56.3% of the locations (Table 1, page 11). Seven of the 10 grouse utilized hardwood saplings as their primary cover type, all having 62% or more of their locations in this type (Table 8). Two grouse primarily used upland oaks and one used bottomland hardwoods. These latter 3 birds were less faithful to a single cover type than birds using hardwood saplings. Only 46-50% of their locations were in their primary cover type. In contrast to the grouse released during 1976-77 (White and Dimmick 1979b), no radioed birds used shrubby thickets of farkleberry or laurel as their primary cover type. Birds in this study were released a long distance away from that cover type, perhaps accounting for its not being used.

Upland oaks were used disproportionately less than their availability (70.3% of the study area), as were farkleberry-laurel thickets and fields (Table 1). Bottomland hardwoods were used in proportion to their occurrence. Farkleberry-pine was a preferred cover type, though only 1 bird used this cover significantly.

Seasonality

Six of the 7 birds surviving longer than 1 month exhibited seasonal habitat shifts, most increasing their use of hardwood saplings as fall progressed (Figure 7). This tendency was especially accentuated by 2 birds (#82 and #90) which, following dispersal from their initial ranges, increased their use of

Table 8. Cover type use by 10 ruffed grouse introduced on NBFSHA, based on percentage of radio locations.

Cover Type	Bird No. N =	1981					1981					1981	1982	Grand
		82 86	84 16	85 96	86 16	90 112	129 64	130 101	135 37	140 129	145 133	Totals 326	Totals 464	Totals 790
Hardwood saplings		17	<u>62</u>	<u>71</u>	<u>63</u>	<u>71</u>	<u>73</u>	<u>68</u>	30	<u>82</u>	21	56.1	56.3	56.3
Upland oaks		<u>50</u>	19	21	31	10	13	32	21	12	<u>48</u>	25.2	27.6	26.6
Bottomland hardwoods		12	-	3	-	10	-	-	<u>46</u>	-	15	7.4	8.0	7.7
Farkleberry-laurel		17	-	3	-	4	9	-	-	-	-	6.7	1.3	3.5
Farkleberry-pine		-	-	1	6	4	5	-	-	4	14	1.8	5.8	4.2
Fields		4	19	1	-	1	-	-	3	2	2	2.8	1.0	1.7

 = Primary cover type.

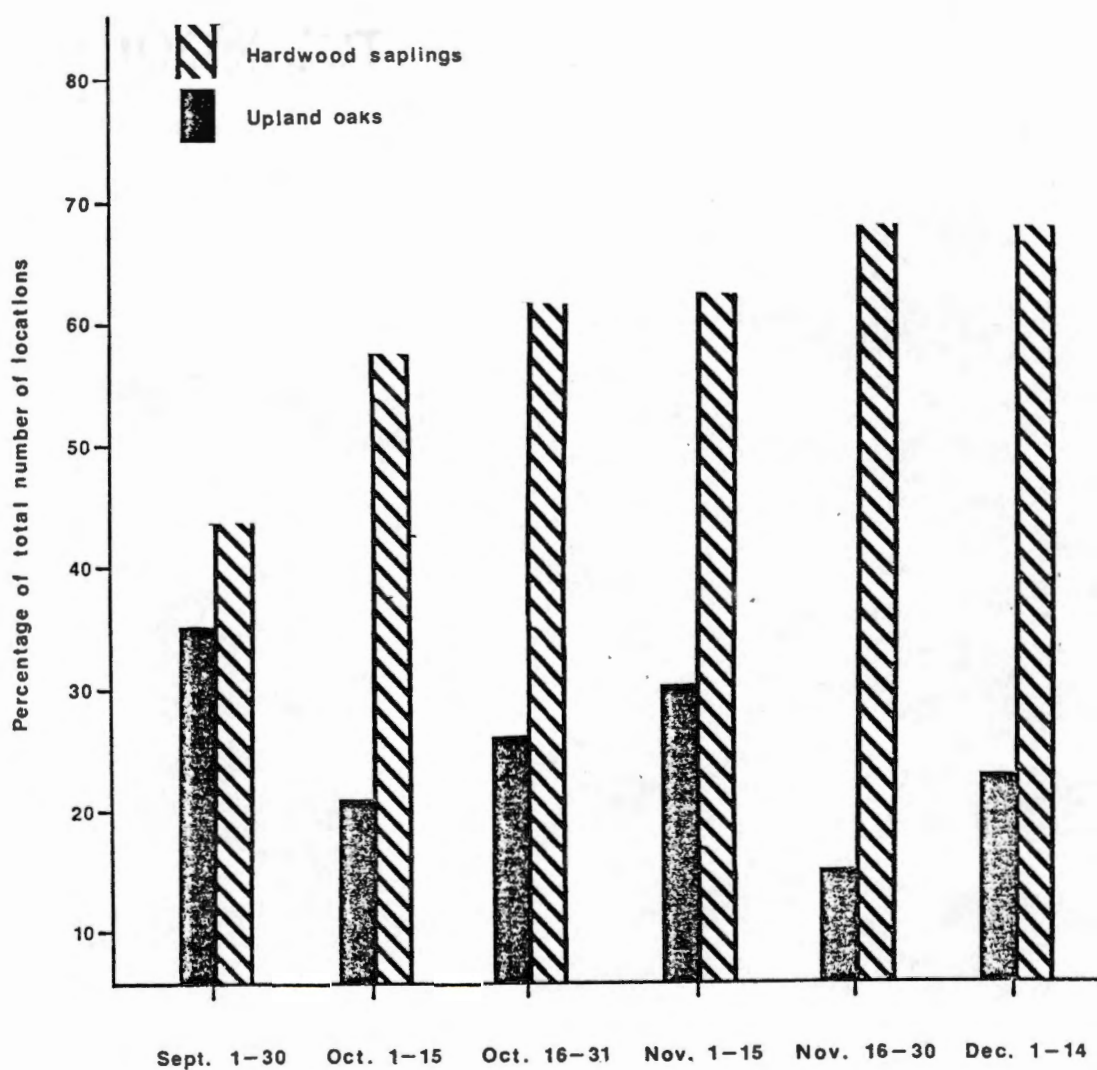


Figure 7. Percentage of radio locations in hardwood saplings v. upland oaks of 7 radioed grouse.

hardwood saplings twofold in one case and from no use to almost exclusive use in the other. Conversely, only 1 bird (#130) shifted its primary cover type from hardwood saplings to upland oaks. Bird #140 displayed no seasonal shift, but maintained an intense use of hardwood saplings. Bird #145 continued to use upland oaks as a primary cover type, but shifted its secondary cover type from bottomland hardwoods to hardwood saplings. All major shifts in habitat use occurred during late September to late October.

Area of Home Ranges

A commonly accepted definition of home range is "that part of an animal's range which it knows and uses regularly" (Wilson 1975). Acknowledging "regular use" as a criterion, obvious dispersal movements from one area of use to another (Birds #82 and #90) and similar initial "exploratory" movements during the first several days after release (Birds #84, #86, #129, #135) were excluded from calculation of the home range size to represent these birds' areas of regular use more accurately.

The convex polygon method of determining home range size was emphasized in this study. Jennrich and Turner (1969) defended the convex polygon over several other methods. It was also used for comparative purposes as home ranges reported by other researchers mentioned herein used this technique.

Area comprising home ranges of the 10 radioed grouse varied from 18.0 to 176.0 ha (Table 9). The size of the home ranges was

Table 9. Home range sizes, most utilized cover types, and dispersal characteristics of 10 radio-equipped ruffed grouse released on NBFSHA.

Year	Bird No.	No. Locs.	Survival (Maximum No. Days)	Primary Cover Type (% Use)	Convex Home Range (ha)	Minimum Home Range (ha)	Maximum Dispersal (m)	$\bar{X}$ Dispersal All Locs. from Release Site
1981	85	96	92	Hardwood saplings (71)	176.0	77.0	1440	600
	82	86	86	Upland oaks (50)	165.5 ^b	83.0	3024	-
		[61] ^a		[Upland oaks] [58]	[153.5]	[74.0]	[1344]	792
		[23]		[Hardwood saplings] [65]	[12.0]	[9.0]	[3024]	2640
	90	112	234 ^c	Hardwood saplings (71)	145.5 ^d	73.5	4032	-
		[20]		[U. oaks/b. hdwds.] [40]	[99.0]	[44.0]	[1536]	840
		[86]		[Hardwood saplings] [94]	[46.5]	[29.5]	[4032]	3672
	86	16	22	Hardwood saplings (63)	20.0	12.0	1296	852
	84	16	22	Hardwood saplings (62)	18.0	7.5	1536	912
Mean					105.0	50.6	2296	
1982	145	133	97	Upland oaks (48)	72.0	45.5	936	300
	140	129	87	Hardwood saplings (82)	33.5	25.0	1104	624
	129	64	44	Hardwood saplings (73)	31.0	23.0	1332	936
	130	101	69	Hardwood saplings (68)	29.5	19.0	1032	384
	135	37	25	Bottomland hardwoods (46)	25.5	15.5	2208	1380
Mean					38.3	25.6	1332	
Mean (all birds)					71.7	38.1	1799	

^aSubrange totals: not included in means.

^bTwo distinct home ranges combined.

^cMinimum survival: alive at last location.

^dTwo distinct home ranges combined: does not include 2 locations when the bird dispersed to a third area between 16 March and 17 April 1982.

neither consistently influenced by the life span of the occupant nor by its sex. The mean home range size for birds released in 1982 was only 36% of that for birds released in 1981 ($P < .10$), as the grouse in 1982 were released near more suitable habitat.

The mean home range size was larger than reported for native northern grouse (Bump et al. 1947, Chambers and Sharp 1958, Schladweiler 1965, Archibald 1975, Bakke 1980). However, the 7 smallest home ranges of these introduced grouse were comparable to those of native Georgia birds (Harris 1981), and all were well within range of those reported for introduced grouse (Jones 1979, White and Dimmick 1979b, Woolf et al., in press). Although the home ranges for grouse introduced into southern ranges appear to be much larger than for native northern grouse, the difference may be exaggerated as home ranges reported for northern grouse have usually been for adults in spring and summer whereas most of the telemetered introduced birds have been juveniles in the fall. Juveniles are acknowledged to be much more mobile than adults.

Daily Movements

The 10 radioed grouse yielded 725 daily movements for analysis. The mean distance for movements within the same cover type was significantly less ($P < .01$) than the mean distance for movements from one cover type to another for both SDLs and CDLs (Table 10). The mean distances for movements within hardwood saplings and for movements within bottomland hardwoods (for SDLs and CDLs) were both less than the mean for movements within upland

Table 10. Mean distances (m) of daily movements of 10 radioed grouse on NBFSHA.

Type of Movement	N	Same Day Locations (SDLs)	Consecutive Day Locations (CDLs)
Within same cover type	492	119 (N=153)	177 (N=339)
Between different cover types	233	202 (N=69)	265 (N=164)
Within hardwood saplings	254	118 (N=114)	167 (N=240)
Within upland oaks	87	144 (N=21)	222 (N=66)
Within bottomland hardwoods	39	94 (N=14)	153 (N=25)

oaks ($P < .05$) but were not significantly different from each other. Movements between other habitat types were not numerous enough for meaningful analysis.

Influence of Cover Use and Seasonality on Home Range Size and Daily Movement

Cover selection, use and seasonal changes within cover types highly influenced the home range size and movements of the radio-equipped grouse. Quantity and quality of food and cover varied markedly from late summer to early winter thus dictating changes in the birds' cover use.

Grouse occupying habitats providing sufficient food and cover in close proximity had the smallest home range sizes and shortest daily movements. Many cover types were suitable in late summer and early fall but the structural quality in most cover types deteriorated during the fall.

Seasonal shifts in habitat use displayed by the grouse likely reflected the changing cover requirements and food availability. In early fall (September - early October), upland oaks and bottom-land hardwoods received much use. During this time grouse were often flushed from thickets of muscadine grape, which offered both cover and succulent fruits for food. As fall progressed, the deciduous shrub and ground cover in these habitat types gradually disappeared, and grouse increasingly used hardwood saplings. At this time the fruits of flowering dogwood had matured and birds

were often flushed from or near these trees. When leaf cover diminished, hardwood saplings and shrubby thickets offered the most structural cover for protection. When dogwood berries became scarce, grouse increased their use of farkleberry thickets; this shrub's berries persisted through November. Laurel thickets were seldom used as they were somewhat limited in extent and are isolated from other adequate winter cover on NBFSHA. After leaf-fall is complete, hardwood saplings provide the best structural cover. As this cover type was located in the moister lowlands, it also contained the green leafy foods important to southern grouse such as greenbrier (Smilax spp.) and Christmas fern (Polystichum acrostichoides) (Smith 1977, Stafford and Dimmick 1979). Thus, seasonal changes in habitat narrowed the range of acceptable habitat, resulting in a more uniform selection of hardwood saplings for winter cover. Home range sizes also became increasingly similar in conjunction with this propensity towards use of similar habitats (Figure 8).

Topographical Relationships

Three parameters of topography were recorded along with each grouse location: slope aspect, slope angle, and relative position on the slope. Topography in the study area is highly dissected.

Slopes of the 4 major aspects were almost equally available to the grouse (Figure 9). The radio-equipped birds did not exhibit

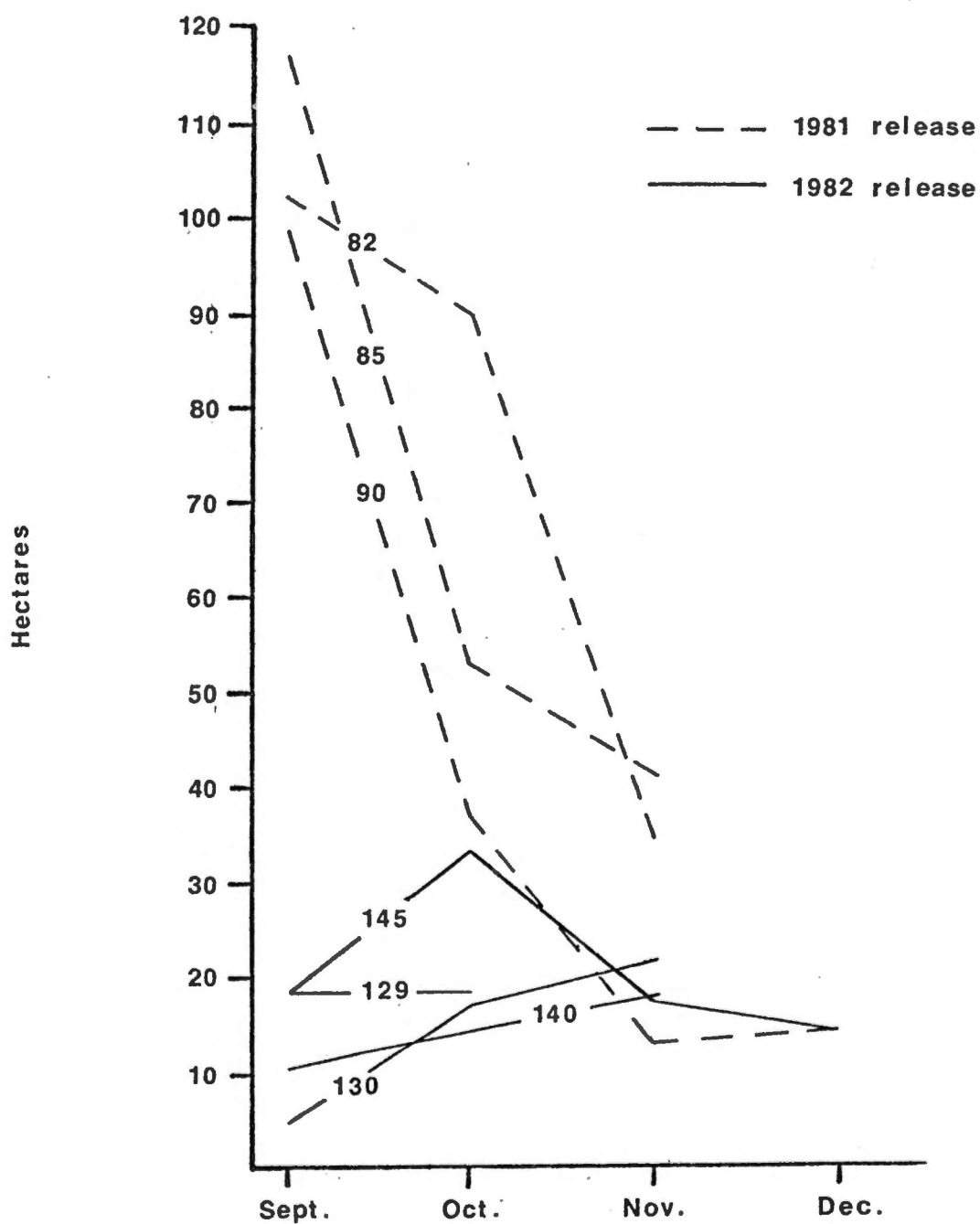


Figure 8. Progressive changes in ruffed grouse home range sizes associated with seasonal habitat changes.

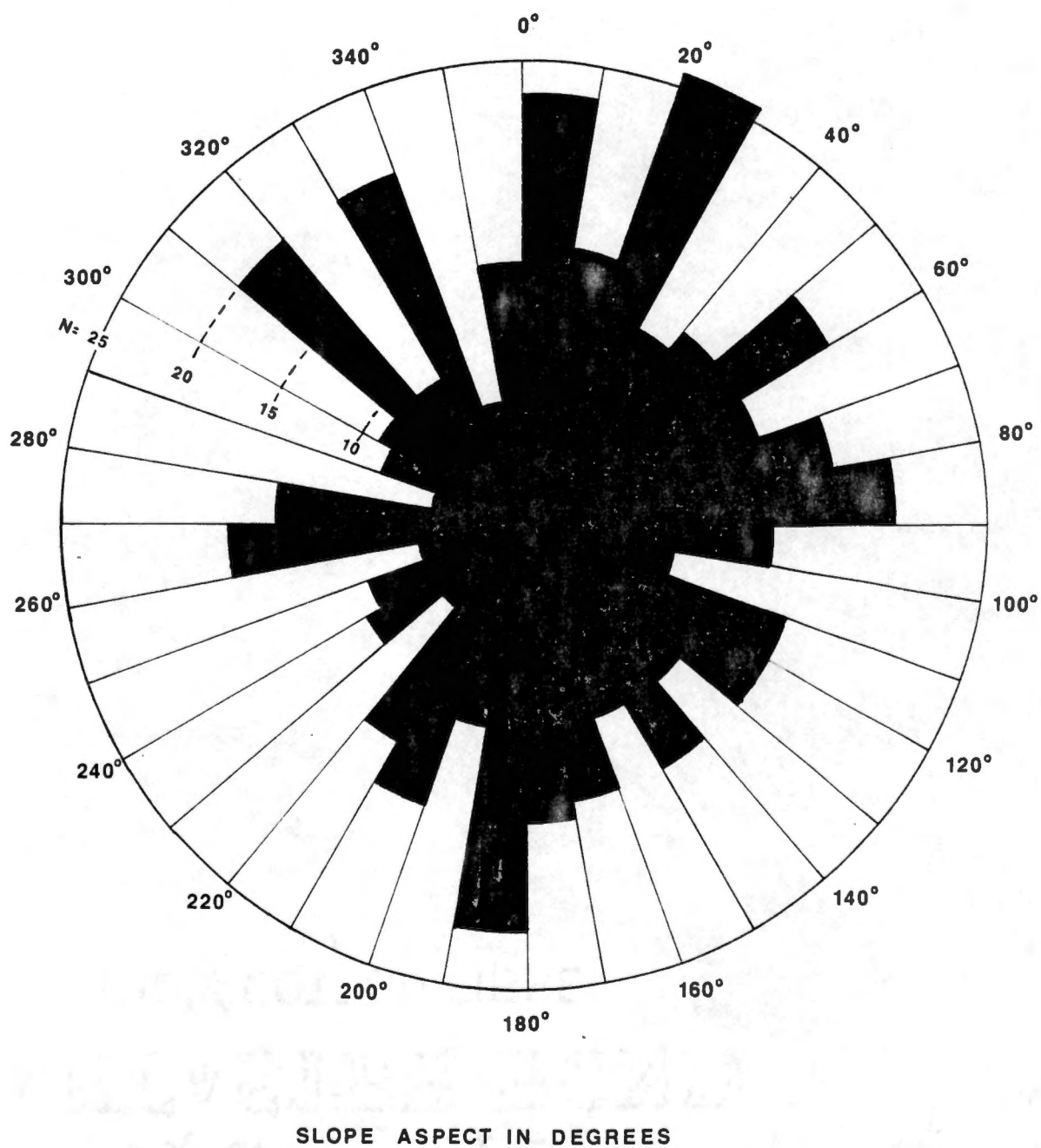


Figure 9. Slope aspects for all grouse locations with some definite orientation (N=491 locations).

a preference for any aspect (Figure 9), utilizing each aspect in proportion to its occurrence on the study area (Table 11).

Thirty-five percent of all locations were on midslopes having a slope angle of 25-39% (Figure 10). Less than 8.0% of the locations were on steep, upper slopes seemingly preferred by the grouse released by White (1978). In agreement with White (1978), use of these areas by grouse are probably due to the topographical influence on the vegetation rather than the topographical features themselves. White's grouse preferred to use the farkleberry-laurel thickets which were found on the xeric steeper south-facing slopes while grouse from the 1981-82 releases frequented the more mesic midslopes and lowlands.

Night Roosts

In 1982 a total of 19 flushes (including 1 non-transmitted bird) were made after dark between 1950-2310 CDT. No apparent roost site preference was detected for either cover type or roost structure. Night flushes were made in all cover types except fields, and the birds roosted in thickets, pines, on grapevines, and in both mature and young hardwoods. However, on 2 windy nights, 5 of 6 grouse were flushed from or very close to the ground. Obviously ground roosting would provide more protection from the wind and a more stable roost during windy nights.

Table 11. Slope aspect utilization by radio-equipped grouse on NBFSHA.

Slope Direction	% Availability	No. Locs. Observed	% Utilization ^a	Pi ^b	99% Confidence Interval	Preference ^c
NE (0°-89°)	29.0	158	32.2	.29	$.369 \leq P_i \leq .275$	0
SE (90°-179°)	21.0	119	24.2	.21	$.285 \leq P_i \leq .199$	0
SW (180°-269°)	25.0	109	22.2	.25	$.264 \leq P_i \leq .180$	0
NW (270°-359°)	25.0	105	21.4	.25	$.255 \leq P_i \leq .173$	0

^aBased on percentage of total locations on slopes with some directional orientation (N=491).

^bTheoretical proportion of occurrence (Neu et al. 1974).

^c0 = used in proportion to the availability of the cover type on the area.

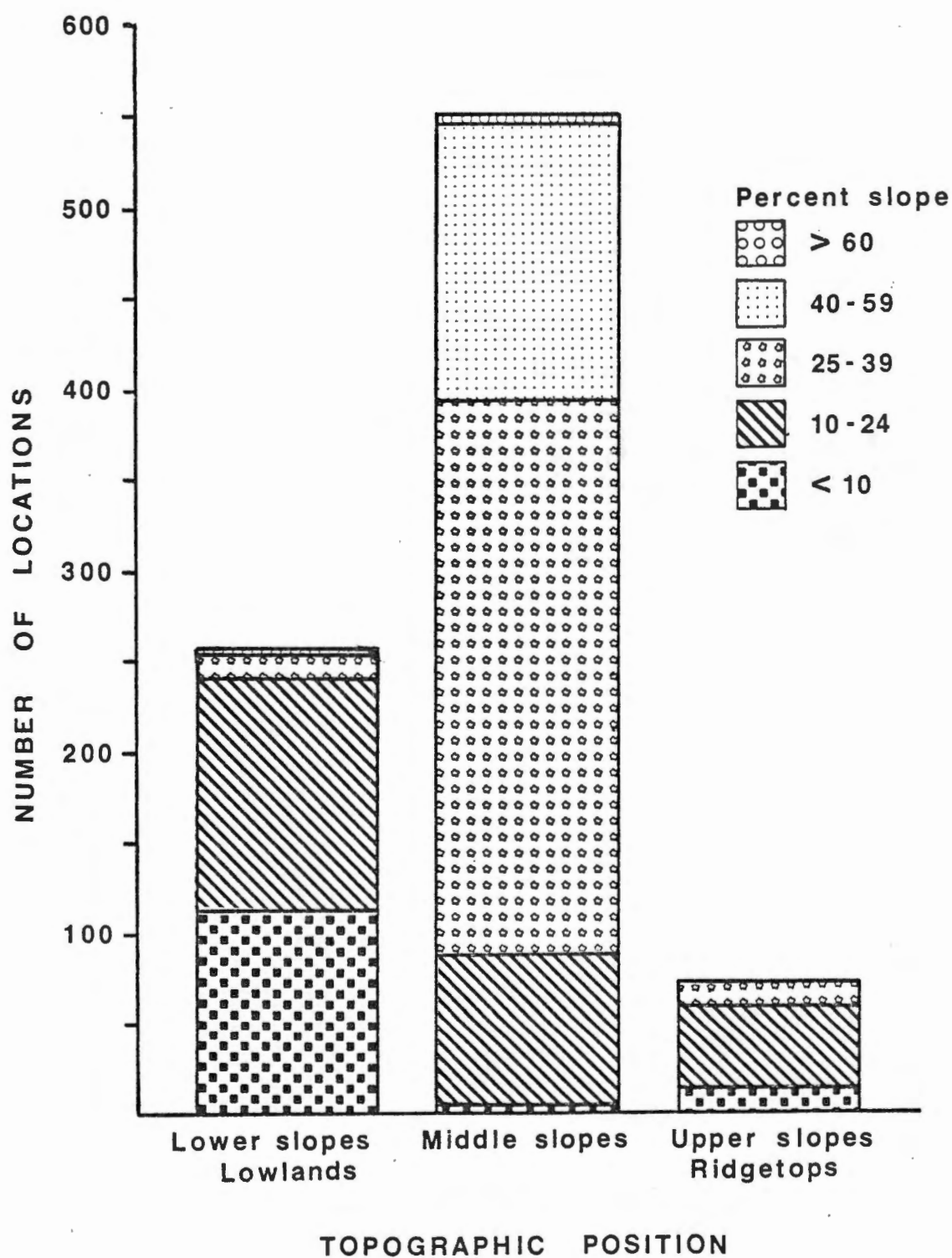


Figure 10. Frequency distribution of grouse locations with respect to topographic position and slope angle (N=871).

CHAPTER IV

SUMMARY AND CONCLUSIONS

Behavior of the introduced birds was similar to grouse in other reintroductions. Transmitted birds showed a strong affinity to the release site. Maximum dispersal was 4.0 km, while the majority remained within 2.0 km of the release site. Home range size was highly variable ranging from 18.0 to 176.0 ha.

The structural quality of the habitat associated with the release site appeared to influence dispersal, home range, and daily movement characteristics. In 1981, 2 of the birds released on Pilot Knob Ridge initially occupied large home ranges and had long daily movements while mainly utilizing upland oaks. Later they dispersed northward to areas of hardwood saplings frequented by other grouse in the Bethel Area. There they relocated into much smaller home ranges and greatly shortened their daily movements. This secondary dispersal may have reflected poor habitat quality in their initial home range, which afforded decreasing protection as leaf fall progressed. In 1982 all birds were released in the Bethel Area: both the home ranges and dispersal movements of the radio-equipped birds were markedly reduced. Thus, birds released in 1981 served as indicators of habitat quality through their movements and selection of cover types.

Hardwood saplings was the most utilized cover type. Seven of the birds used hardwood saplings as a primary cover type, while

the 2 birds which occupied multiple home ranges principally used hardwood saplings once they dispersed from their initial home ranges. None used farkleberry-laurel thickets significantly, in contrast to those in the first NBFSHA attempt. There are 2 apparent reasons for this. First, areas classified by White (1978) as open land or slashings have now grown into dense stands of hardwood saplings (about 9-12 years old), providing a greater extent of excellent habitat previously not available or as attractive. Second, grouse seem to select the densest cover immediately available to them after their initial dispersal from the release site. White released his grouse very close to farkleberry-laurel thickets whereas most of our grouse were released near hardwood saplings and far from laurel thickets.

Survival of the transmitted birds was low (84% mortality). Transmitter weight and design probably contributed to a significant number of deaths, particularly those occurring shortly after release.

Though survival of transmitted birds was low, survival of non-transmitted birds appeared to be substantial. Non-transmitted birds were observed frequently during the 1982 fall field season. Observation of an unbanded grouse, and consistent use of at least one drumming activity center and periodic observations of grouse in different areas for 3 years strongly indicate that reproduction has occurred, or at the very least that survival of non-transmitted birds has been good. The excellent winter

cover provided by hardwood sapling regrowth during this latest restoration attempt probably contributed significantly to the over-winter survival of the grouse.

As grouse are still present on the study area almost 3 years after the first stocking of this second restoration attempt on NBFSHA, strong consideration should be given towards releasing more birds. This may help prevent this restoration attempt from becoming a "straggling failure" as has happened with other re-introductions where only a few releases of small numbers of birds were made. Locally trapped birds should be obtained if possible to provide a genetic stock best suited to the region.

Gullion (1977) observed that lack of proper degree of forest disturbance poses the most serious threat to the continued abundance of grouse over some 73 million acres of forest land in the north-eastern United States. Though southern forests lack aspen, considered essential to the prosperity of northern grouse, the structural requirement of southern grouse is similar to that of northern grouse (Gullion, in press). Dense stands of saplings 10-25 years old are critical to support breeding grouse over winter. Increasing the quantity of clear-cutting may be a key to restoring ruffed grouse to the Western Highland Rim. In this region, mature forest is abundant, but young forested areas are limited. Sites to be favored for future restoration attempts should be tracts, whether public or private, where management practices are scheduled to provide this critical regrowth.

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APPENDIX

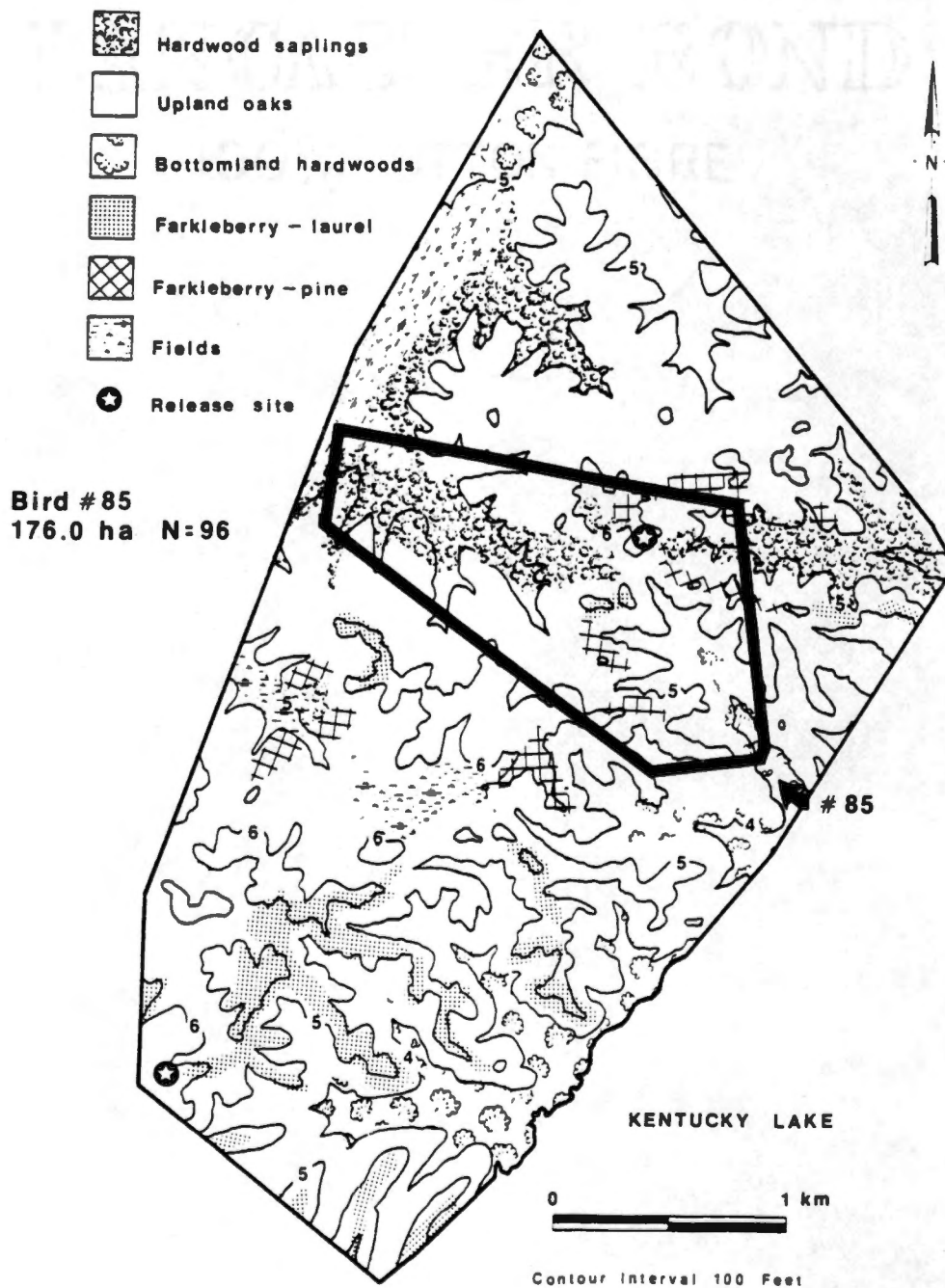


Figure 11. Convex home range for Bird #85. N = number of locations.

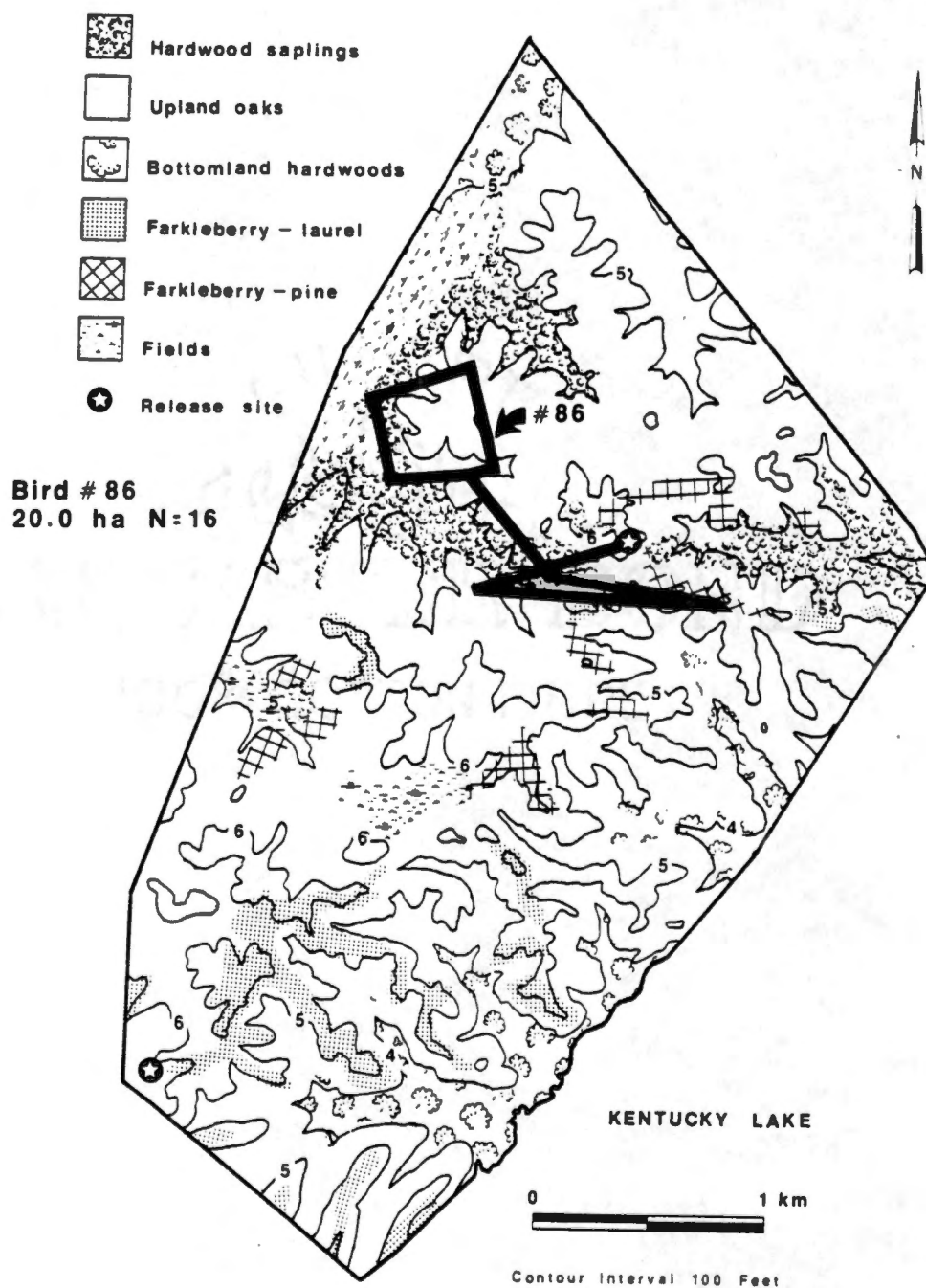


Figure 12. Convex home range for Bird #86.

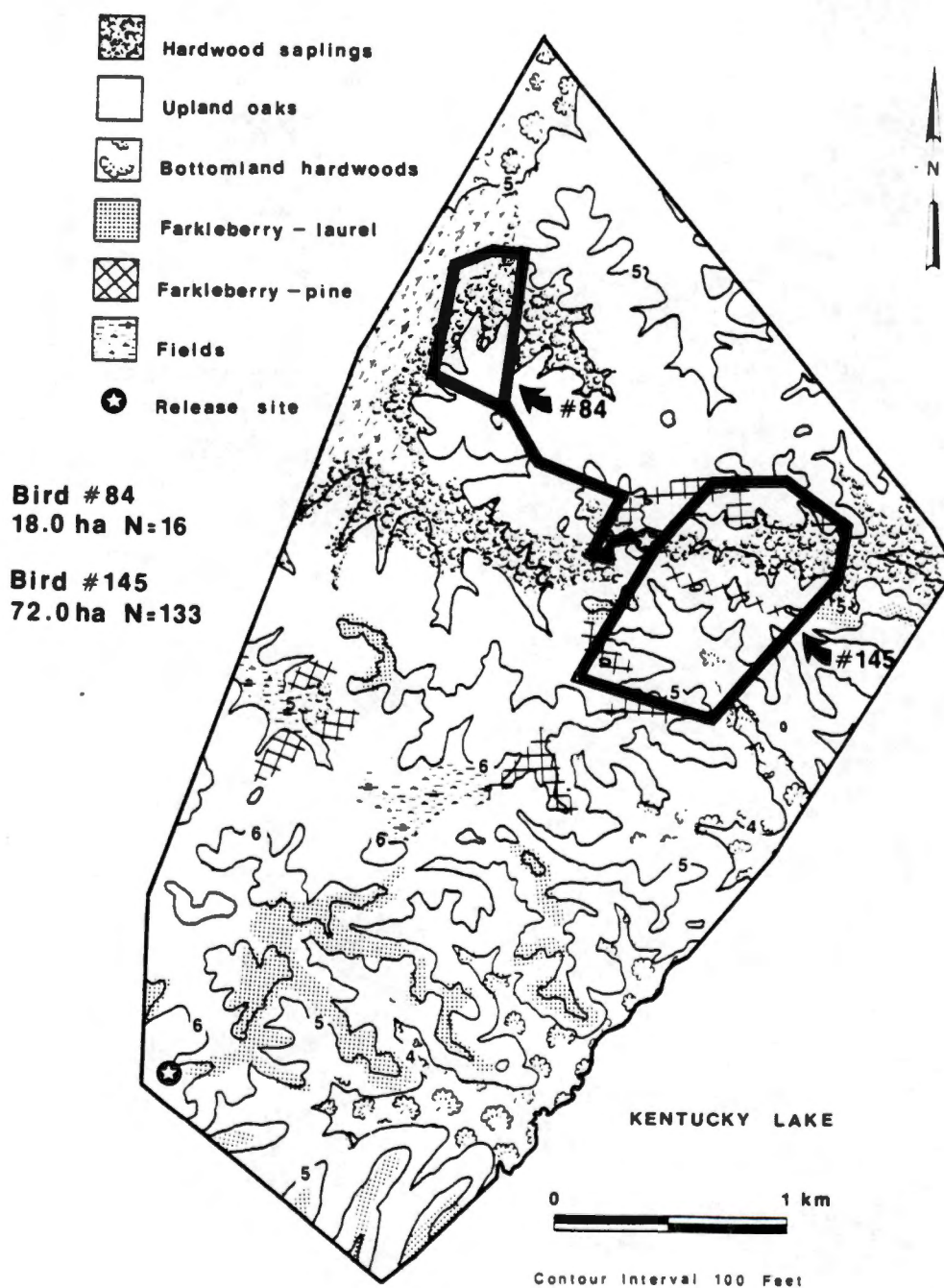


Figure 13. Convex home ranges for Bird #84 and Bird #145.

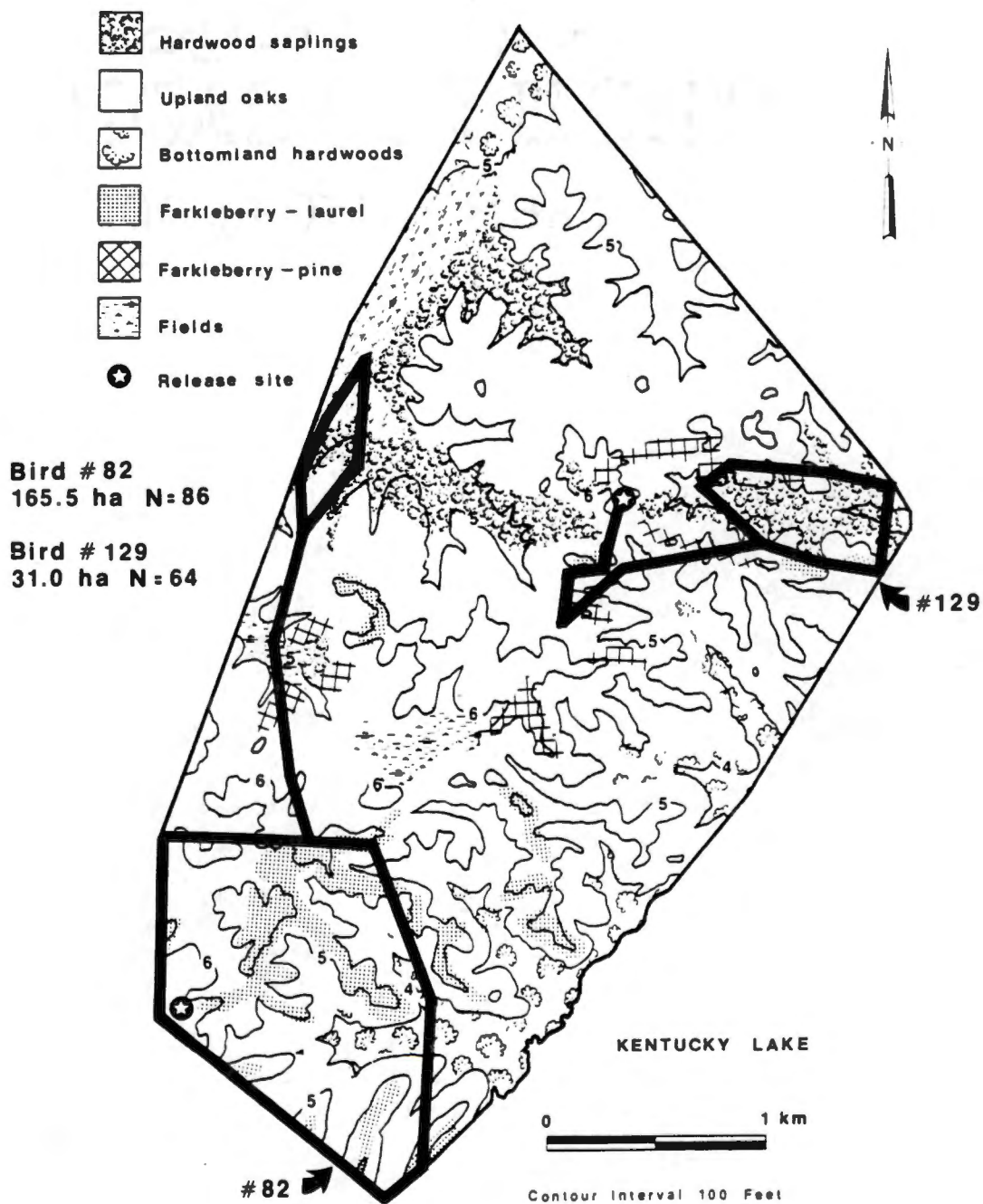


Figure 14. Convex home ranges for Bird #82 and Bird #129.

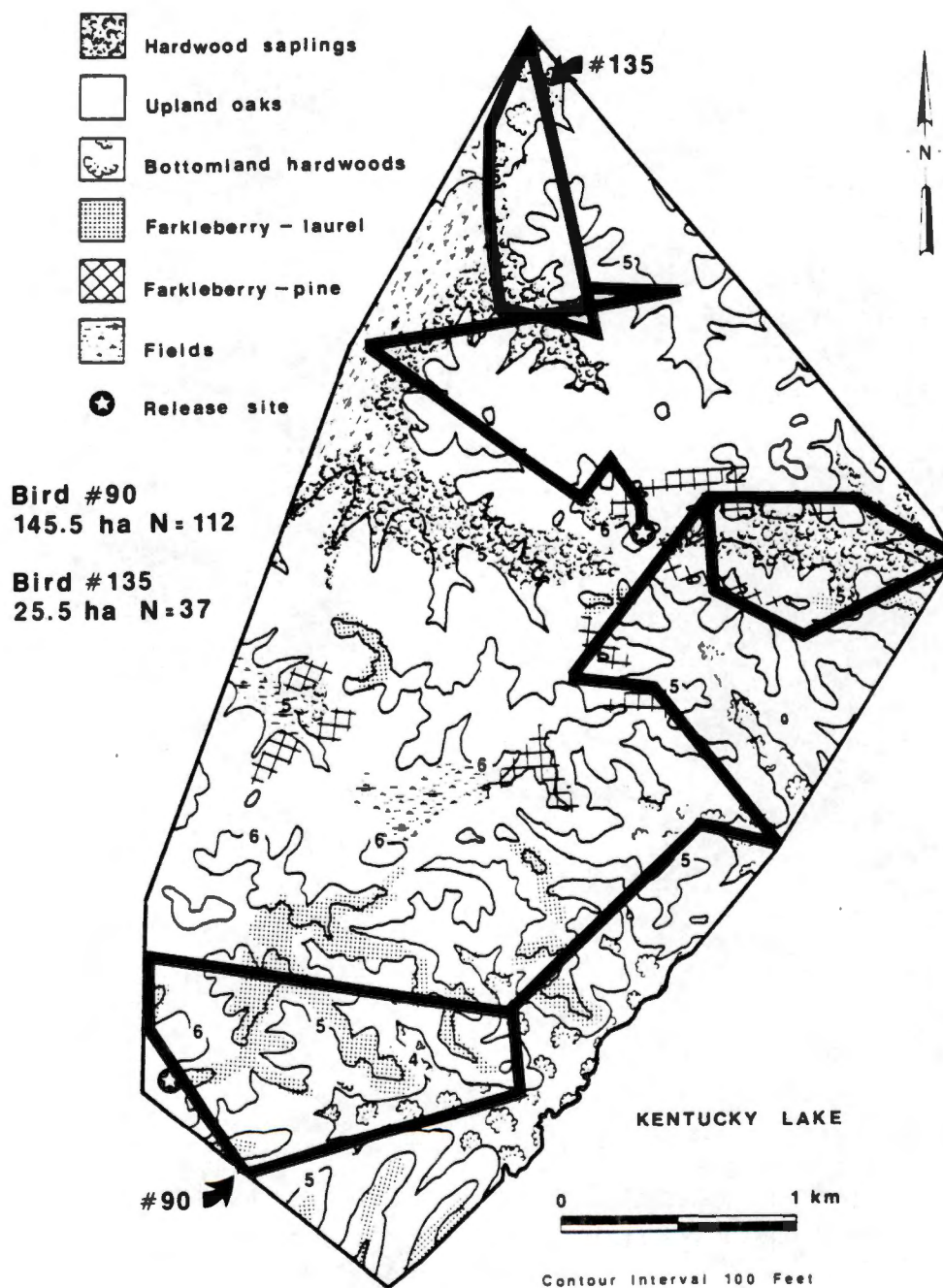


Figure 15. Convex home ranges for Bird #90 and Bird #135.

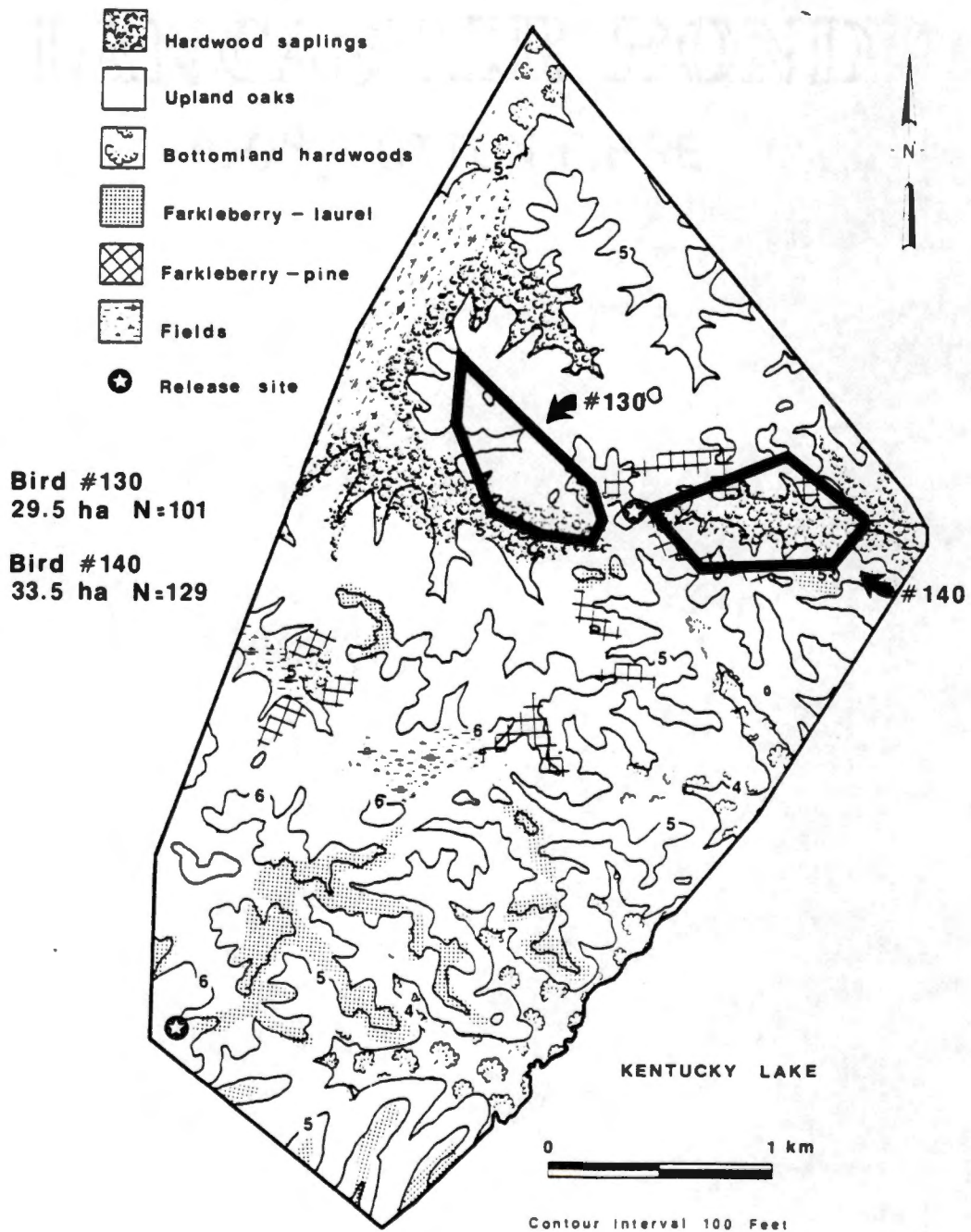


Figure 16. Convex home ranges for Bird #130 and Bird #140.

VITA

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