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Appreciation is expressed to Mr. Charles Beekendorf Fredericksburg, Texas for permission to reproduce several of his wild turkey drawings.

FOREWORD

Immediately following the Second National Wild Turkey Symposium in Columbia, Missouri, the Texas Chapter of the Wildlife Society solicited from the parent society the privilege of sponsoring the Third National Wild Turkey Symposium in 1975. As soon as the approval of this proposal was given, a Chapter Steering Committee and a Program Committee were selected, the latter including turkey workers from seven different states. The Chapter also secured agreement from the Texas Parks and Wildlife Department to act as co-sponsor of the Symposium.

The program developed included at least four intriguing facets to which emphasis was accorded. An entire session was devoted to papers on turkey poults -- their preferred habitat; their food habits; and their changes with age, behavior, and survival. Consideration of economics, aesthetics of turkey hunting, and hunting ethics sounded a strong new note in another session. Finally, approximately 130 individuals participated in an all day field tour through territory which looked like anything but turkey habitat to most of the visitors. This pointed up more emphatically the amazing special adaptabilities which permit various subspecies of wild turkeys to survive in a diversity of habitats.

Author response indicated the definite possibility of scheduling wild turkey symposia at five-year intervals, if early planning and adequate publicity are provided by sponsors. Such time intervals normally permit the completion of enough valid research and testing of new management efforts to round out an excellent program. Finally, the early selection of a qualified editor, and dissemination of clear editorial guidelines, together with serious editing of some papers in advance, helps to improve quality of manuscripts, and reduces the time lag in publication of the PROCEEDINGS. In this connection we owe generous thanks to Lowell K. Halls, Editor of the 1975 PROCEEDINGS, and to his secretary, La Wanda Forsythe.

W. C. Glazener, Chairman
Program Committee

ACKNOWLEDGEMENT

The Texas Chapter of The Wildlife Society gratefully acknowledges numerous individuals, institutions, organizations, and agencies for making the Third National Wild Turkey Symposium a successful and informative meeting. Thanks are extended to the Texas Parks and Wildlife Department for its assistance as co-sponsor. Appreciation is expressed to authors and co-authors from 16 states for their manuscripts, and to Chairmen of the eight program sessions.

Members of the National Program Committee who generously gave of their time and efforts are: W. C. Glazener, Chairman, Welder Wildlife Foundation; R. Wayne Bailey, Wildlife Biologist, North Carolina Wildlife Resources Commission; George A. Gehrken, Recreation Coordinator, Union Camp Corporation; Horace G. Gore, State Wide Projects, Texas Parks and Wildlife Department; Lowell K. Halls, Project Leader, Southern Forest Experiment Station; William H. Kiel. Wildlife Biologist, King Ranch, Inc .; John B. Lewis, Research Biologist, Missouri Department of Conservation; Tom H. Logan, Field Representative, National Audubon Society; Lovett E. Williams, Jr., Wildlife Research, Florida Game and Freshwater Fish Commission; Gerald A. Wunz, Wildlife Biologist, Pennsylvania Game Commission.

Arrangements Committee members who helped make the meeting more enjoyable are: Charles W. Ramsey, Texas Agricultural Extension Service; Robert L. Cook, Texas Parks and Wildlife Department; Horace G. Gore, Texas Parks and Wildlife Department; Charles A. Segelquist, U. S. Forest Service; John O'Dowd, Texas Parks and Wildlife Department; William H. Kiel, King Ranch, Inc

Especially appreciated were the courtesies extended by Mrs. Helena K. Evans, who introduced the wives of attendants to historic sites in San Antonio.

The following organizations and persons deserve special thanks for their contributions to the printing of the PROCEEDINGS:

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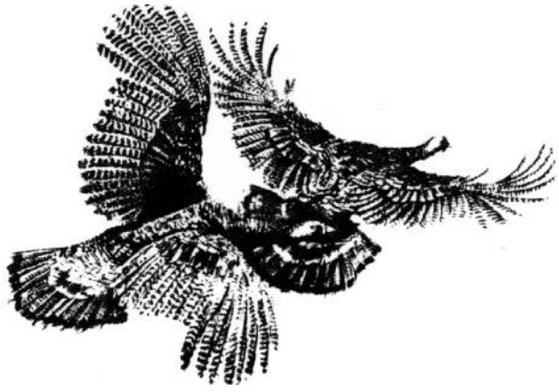

WILD TURKEY MANAGEMENT IN CALIFORNIA

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Abstract: Wild turkey management in California consists of releasing wild-trapped turkeys and conducting a fall and spring turkey hunting season. Three varieties of turkeys, totaling 1,287, have been released. The estimated population in 1973 was 2,310 Rio Grande turkeys (*Meleagris gallopavo intermedia*), 5,990 California hybrid turkeys, and 650 Merriam's turkeys (*M.g. merriami).* The annual turkey harvest has increased from 29 in 1968 to approximately 2,000 in 1973. The 1974-75 fall and spring seasons will be 46 days with a bag limit of four turkeys. Thirty-five counties will be open for the spring hunt.

Key words: *Meleagris gallopavo gallopavo, M. g. merriami, M. g. intermedia,* California hybrid turkey

Mexican turkeys (M*eleagris gallopavo gallopavo*) were first introduced into California on Santa Cruz Island in 1877. From then until 1951, 3,350 game farm turkeys were released (Burger 1954). The turkey program was inactive from 1951 to 1959. In 1959, 62 wild-trapped Rio Grande turkeys were flown from Texas and released in San Diego County. This plant was successful with good reproduction occurring the first spring after stocking. Following this plant, wild-trapped turkeys of the Merriam's, Rio Grande, and California hybrid (Mexican x Merriam's x domestic) varieties were released in potential turkey range throughout the state (Harper and Smith 1973).

Turkey management in California currently consists of releasing wild-trapped turkeys of various races in suitable habitat and holding fall and spring turkey hunts to take surplus turkeys.

Harold T. Harper, California Department of Fish and Game, provided assistance and leadership in obtaining information for this paper. The information on the turkey releases was extracted from the Job Final Report VI-3, a contribution of Federal Aid to Wildlife Restoration, Project W-47-R-22.

TURKEY RELEASES

Rio Grande Turkeys

By 1965, the turkey population in San Diego County was 200. The initial introduction of Rio Grande turkeys was encouraging enough to start the California Department of Fish and Game's exchange program with the Texas Parks and Wildlife Department. By 1967 trades were arranged whereby California sent wild-trapped ring-necked pheasants, chukars, and mountain quail to Texas in exchange for wild-trapped turkeys. Under this program, 540

turkeys have been received from Texas. An additional 69 turkeys were trapped from established flocks in California and released into adjacent habitat. Rio Grande turkeys have been released into 33 different areas (Fig. 1). Sustaining populations have been established from 76 percent of these releases. Only 12 percent are considered to be unsuccessful, and another 12 percent are unclassified because enough time has not elapsed since they were released.

The occupied range of the Rio Grande turkey in California covers. 1,380,800 hectares (ha) in 18 counties (Fig. 2). They are found from sea level on the valley floor to about 500 meters (m) in the northern Sacramento Valley and 750 to 1,000 m in San Diego County. In the northern part of their range, the average rainfall approaches or exceeds 150 centimeters (cm) annually at the higher elevations. Most of the rain falls from November through March.

Population estimates on a statewide basis are considered, conservative. The most recent (July 1973) estimate was 2,310 turkeys (Table 1).

California Hybrid Turkeys

California hybrid turkeys evolved as a separate race from birds raised in State game farms from 1900 to 1950 when 3,350 birds were released in 23 counties. From these game farm turkeys, three populations were established in Sonoma County, Santa Clara County, and the largest and most successful in San Luis Obispo County.

In 1961 the Department began trapping and transplanting turkeys from San Luis Obispo County. Since then, 591 California hybrid turkeys have been released into new areas (Fig. 3). Of the 30 releases, 53 percent have been successful, 16 percent unsuccessful, and 31 percent are unclassified.

Wild-trapped California hybrid turkey populations have been established in 20 counties with an estimated population of 5,990 (Table 1). They are found in the Coast Range at elevations ranging from 200 to 2,000 m and between 800 and 1,600 m in the Sierra Nevada Mountains (Fig. 2). The total number of ha occupied by this race in California is 654,900.

It appears that this species has decreased since 1969, but whether the decrease is real or imaginary is unknown. It could be a reflection of refinement of original estimates.

Merriam's Turkeys

Wild-trapped Merriam's turkeys have been stocked in five areas in California (Fig. 3), and four sustaining populations have been established. In addition, Merriam's turkeys have become established in Alpine County as a result of stocking by the Nevada Fish and Wildlife Department with birds wild-trapped in Arizona.

Merriam's turkeys are usually in small groups (less than 10 birds) and are found in areas that are remote and closed by winter storms. People do not get into these areas to observe birds in winter flocks.

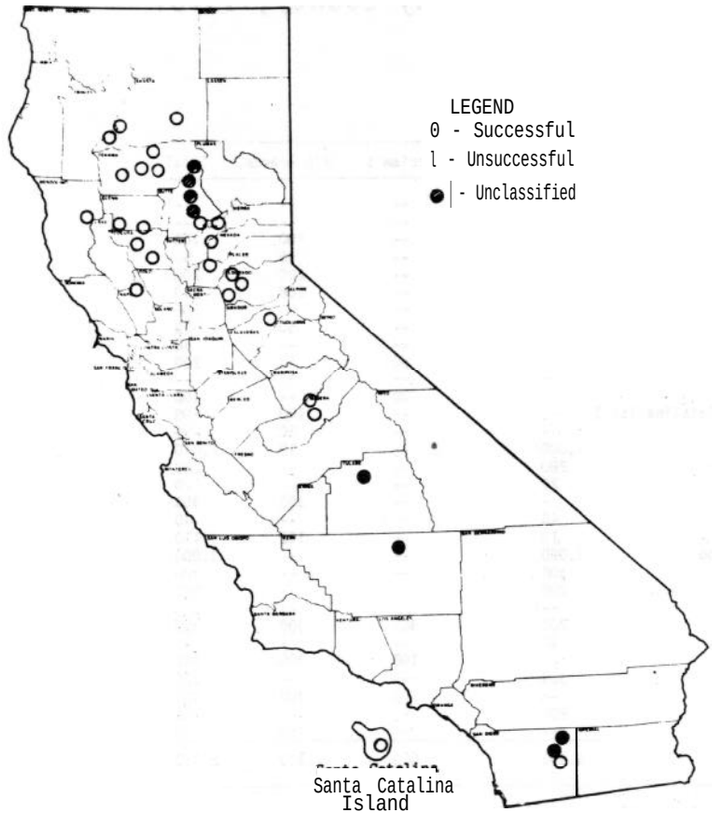

Figure 1. Release sites for Rio Grande turkeys.

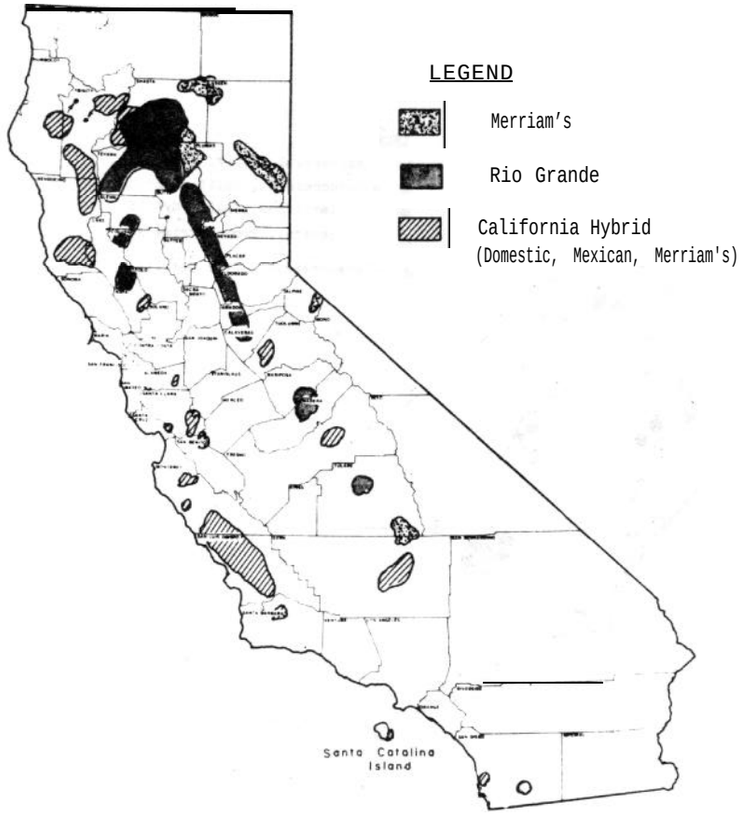

Figure 2. Established populations of wild turkeys, 1974.

Table 1. Estimated turkey populations by county, 1973.

County	California Hybrid	Merriam's	Rio Grande	Total
Alameda	--[1]	--	--	--[1]
Amador	--	--	--[1]	--[1]
Butte	--	--	100	100
Calaveras	--	--	50	50
Colusa	--	--	200	200
El Dorado	--	--	200	200
Fresno	200	--	--	200
Glenn	50	--	50	100
Humboldt	50	--	--	50
Kern	100	50	50	200
Lake	--	--	--[1]	--[1]
Lassen	--	100	--	100
Los Angeles (Catalina Isl.)	--	--	100	100
Madera	--	--	50	50
Mendocino	1,000[2]	--	10	1,010
Monterey	280	--	--	280
Napa	20	--	--	20
Nevada	--	--	350	350
San Benito	40	--	--	40
San Diego	10	--	100	110
San Luis Obispo	3,000	--	--	3,000
Santa Barbara	300	--	--	300
Santa Clara	200	--	--	200
Santa Cruz	--[1]	--	--	--[1]
Shasta	200	300	300	800
Sonoma	40	--	--	40
Tehama	--	100	300	400
Trinity	300	--	--	300
Tulare	--	100	300[3]	400
Tuolumne	200	--	--	200
Yuba	--	--	150	150
Total	5,990	650	2.310	8,950

[1]No population estimates available.
[2]Includes 775 birds from private release - source unknown.
[3]Private release.

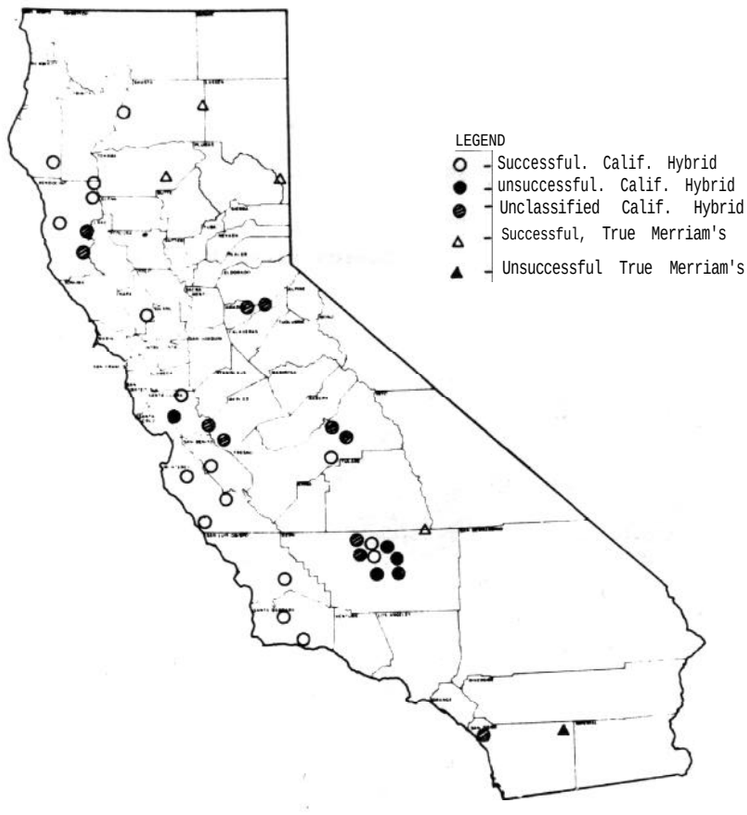

Figure 3. Release sites for California hybrid and Merriam's wild turkeys.

The estimated population for Merriam's turkeys is 650 (Table 1). This population appears to be stable, although annual fluctuations occur in each flock. Their occupied range encompasses 734,800 ha.

HUNTING SEASON

Since the first one-day season in San Luis Obispo County in 1968, 34 additional counties have been added to the open season. The 1974 fall season will run for 23 days with a bag limit of two birds, either sex, per season. The 1975 spring season will run for 23 days with a bag limit of one bearded turkey per day with a seasonal limit of two.

Turkey hunting is becoming more popular as additional areas are opened. It is estimated that 5,000 to 7,000 hunters will harvest approximately 2,000 turkeys with the present seasons and bag limits.

DISCUSSION AND RECOMMENDATIONS

Turkeys have been established in each county that has potential turkey habitat in California, but there is still unoccupied habitat adjacent to established flocks. By trapping turkeys from these flocks and moving them to adjacent areas, the establishment of new flocks can be accelerated.

A reliable census method is needed to help monitor turkey populations. Present populations are rough estimates based on reported sightings projected over large areas. At best, they reflect general trends.

The present hunting program should continue. There is no evidence of overharvest in any area in the state, and the present season and bag limits should be maintained and evaluated.

As a management practice, areas should be opened to hunting three to five years after a sustaining population has been established. This helps to remove the surplus turkeys and promotes expansion of turkeys into previously unoccupied range. Hunting also keeps the turkeys in a wild state and helps to prevent domestication.

Turkey hunting is a popular sport that contributes directly toward the goals of wild turkey management in California.

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HABITAT USE BY MERRIAM'S TURKEY IN SOUTHWESTERN UTAH

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Abstract: In southwestern Utah Merriam's wild turkeys *(Meleagris gallopavo merriami*) used a mountain brush with scattered ponderosa pine during fall, winter, and early spring. Late spring use was associated with ponderosa pine and aspen-mixed conifer ecotones. In summer, broods preferred glades dominated by aspen with intermingling mixed conifer, while a male flock used cut-over mixed conifer clearings.

Key words: *Meleagris gallopavo merriami, Pinus ponderosa, Populus tremuloides,* seasonal habitat use

Merriam's turkey is not considered endemic to Utah (Mosby 1973, Schorger 1966), although archaeological evidence indicates Indians of southern counties may have had domestic turkeys. Attempts to establish wild turkey date back to 1925 when 15 wild toms and 50 domestic hens were released on Antelope Island in the Great Salt Lake. This and several subsequent releases of game farm stock prior to 1950 experienced varying degrees of temporary success, but resulted in ultimate failure (Popoy and Low 1950).

The present distribution resulted from a series of transplants of wild-trapped Merriam's turkeys from Colorado and Arizona, beginning in 1952. Since then, populations have increased through natural reproduction and additional transplants. It appears that habitat, and consequently, turkey populations are somewhat spotty over most of the Utah range.

Wild turkeys presently are established in six southern Utah localities (Fig. 1). Their distribution closely coincides with the distribution of ponderosa pine (*Pinus ponderosa* Laws) as described by Johnson (1970). Ponderosa pine covers a significant portion of Merriam's turkey range (McDonald and Jantzen 1967), and was used as an indicator of suitable habitat when turkeys were introduced into Nebraska, Montana, Wyoming, and other western states (Menzel and Hurt 1973, Mosby 1973).

Legal hunting began in 1963 and, with but few interruptions, has continued in all areas where there are established populations (Table 1). Hunting pressure has been low usually from 200 to 400 hunters afield. Hunter success has been relatively good, averaging 25 percent for fall hunts and 12 percent for spring.

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Table 1. A summary of wild turkey transplants in Utah, 1952-73.

County	Release Site	Year	Source	Turkeys Released			Results	Hunting Seasons
				Hens	Toms	Total		
Grand	LaSal Mountains	1952	Colorado	10	6	16	Population established	1963-73
Kane	East Zion Area	1957-60	Arizona	23	10	33	Population established	1963-73
Garfield	Boulder Mountains	1958	Colorado	6	9	15	Population established	1963-73
Beaver	Tushar Mountains	1968	Utah	19	5	24	Marginal population	1970-73
Washington	Pine Valley Mountains	1962-63	Utah	7	6	13	Failed	--
		1968	Utah	6	1	7	Population established	1970-73
	Enterprise Reservoir	1972-73	Utah	8	4	12	Uncertain	--
San Juan	Blue Mountain	1957	Colorado	12	3	15	Failed	--
		1970-72	Utah	14	6	20	Apparently established	--
	Elk Ridge	1959	Colorado	6	4	10	Failed	--
		1969-72	Utah	6	3	9	Marginal success	--
Sevier	Old Woman Mountain	1960-62	Utah	15	7	22	Failed	--
Daggett	Dowd Mountain	1962-64	Utah	10	7	17	Failed	--
TOTALS				142	71	213		

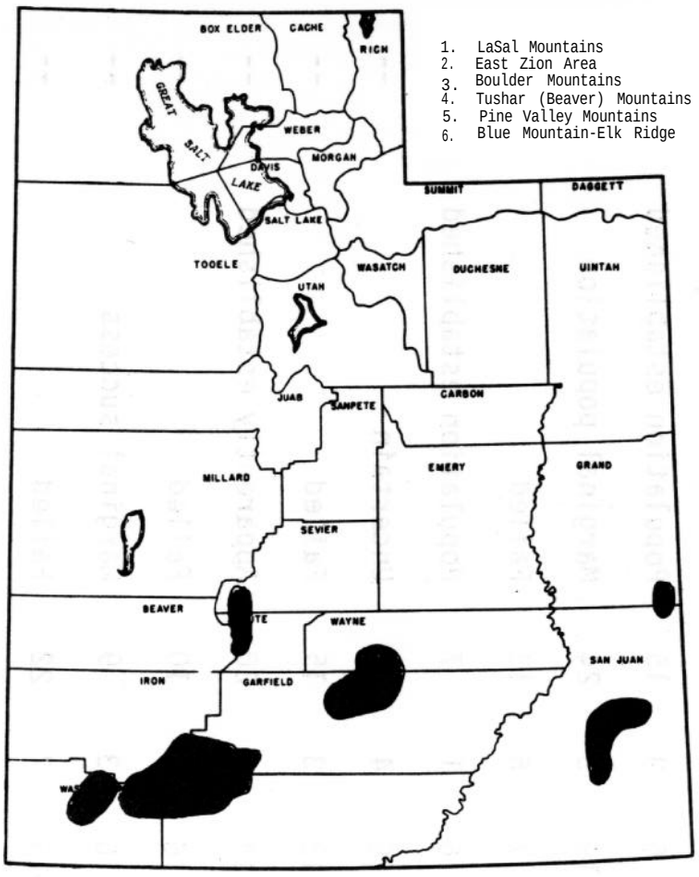

Figure 1. Approximate distribution of Merriam's turkey in Utah.

Prior to the initiation of this project in March 1972, ecological studies on wild turkeys had not been attempted in Utah, and there was no published information on the status of this game bird. Furthermore, there was little information available to game managers for evaluating future Utah transplant sites. Consequently, the study was undertaken to compile life history data and to determine habitat utilization. This paper summarizes research conducted from March 1972 through August 1973.

STUDY AREA DESCRIPTION

The study area, located in part of the East Zion Area (Fig. 1), included 83,360 hectares (ha) of rugged terrain east and north of Zion National Park. The elevation is between 1,829 and 3,049 meters (m). Average annual precipitation is 36 centimeters (cm).

The five major habitat types were: mountain brush, 36,556 ha; pinyon-juniper, 16,231 ha; mixed conifer (spruce-fir), 14,117 ha; aspen, 5,317 ha; and ponderosa pine, 4,992 ha. Minor types totaling 6,147 ha were included with the associated major types. Turkeys were not observed in the pinyon-juniper type, thus only four broad vegetative communities are discussed.

The composition and abundance of vegetation surrounding a turkey observation site were reported by Bryant (1974). Free-flowing water was available in all seasons on or near each habitat type.

The mountain brush type consisted primarily of Gambel oak *(Quercus gambelii* Nutt.), wild rose (*Rosa woodsii* Lindl.), serviceberry *(Amelanc*hier *utahensis* Koehne), pinyon pine (P*inus edulis* Engelm.), juniper *(Juniperus* spp.) and ponderosa pine. This type dominated elevations between 1,829 and 2,286m. Species composition varied with exposure, topography, and elevation, but scattered ponderosa pines were always conspicuous.

Habitats dominated by ponderosa pine were located between 2,286 and 2,591 m. The relative abundance of spruce *(Picea* spp.), fir *(Abies* spp.), and aspen *(Populus tremuloides* Michx.) depended primarily upon the northerly exposure of steep (10-20°) slopes. Important shrubs were snowberry (*Symphoricarpos oreophilus* A. Gray) and currant *(Ribes* spp.).

The aspen type was usually intermingled with mixed-conifers (including ponderosa pine) on steep slopes and ridges, but also occurred in large (500 ha) monotypic stands. The elevation ranged from 2,134 to 2,743 m. Of the types described, aspen glades were the most productive of grasses and forbs (Coles and Pedersen 1969). Shrubs were similar to those of the ponderosa pine type.

The dense, mixed conifer type was mostly above 2,591 m, except on north-facing slopes where it occurred at 2,134-2,591 m. Dominant overstory species were blue spruce (*P. pungens* Engelm.) and Engelmann spruce *(P. engelmanni* Parry), white fir (*A. concolor* Lindl.) and subalpine fir *(A. lasiocarpa* Nutt.), with a scattering of Douglas fir (*Pseudotsuga menziesii* Franco) and ponderosa pine at lower elevations. This type had very little herbaceous or shrubby understory vegetation.

METHODS

The entire study area was mapped as to habitat type. U. S. Forest Service Range Surveys of Grazing Allotments were used for portions within the Dixie National Forest. Habitat types on private, state, and BLM lands were delineated following the Utah Big Game Range Inventories (Coles and Pederson 1969).

The study area was searched thoroughly for turkeys and turkey signs as conditions and terrain dictated. Summer transects were established and surveyed in direct proportion to the availability of the four major habitat types. During fall, winter, and spring the area was systematically traversed using the most appropriate modes of travel (i.e. walking, horseback, snowmobiles, 4-wheel drive).

Observations of turkeys and signs were plotted on an overlay of the habitat type map to provide information on seasonal turkey distribution and habitat use. Percent utilization was computed as the number of observations recorded on each habitat type relative to the total recorded for all types.

A preference index (P.I.) for each habitat type was calculated for each month. The index was a ratio of percent use:percent availability. A P.I. of one was interpreted as use in proportion to availability. A ratio less or greater than one indicated turkeys were either avoiding or favoring the habitat type. Turkeys probably were more readily observed in open habitat types such as aspen glades, thus preference indexes for such types were biased accordingly.

To realistically assess a P.I. during winter months, we adjusted the index with respect to availability of habitat types. Turkeys were not observed at elevations higher than 2,286 m from December to March, probably due to increased snow depths. Therefore, habitat types above this elevation were arbitrarily omitted when winter habitat availability was computed.

RESULTS AND DISCUSSION

Winter (January-March)

Turkeys used the mountain brush complex, with scattered ponderosa pine, exclusively during winter (Fig. 2). Because the other types were at higher elevations where snow was deeper, mountain brush probably was the only available type which could satisfy the turkeys' daily needs. Observations were based on one severe winter, whereas milder winters usually prevail. Thus, turkeys likely use more of the ponderosa pine type than indicated by this study.

The mountain brush type contained scattered pinyon pine and juniper and these species were present at turkey observation sites (Bryant 1974). However, the pinyon-juniper community was below 1,829 m and devoid of any turkey observations. Non-use of this type by turkeys was attributed to a lack of suitable food and to a lack of suitable roost trees. All winter roosts located on the study area were over-mature ponderosa pine.

Chapparral browse and pinyon-juniper usually are found on the historic range of Merriam's turkey (MacDonald and Jantzen 1967). A mountain shrub type also was included in a Colorado study area (Hoffman 1968). The winter habitat used by Utah turkeys closely resembles winter habitats described for Arizona (Scott and Boeker 1973).

Spring (April -June)

Almost half of the spring observations occurred on the mountain brush type (Fig. 2). The P.I. for this type declined from April to June, while that for ponderosa pine and aspen increased (Fig. 3). Ponderosa pine was preferred during May, whereas aspen was preferred in June. These trends suggest that the mountain brush-ponderosa pine or mountain brush-aspen ecotones may represent nesting habitat. Other authors have reported similar selections of nesting habitat (Hoffman 1962, Knopp 1959, Ligon 1946). Hens nesting in ecotones close by aspen glades or ponderosa pine clearings have food sources readily available for young poults.

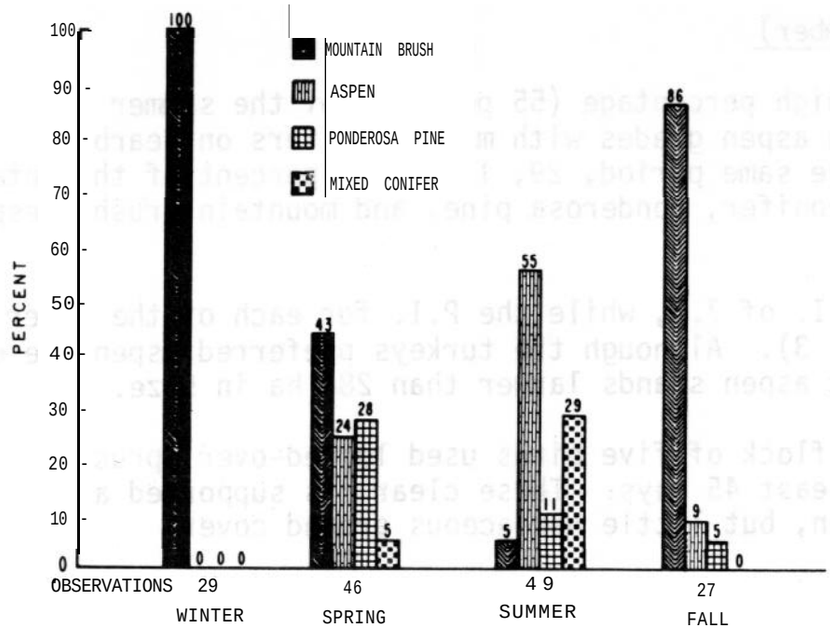

Figure 2. Seasonal turkey use of four habitat types.

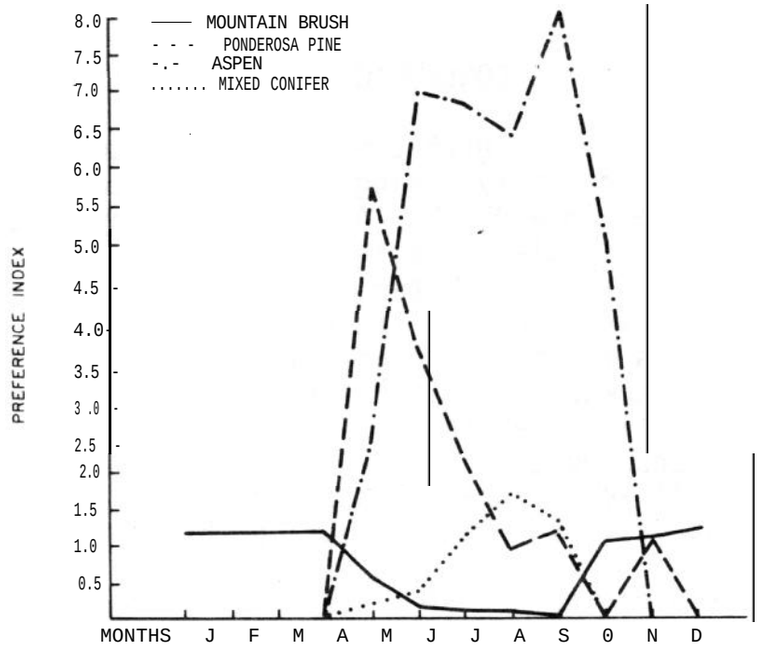

Figure 3. Monthly preference indices (percent use/percent availability) of four habitat types.

Summer (July-September)

A relatively high percentage (55 percent) of the summer brood observations occurred on aspen glades with mixed conifers on nearby slopes and ridge tops. For the same period, 29, 11, and 5 percent of the total use occurred in mixed conifer, ponderosa pine, and mountain brush, respectively (Fig. 2).

Aspen had a P.I. of 7.1, while the P.I. for each of the other types was less than 1.5 (Fig. 3). Although the turkeys preferred aspen, we observed none using monotypic aspen stands larger than 280 ha in size.

An adult male flock of five birds used logged-over spruce-fir clearings at 3,048 m for at least 45 days. These clearings supported a dense regrowth of currant and aspen, but little herbaceous ground cover.

Colorado and Arizona turkeys also have been noted to use mixed conifer types at higher elevations during summer (Hoffman 1968, MacDonald and Jantzen 1967, Scott and Boeker 1973). However, it has not been reported that broods consistently used aspen glades.

Fall (October-December)

During the fall, 86 percent of the turkey observations were on the mountain brush type (Fig. 2). The P.I. for this type increased from September to December (Fig. 3). A similar pattern of seasonal use in this type of vegetation had been reported for other areas (Hoffman 1973, Ligon 1946).

CONCLUSION

Wild turkeys in southwestern Utah preferred the mountain brush type during late fall, winter, and early spring, probably because of roost trees, available food, and minimal snow depth. A monotypic pinyon-juniper type contained practically no suitable roost trees, and deep snows covered food sources in habitats at elevations greater than 2,286 m. It is unlikely that food limited turkey use of pinyon-juniper, since turkeys use juniper berries as emergency foods (Scott and Boeker 1973). It appears that food in the mountain brush type was sufficient for turkeys, even in a severe winter. The bounds of optimum habitat during fall, winter, and early spring probably depended upon snow depth and the presence of over-mature ponderosa pine for roost trees. It seems apparent that ponderosa pine may, in fact, be an essential element of turkey habitat during this period.

In summer, the greatest number of turkey observations were on aspen glades broken by mixed conifers. These glades were a source of preferred foods (i.e. forbs, grasses, and insects), while nearby mixed conifers probably provided "edge" effect and escape cover.

The relatively little use of the ponderosa pine type during the summer is not readily explained, but probably is related to microclimatic conditions. Apparently the turkeys preferred the cooler and more moist conditions at higher elevations, which were dominated by mixed conifers and aspen and where ponderosa pine roost trees were not limited.

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STATUS OF WILD TURKEY RESTORATION IN EAST TEXAS

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Abstract: Wild turkey restoration efforts in east Texas began in the early 1940's. From then until the early 1950's pen-reared eastern wild turkeys (*Meleagris gallopavo silvestris*) were released in one county and wild-trapped Rio Grande turkeys (*M. g. intermedia)* in 27 counties. The wild-trapped birds generally increased for the first three to five years and then declined.

Wild turkeys from Georgia, South Carolina, and Florida *(M. g. osceola)* were stocked on five areas from 1959-74. Results were moderate to good on three areas, one was a failure, and one is inconclusive. Eight other areas were stocked with a combination of eastern gobblers and Rio Grande hens and with wild turkeys from two of the original release areas. Restoration efforts are handicapped by loss of suitable habitat.

Key words: *Meleagris gallopavo silvestris*, *M. g. intermedia, M. g. osceola*

In 1942, the native population of eastern wild turkeys in east Texas was probably less than 100 birds due to overhunting and destruction of ancestral habitat. Flocks were limited to five isolated colonies in Marion, Montgomery, Newton, Sabine, and San Augustine Counties (Texas Game, Fish and Oyster Commission 1945). The lands were owned primarily by large landowners and National Forests. Pine timber production was the primary use, cattle grazing was secondary.

Efforts to restore turkeys were first made with semi-wild eastern pen-reared turkeys in the early 1940's under the direction of C. C. Newman. These early releases soon disappeared. From the late 1940's through the early 1950's approximately 2,000 Rio Grande turkeys were released in 27 counties. These releases of 50 to 150 birds at each site generally increased for the first three to five years, and then declined rapidly. Birds lasted as much as 10 years on only two areas.

From 1959 through 1974, five areas were stocked with 99 eastern wild turkeys from Florida, Georgia, and South Carolina. In addition, eight areas were stocked with a combination of 263 eastern and Rio Grande turkeys (Table 1 and Fig. 1). The restoration efforts were conducted under Federal Aid Project W-27-D. Pen-reared birds released by private landowners and hunting clubs are not included in this report.

The principle woody plant species found in the restoration areas are listed in Table 2.

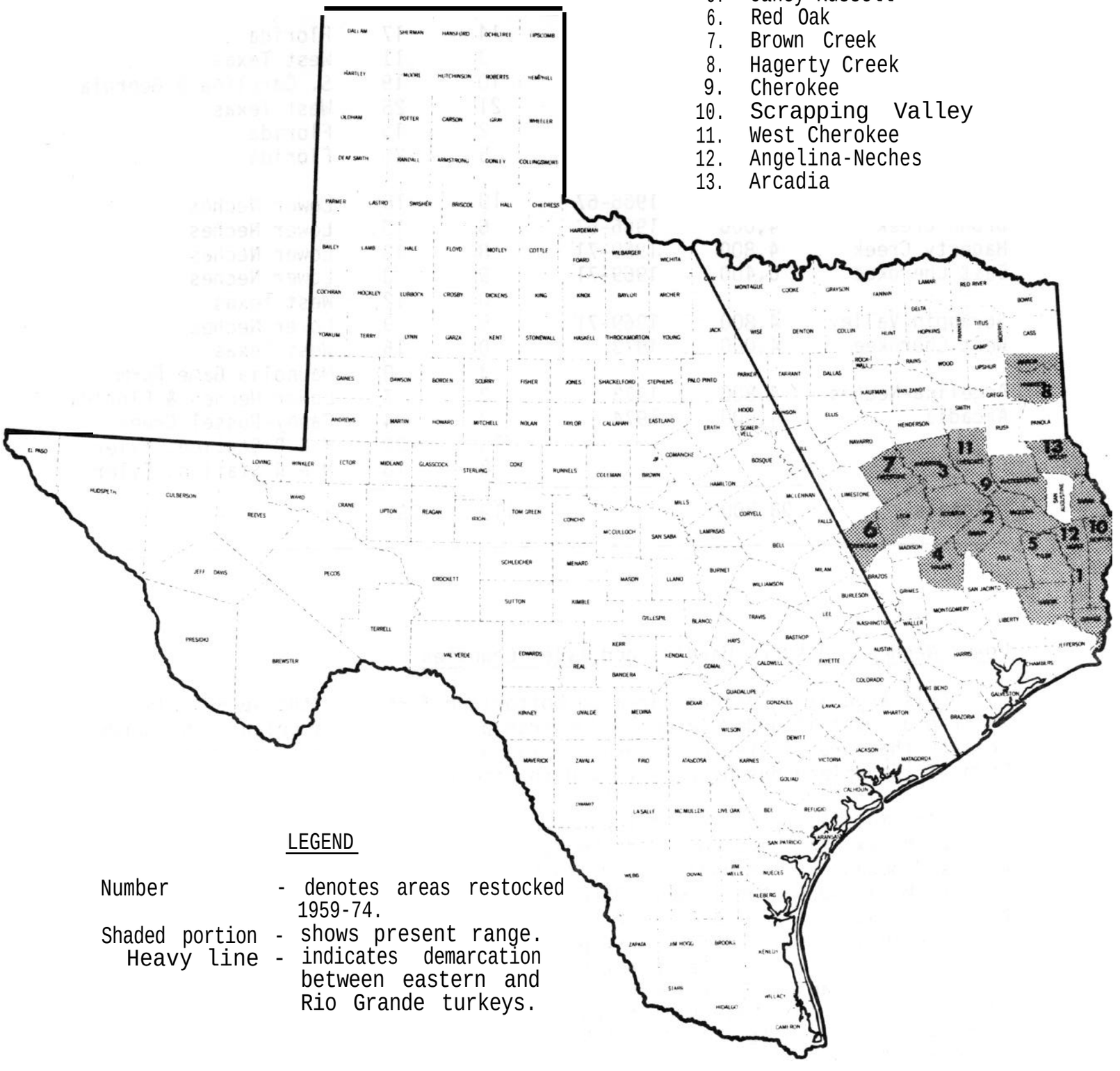

Figure 1. Restocking areas and counties reporting wild turkeys in east Texas, 1959-74.

Table 1. Wild turkey releases in east Texas, 1959 through 1974.

Release Areas	Size	Time	Gobblers	Hens	Source of Turkeys
	Ha.	Yr.	No.	No.	
Lower Neches	35,000	1959-62	14	17	Florida
			3	11	West Texas
Alabama Creek	5,500	1959-62	10	19	S. Carolina & Georgia.
Engeling	4,400	1960	21	25	West Texas
Nelson Creek	4,800	1963	2	13	Florida
Caney-Russell Creek	6,000	1964	5	20	Florida
Red Oak	4,800	1966-67	10	18	Lower Neches
Brown Creek	4,000	1966-67	6	13	Lower Neches
Hagerty Creek	4,800	1969-71	8	13	Lower Neches
East Cherokee	6,400	1969-71	9	3	Lower Neches
			0	12	West Texas
Scrappin Valley	4,800	1969-71	5	9	Lower Neches
West Cherokee	4,000	1973	0	15	West Texas
			3	0	Magnolia Game Farm
Angelina-Neches	4,800	1973	2	7	Lower Neches & Florida
Arcadia	4,000	1974	3	4	Caney-Russel Creek
			10	20	M & R Station, Tyler
			8	18	M & R Station, Tyler
Totals	93,300		119	237	

Lower Neches - Jasper, Hardin, and Tyler Counties

This area is a typical hardwood bottomland forest on the Neches River watershed, most is under large landownership. It includes upland pine-hardwood forests that are crossed by several spring branches with numerous waterholes. Much of the upland has been converted to pine plantations.

The initial release of wild-trapped eastern turkeys in Texas was made in 1959 with six Florida birds. At the same time, 14 Rio Grande turkeys were released because additional eastern turkeys were unavailable. In 1960 and 1962 the stock was supplemented with 25 Florida birds. During the first five years of these stocking efforts, winter and spring-summer plantings were made of small grains, milo, corn, clovers, peas, and chufas. Turkeys did well on and near the release area. The most turkey sight records of 272 and 281 were recorded in 1963 and 1969, respectively (Table 3). The estimated turkey populations remained relatively high through 1972. The highest average brood size recorded was 8.1 poults in 1963 (Table 3). There was a sharp population decline in 1973. In 1974 sight records were only 31 and the brood size was 1.0. Possible explanations for the decline are the incidence of blackhead which was reported in nearby domestic turkeys in 1967, 1968, and 1972. Although 103 birds were trapped from this area during 1965 through 1974, it is not felt that trapping was a factor in the population decline.

Table 2. Principal woody plant species on east Texas wild turkey restoration areas.

Overstory Species	Understory Species
Ash *(Fraxinus* spp.)	Blackberry *(Rubus* spp.)
Baldcypress(T*axodium distichum)*	Dogwood (*Cornus florida*)
Beech *(Fagus grandifolia)*	Dwarf Sumac (*Rhus copallina*)
Blackgum (*Nyssa sylvatica)*	French Mulberry *(callicarpa americana)*
Elm *(Ulmus* spp.)	Fringetree (*Chionanthus virginica*)
Hickory *(carya* spp.)	Grape *(Vitis* spp.)
Oak (Quercus spp.)	Greenbrier *(Smilax* spp.)
blackoak (*Q. velutina*)	Gum Elastic (*Bumelia lanuginosa*)
blackjack (*Q. marilandica*)	Haw *(Crataegus* spp.)
cherrybark (*Q. falcata*)	Holly *(Ilex* opca)
overcup (*Q lyrata)*	Hornbeam (*Carpinus caroliniana*)
pin (*Q. palustratis)*	Horsesugar (*Symplocos tinctoria*)
post (*Q. stellata*)	Huckleberry *(Vaccinium* spp.)
red (*Q. rubra)*	Ironwood (*Ostrya virginania)*
sandjack (*Q. cinerea*)	Panicum *(Panicum* spp.)
wateroak (*Q. nigra)*	Persimmon (*Diospyros virginiana)*
whiteoak (*Q. alba)*	Red Mulberry (*Morus rubra)*
willow (*Q. phellos)*	Sassafras (*Sassafras albidum)*
Pine *(Pinus* spp.)	Supplejack (*Berchemia scandens)*
Prickly Ash (*Xanthoxylum clava-herculis)*	Viburnum *(Viburnum* spp.)
Sweetbay (*Magnolia virginiana)*	Yaupon (*Ilex vomitoria*)
Sweetgum (*Liquidambar styraciflua)*	
Tupelo Gum (*Nyssa aquatica*)	

Alabama Creek - Trinity County

This area ranges from Neches River hardwood bottomland on the east to sandy gently rolling hills with shortleaf pines on the west. Five creek systems are intermittent, but push-up type water impoundments and rocky pot holes provide year-round water. Approximately 1,200 hectares (ha) of the river bottom is under a selective hardwood management system. Interspersed plantings of slash pine and timber stand improvement practices have converted much of the upland area to pine stands, and created a dense understory.

Twenty-nine eastern turkeys were wild-trapped in South Carolina and Georgia and released on this area from 1959 through 1962 (Table 1). These birds had access to chufas and other supplemental plantings such as oats, peas, milo, and corn. Adult birds were seen frequently during the first five years, but poults were seldom recorded. Since 1965, turkeys have declined to a remnant population. This area is open public land and the heavy concentration of hunters, fishermen, and campers probably contribute to the turkey decline.

Table 3. The number of wild turkey sightings, broods, and brood sizes on two restoration areas, 1962 through 1974.

Year	Lower Neches			Caney-Russel Creek		
	Sightings	Broods	Brood sizes	Sightings	Broods	Brood sizes
1962		19	6.6	-	-	-
1963	272	12	8.1	-	-	-
1964	147	11	7.2	-[1]	-	-
1965	181	19	6.6	-	-	-
1966	206	10	4.9	45	5	2.8
1967	217	12	5.9	229	6	5.8
1968	249	9	3.3	220	9	3.3
1969	281	8	5.4	116	7	5.4
1970	202	5	4.6	162	6	4.3
1971	185	5	5.4	131	12	5.6
1972	188	6	4.2	201	6	5.5
1973	91	1	6.0	101	4	5.2
1974	31	2	1.0	119	5	6.6

[1]Birds were stocked in 1964 but observations were not made until 1966.

Engeling Wildlife Management Area - Anderson County

This research area in the Post Oak Belt is owned by the Texas Parks and Wildlife Department. It is traversed by a live creek and interlaced by numerous intermittent creeks and springs on gently rolling hills. It is managed primarily for white-tailed deer, squirrels, and cattle.

Rio Grande turkeys were released in 1960 (Table 1). Nesting success was poor and the birds disappeared from the area.

Nelson Creek - Walker County

This area consists of Trinity River bottomland and upland areas interlaced by creeks. Large landownership and open areas are common. Much of the area has been converted to pasture and to pine plantations.

Fifteen eastern wild turkeys from Florida were released in 1963 (Table l), and soon scattered out over a large area along Nelson Creek and the Trinity River. In recent years there were approximately 100 turkeys in several scattered flocks. Currently the population is declining, probably because of the range changes from pine-hardwood and hardwood bottoms to improved pastures and pine plantations.

Caney-Russell Creek - Tyler County

This area is on the Neches River and contains a good variety of hardwood bottomland, upland pine-hardwood, and longleaf pine stands. Much of the upland has an open understory with well drained hilly sites for nesting.

Twenty-five wild-trapped Florida turkeys were released in 1964 (Table 1). Turkey sight records have been fairly consistent through 1974. Reproduction has been good, with 2.8 to 6.6 poults per brood (Table 3). Turkeys now occupy over 40,000 ha. In 1974, 12 turkeys were trapped for release on other areas. Good protection from illegal hunting and other human disturbance, coupled with the relatively open understory and adjacent hardwood bottoms appear to be the key factors in the success of this release.

Red Oak - Robertson County

This area along the Navasota River is west of the pine belt. It contains a good variety of hardwoods and clearings with numerous improved pastures replacing the deep woods.

Twenty-eight turkeys trapped from the Lower Neches Area were released from 1966 through 1972 (Table 1). Fairly good reproduction has been reported by landowner cooperators. Hens with poults have been seen across the Navasota River with scattered flocks over an estimated 20,000 ha in Robertson and Leon Counties.

Brown Creek - Freestone County

This area on the Trinity River contains a variety of oaks and other hardwoods adjacent to well drained hilly sites.

Nineteen turkeys trapped from the Lower Neches Area were released in 1966-67 (Table 1). Initial results were good and several hens were sighted with 3 to 10 poults. The future of these turkeys is doubtful because of a 1,012 ha water impoundment and a wide-scale strip mine of lignite on the area.

It is interesting to note that on the Tehuacana Creek bottom located approximately 18 miles northwest from this area there is a remnant flock of 15 to 30 birds from a 1949-50 Rio Grande turkey restoration effort.

Hagerty Creek - Harrison County

This area contains Hagerty and Cypress Creek bottoms with fairly steep well drained adjacent upland. It contains some open pasture land and pine plantations.

Twenty-one turkeys trapped from the Lower Neches Area were released from 1969 through 1973 (Table 1). Reproduction has been generally good on the release area and on Cypress Creek approximately 25 kilometers (km) away. Flocks are now scattered over an estimated 15,000 ha.

East Cherokee - Cherokee County

This area includes typical hardwood bottomland forest on the Angelina River and an upland pine-hardwood type interlaced with numerous hills and valleys. Much of the upland area has been converted to pines. There are several spring-fed branches on the upland areas.

Twelve eastern turkeys trapped from the Lower Neches Area and 12 Rio Grande hens from West Texas were released in 1969-71 (Table 1). Most of the turkeys remained near the original release area. Several broods of 4 to 10 poults per hen were seen in recent years. Scattered flocks have been reported over an estimated 30,000 ha.

Scrapping Valley - Newton County

This is an upland pine-hardwood site with numerous spring branches. It includes some open longleaf pines and a wide variety of hardwood trees.

Fourteen turkeys trapped from the Lower Neches Area were released from 1969-71 (Table 1). Turkeys are staying close to the release site although sight records have been reported over an estimated 10,000 ha. Many sight records of 3 to 10 poults per brood are regularly reported.. Fifteen nesting hens were seen by cooperators during the spring of 1974. This release site is under close landowner control, and includes a supplemental feeding program for elk, other exotics, and wild turkeys.

West Cherokee - Cherokee County

This area includes a portion of Neches River bottomland and some upland pine-hardwood sites with a heavy understory. There are several spring-fed branches on the uplands.

Fifteen Rio Grande hens from West Texas and three eastern gobblers from the Magnolia Game Farms were released in 1973. Some reproduction has been reported and scattered flocks are present near the release site.

Angelina-Neches - Jasper County

This is a bottomland forest in the forks of the Angelina and Neches Rivers. It includes numerous sloughs, ox-bow lakes, and flat bottomlands that support a wide variety of hardwoods.

Nine eastern turkeys, seven from Florida and two from the Lower Neches Area, were released in 1973 (Table 1). Two flocks of adult birds and one hen with six to eight poults were seen during the summer of 1974.

Arcadia - Shelby County

This rolling and hilly area along the Attoyac River contains numerous upland intermittent streams. The upland pine-hardwood type and pastures furnish a good variety of habitat within a short distance.

Seven eastern turkeys trapped from the Caney-Russell Area were released in 1974. In late summer, 30 pen-reared eastern turkeys from the Management and Research Station in Tyler were released. These pen-reared birds were from South Carolina broodstock. An additional 26 birds from the research station were released on the west side of the Attoyac River in September 1974.

DISCUSSION

Presently there are more than 1,000 eastern and eastern-Rio Grande turkeys at 13 general locations in 20 east Texas counties from Robertson County on the west to Newton County on the east (Fig. 1). The turkeys appear to be on the increase at two locations but failures at two locations. At nine locations the prospects are good but results are inconclusive at this time.

Further stocking of turkeys will be made in the best habitat available. However, we cannot discount the fact that the native eastern wild turkey historically spent the winters in river bottoms and moved to higher well-drained uplands in the spring and summer.

Based on our experience the ultimate success of wild turkey stocking in east Texas will depend on habitat-related factors - such as conversion of hardwoods to short-rotation pines, access to adequate roost sites, establishment of year-round supplemental food plots, encroachment of habitat by water impoundments and urbanization, and availability of large secluded forest areas. In most cases these factors are becoming more restrictive to the turkey.

In spite of these problems the Texas Parks and Wildlife Department intends to put and keep the wild turkey on the list of huntable game species in east Texas.

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THE STATUS OF THE WILD TURKEY IN 1974

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Abstract: The four subspecies of wild turkeys *(Meleagris gallopavo* subspp.) in the United States probably declined to their lowest numbers in the late 1930's. Development of techniques for the live-capture of free-ranging wild turkeys permitted their restoration in areas where they had been extirpated and encouraged the establishment of huntable populations beyond their ancestral geographic limits. Within the past quarter century, the number of states having a legal hunting season has increased from 15 to 39 (including Hawaii), the annual harvest has risen from about 47,000 in 1951 to some 137,000 in 1970, and the population has expanded from an estimated 320 thousand in 1952 to about 1.3 million in 1974. Huntable populations have been established or reestablished on more than 777,000 square kilometers (km^2) of range since 1938. The turkey is not faring well everywhere, however, and trouble spots do exist.

Key words: *Meleagris gallopavo*, live-trapping, population increase, extirpation, range extension

It has been my privilege to examine the status of the wild turkey on four previous occasions, beginning in 1937. My first contact with the wild turkey was in the late 1920's when I began hunting it as a high school student. My success in outwitting this wily sporting bird was quite meager at first and has steadily declined over the ensuing 40-50 years. Fortunately for many of us, our ability to bag a turkey is negatively correlated with our fascination for and interest in this our largest upland game bird.

In 1937, the wild turkey was in trouble throughout most of its range (Mosby 1937). By 1930, more than 29 states were, or had, engaged in stocking programs in efforts to stem the decline of existing populations (Boyer 1929). In the late 1920's and early 1930's there was a scarcity of factual information on existing game bird populations in most states because of a paucity of both funds and trained personnel. For example, in 1936 I requested information from various states about the distribution and status of the eastern wild turkey (*M. g. silvestris).* One state game official replied that they had no eastern wild turkey "... just the old time native wild turkey." He said their turkey population was declining but that the situation soon would be corrected by the restocking program just getting underway! During the late 1930's Blakey (1941) expressed the concern that the wild turkey was declining throughout all of its range to such a degree that it might soon decrease to the point where it could no longer be considered a game species in most states.

This paper is contribution No. 75-l of the Department of Fisheries and Wildlife Sciences.

The major thrust of "turkey management" efforts to stem the general decline in most states was confined to restocking (Boyer 1929). In the eastern part of the turkey's range, involving the eastern and Florida subspecies (*M. g. osceola*), the stock was raised on game farms because of the inability to live-trap wild birds in quantity (Baldwin 1947). The game-farm stock proved unproductive and several states, notably Missouri, Virginia, and Pennsylvania, undertook extensive restocking programs with birds secured by mating captivity-reared wild hens with native wild gobblers. It was assumed that improved genetics would overcome the lack of success experienced with "domestic blood" in game-farm stock. These restocking efforts were unsuccessful (Leopold 1944, Wunz 1973). However, the two western subspecies, the Rio Grande (*M. g. intermedia*) and Merriam (*M. g. merriami*), were more easily live-trapped (Glazener et al. 1964), and consequently a larger number of these birds were available for restoration efforts. The Rio Grande subspecies was widely transplanted throughout Texas and in many other states but proved successful only in areas having less than 76 centimeters (cm) of rainfall (Glazener 1967).

Fig. 1 shows the distribution of the 4 subspecies of the wild turkey in the United States in 1948 (Walker 1949, Mosby 1949). At this time the 2 eastern subspecies occupied only some 12 percent of their original range (Mosby 1949). Restoration efforts, particularly for the 2 eastern subspecies, began to pay off in the early 1950's with the perfection of the cannon-net trap.

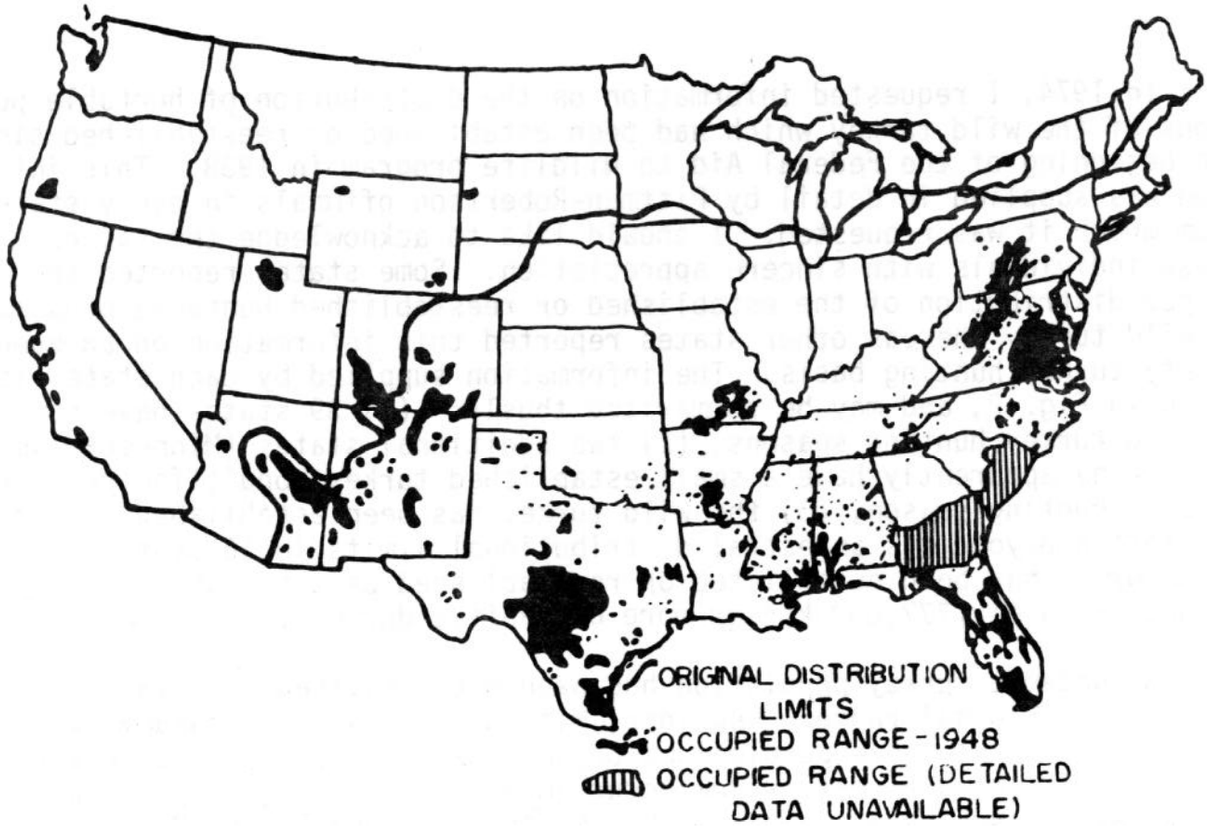

Figure 1. Original distributional limits and 1948 occupied range of the wild turkey in the United States (Walker 1949, Mosby 1949).

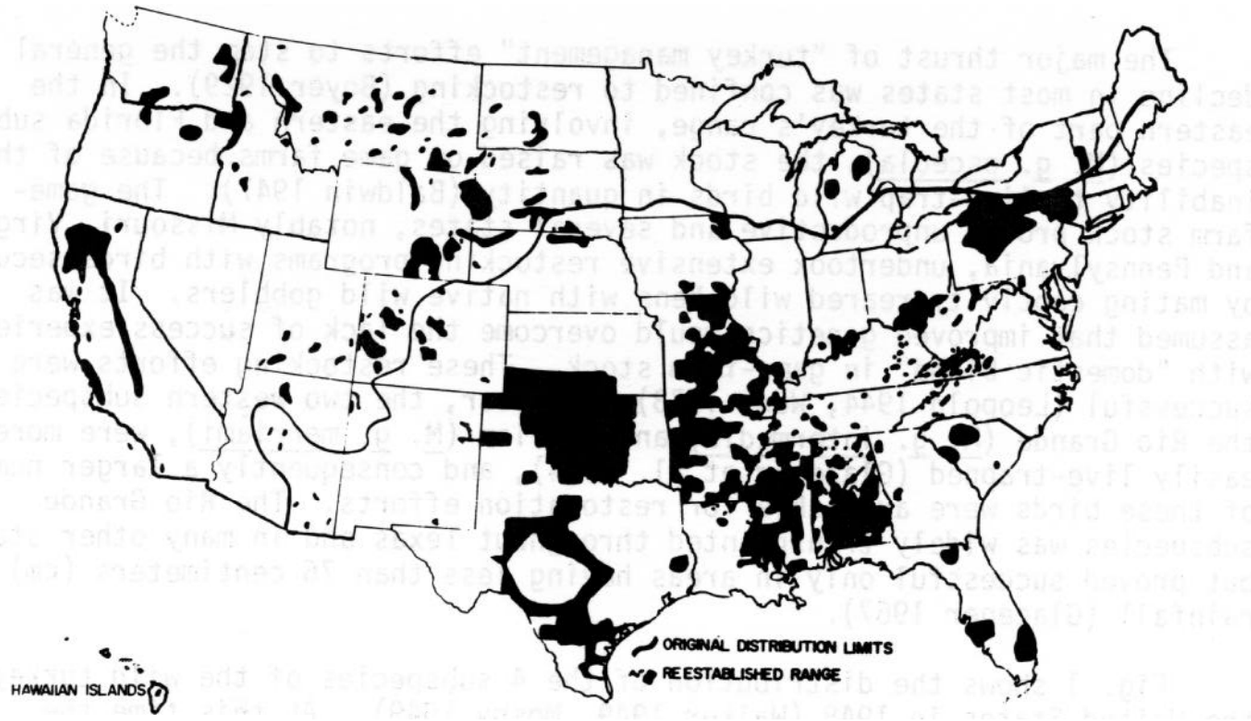

Figure 2. Areas where the wild turkey has been established or reestablished as a huntable population since 1938.

In 1974, I requested information on the distribution of huntable populations of the wild turkey which had been established or reestablished since the beginning of the Federal Aid to Wildlife program in 1938. This information was supplied in detail by Pittman-Robertson officials in every state from which it was requested. I should like to acknowledge the favors of these individuals with sincere appreciation. Some states reported the mapped distribution of the established or reestablished huntable populations of wild turkey whereas other states reported this information on an open-county turkey hunting basis. The information supplied by each state, is shown in Fig. 2, and may be summarized thusly: (1) 39 states have some type of wild turkey hunting seasons, (2) two additional states (Minnesota and Wisconsin) apparently have a small established turkey population but currently have no hunting season, (3) the wild turkey has been established as a huntable population beyond its ancestral distributional limits in 16 states, (4) the wild turkey has been established or reestablished as a huntable game species on approximately 777,000 km^2 or more of habitat during the last quarter century.

A huntable turkey population has been reestablished over large areas within the original range. New York, Missouri, Arkansas, Alabama, and Texas are examples. Huntable populations beyond the recorded original distributional limits of the species now occur in Vermont, Michigan, North Dakota, South Dakota, Nebraska, Colorado, New Mexico, Arizona, Utah, Montana, Wyoming, Idaho, Washington, Oregon, California, and Hawaii. The eastern Florida turkey has about doubled their area of occupied range in the past 35 years (Fig. 2).

It is my best estimate, based on the Big Game Inventory and other information, that the United States population of the wild turkey was about 320,000 in 1951. Information received from the states and other sources suggests that the wild turkey population in 1974 was about 1.3 million, or a population increase of about 4-fold.

Turkey harvests have increased in proportion to population expansion. The annual harvest of the wild turkey was reported in the Big Game Inventories assembled annually by the U. S. Fish and Wildlife Service from 1951 until these inventories were discontinued in 1970. In 1951, the estimated harvest of wild turkeys was reported to be about 47,000. This increased to about 137,000 in 1970. The number of states having a legal hunting season increased from 15 in 1951 to 39 in 1974.

The increase in numbers, in range, and in harvest of the 4 subspecies of the wild turkey has been a bright spot in American game management, ranking with similar successes with the deer and pronghorn restoration programs. Details of the turkey restoration programs in the several states are well documented by Southeastern Section, The Wildlife Society (1959), Hewitt (1967), Sanderson and Schultz (1973), and by papers presented at this Third National Turkey Symposium. The current wild turkey literature suggests that, in addition to transplanting successes, factors which have contributed to the increase of the wild turkey are: the regrowth of cut-over forests; the abandonment of submarginal farms; the acquisition of extensive forested areas by the U. S. Forest Service, by state forest and wildlife agencies, and by industrial forest enterprises; and the movement of rural populations to cities.

Other evidence of the changed status of the wild turkey include the formation of two professional wildlife groups with particular interest in this bird - the Northeast and Southeast Wild Turkey Committees. The completeness and detail of the 1974 responses, as compared with the great difficulty experienced in securing factual data in 1937 is another example of the improvement in the status and management of the wild turkey. It illustrates that the wild turkey is currently receiving professional attention in all of the 41 states which have a free-living wild turkey population. Finally, the formation of a nation-wide group of sportsmen into the National Wild Turkey Federation indicates that a large number of sportsmen propose to see that this fine game bird continues to receive the attention it deserves.

All is not well with wild turkeys throughout their entire range, however. They have declined in several of the long-established habitats and their response to management programs have been disappointing in some areas. Some of the possible explanations for decreases in specific states are as follows: industrial forestry practices favoring a pine monoculture, Alabama; development of forested areas for livestock production, Gulf states; parasitism and disease, South Carolina and Florida; suburban sprawl, northern Virginia; and range improvement and channelization, Texas. Reasons for decreases are unknown at the Welder Wildlife Refuge in Texas, in central Virginia, and on the Land-Between-the-Lakes Recreational Area in Kentucky and Tennessee.

The turkey has proven to be a much more adaptable bird than was thought possible 25 years ago. It has survived the extreme weather of Minnesota, northern Lower Peninsula of Michigan, and North Dakota. It has existed in

close proximity to human habitation such as the intensively used Presque Isle State Park, Pennsylvania (Munz and Hayden 1973). Its adaptability to habitat within and beyond its original distribution is an attribute that we all hope will assure this outstanding game bird a permanent place as the most desirable trophy of all North American game birds.

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PARASITISM AMONG WILD TURKEYS IN THE SOUTHEAST

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Abstract: Immature and adult wild turkeys (*Meleagris gallopavo silvestris)* from Alabama, Arkansas, Mississippi, South Carolina, and West Virginia were examined for helminth parasites. Eleven trematodes, 8 cestodes, 1 acanthocephala, and 15 species of nematodes were found in 425 turkeys. Two nematodes, *Heterakis gallinarum* and *Ascaridia dissimilis*, were the most prevalent and widely distributed helminths. Cestodes and nematodes comprised the majority of parasites harbored. Variations in prevalence and distribution of helminths were found for adult and immature birds.

Key words: *Meleagris gallopavo silvestris*, parasites, helminths, trematodes, cestodes, acanthocephala, nematodes

Awareness of the potential hazards of disease and parasites for wild turkey populations has existed for many years (Stoddard 1935), however, only relatively recently have these entities been studied in depth. In 1970 we presented a general review of parasitism and disease among southeastern wild turkeys (Prestwood et al. 1973). Additional information is presented herein on the prevalence and distribution of helminth parasites among selected wild turkey populations of the Southeast.

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MATERIALS AND METHODS

From 1964 through 1973, 425 eastern wild turkeys were examined for helminth parasites. Included were 250 adults, 62 juveniles, and 113 poults from 7 study sites in 5 states (Table 1). Specimens were obtained on an annual or semi-annual basis for 3 or more years except on a few areas where only single collections were made.

Hunter-killed birds were utilized for many of these studies and the following specimens usually were obtained: head, respiratory tract, upper and lower digestive tract, liver, kidneys, bursa of Fabricius, and oviduct. Poults were obtained by shooting, and similar studies were made. Parasitologic examination of birds generally followed procedures described by Prestwood (1968).

Table 1. Collection sites, number, and age class of wild turkeys examined from the southeastern United States.

State County	Locality Number	Year(s) and Season(s) of Collection	Number of Turkeys		
			Poult	Juvenile	Adult
Alabama					
Clarke	1	March and July 1965-67	21	0	62
Arkansas					
Arkansas	2	October 1967	0	6	9
Crittenden	3	July 1970	0	1	4
Mississippi					
Bolivar[1]	4	April & August 1964-66	82	0	134
Tunica	5	May & July 1966-68	10	0	20
South Carolina					
Georgetown	6	April 1973	0	0	5
West Virginia					
Pocahontas	7	October 1965-73	0	55	16
			113	62	250

[1]Also included birds from Desha County, Arkansas.

RESULTS AND DISCUSSION

Thirty-four different species of helminths were identified from turkeys on the seven study sites. The species and their percentage prevalence and composition in the total parasite fauna of immature and adult turkeys are presented in Table 2. In addition, trematodes--*Athesmia heterolecithodes, Renicola hayesannieae*, and *Tanaisia zarudnyi*--and nematodes--*Oxyspirura* spp. and *Singhfilaria hayesi*--were found. These helminths are not-listed in the table since it was impossible to retrieve all specimens and all organs were not available for examination. Intestinal capillary worms were not differentiated to species, however *C. caudinflata* and *C. obsignata* were identified. Two species of *Cyrnea, C. colini* and *Cyrnea* spp., also were not differentiated.

Trematodes were relatively uncommon among wild turkeys on the 7 study sites, although 11 species were recovered from the 425 birds. These parasites were found in both immature and adult birds. On most study sites, trematodes accounted for only a small percentage of the total parasite fauna harbored by turkeys (Table 2). *Echinoparyphium recurvatum* and *B. virginianum* were most widely distributed flukes infecting turkeys. A variety of waterfowl and shorebirds as well as pigeons *(Columba);* pheasants (*Phasianus*), and chickens (*Gallus*) harbor *E. recurvatum*. Opossums (*Didelphis marsupialis*), skunks (*Mephitis mephitis*), and mink (*Mustela vison*) commonly are infected with *B. virqinianum*. The variety of definitive hosts which can be utilized by these two helminths probably account for their wide distribution among turkey populations of the Southeast. Liver flukes (*A. heterolecithodes*) and kidney flukes (*R. hayesannieae*) were locally common. Pathologic lesions were not observed in turkeys infected with intestinal flukes. Bile duct thickening and dilatation were observed with liver fluke infections. Dilatation of renal tubules was noted in kidney fluke infections.

Cestodes commonly were found in wild turkeys on the seven study sites, and eight species were identified. *Metroliasthes lucida, R. williamsi*, and *E. ransomi* were the mostwidely distributed. The widespread availability of suitable intermediate hosts, e.g., grasshoppers, ants, beetles, and their importance as food items for turkeys may account for this distribution. Both immature and adult turkeys harbored cestodes. Among young birds, *M. lucida* and *R. ransomi* were most prevalent. In adult birds, *R. williamsi* and *M. lucida* were most prevalent. Cestodes comprised a substantial portion of the helminths harbored by turkeys and constituted nearly 62 percent of the total parasite fauna of immature birds. On some study sites, cestodes accounted for more than 40 percent of the helminths found in adult turkeys, although overall they accounted for about 16 percent of the parasites in adults. Pathologic lesions were not observed with tapeworm infections even though some birds harbored relatively large numbers of these flatworms.

Acanthocephala were the most rarely encountered group of helminths infecting turkeys, and only one genus was identified. Thorny-headed worms were found on three study sites, most frequently among poults. They contributed little to the parasite burden of turkeys. Pathologic lesions were not noted with the low numbers of *Mediorhynchus* spp. found during this study.

Wild turkey usually were infected with nematodes, and 15 species were identified from this host. *Heterakis gallinarum, A. dissimilis*, and *Strongyloides* spp. were the most prevalent. *Heterakis* accounted for a

Table 2. Percent prevalence and composition of helminths harbored by immature and adult wild turkeys in the southeastern United States.

Helminth	Immature		Adult		Locality
	Prevalance	Comp.	Prevalance	Comp.	
Trematoda					
Brachylaima virginianum	4.6	<l	3.2	<l	1,3,5-7[1]
Cotylurus flabelliformis	1.1	<l	0.4	<l	1,4
Echinoparyphium recurvatum	4.0	<l	8.4	3.2	2-6
Leucochloridium spp.	5.1	<l	2.8	<l	4,5
Prosthogonimus ovatus	0.6	<l	0.4	<l	4,5
Psilotornus audacirrus	--		0.4	<l	1
Strigea spp.	0.6	<l	0. 8	<l	1,2
Zygocotyle lunata	--		0.4	<l	2
Cestoda					
Amoebotaenia cuneata	11.4	2.0			4,7
Davainea meleagridis	1.7	<l	0.8	<l	3,4,7
Hymenolepis spp.	0.6	<l			5
Imparmargo baileyi	7.4	4.6	1.6	<l	7
Metroliasthes lucida	48.6	26.7	58.0	7.2	1,2,4-7
Raillietina georgiensis			0.8	<l	4
R. ransomi	30.8	26.9	20.4	2.6	1,2,4,7
R. williamsi	12.0	<l	68.0	5.9	1,2,4,5,7
Acanthocephala					
Mediorhynchus spp.	11.4	<l	0.8	<l	4,5,7
Nematoda					
Ascaridia dissimilis	94.8	11.8	94.8	24.4	1-7
Capillaria annulata	0.6	<l	--		5
C. contorta	--		0.8	<l	4,5
Capillaria spp.	10.3	1.3	52.0	8.2	1-7
Cyrnea spp.	30.8	<l	16.4	<l	l-5,7
Dispharynx nasuta	10.3	<l	0.8	<l	1,4,5,7
Gongylonema ingluvicola	0.6	<l	1.2	<l	1,7
Heterakis gallinarum	96.0	17.1	96.8	42.4	1-7
Strongyloides spp.	45.7	5.0	44.8	4.4	1-7
Syngamus trachea	8.6	<l	8.4	<l	1,3-5,7
Trichostrongylus tenuis	2.3	<l	8.0	<l	1,2,4,6

[1]See Table 1 for locality numbers.

substantial portion of the helminth burden harbored by wild turkeys, particularly adults. Transmission of *Heterakis* may be direct or indirect via earthworms. Transmission via the earthworm is considered the more important route in free-living birds (Lund 1969, 1972). The presence of *Heterakis* is important since it is the means for transmission of the protozoan parasite, *Histomonas meleagridis,* which causes blackhead disease (histomoniasis, enterohepatitis). Blackhead occasionally was encountered in poults or juvenile turkeys and was diagnosed in turkeys on three study sites, viz., Clark County, Alabama; Desha County, Arkansas and Bolivar County, Mississippi; and Pocahontas County, West Virginia. Considering the prevalence, distribution, and mode of transmission of *Heterakis,* blackhead probably is more common among wild turkeys than it usually is considered to be.

Large roundworms, *A. dissimilis*, also contributed substantially to the helminth burden of wild-turkeys. Adult turkeys harbored higher numbers of ascarids than did young birds. Pathologic effects of *A. dissimilis* were not noted.

Strongyloides spp., although widely distributed, did not constitute a large portion of the overall worm burden on most areas. Lesions were not attributed to these helminths.

Cyrnea spp. similarly were rather prevalent and widely distributed among turkeys. Lesions were not associated with these helminths.

Stomach worms, *D. nasuta,*were not prevalent among turkeys and contributed little to the entire-parasite fauna. These helminths were found primarily in young birds and were most prevalent on the Alabama study site. Sowbugs (*Porcellio scaber*) are intermediate hosts for *D. nasuta* and a wide variety of song, garden, and game birds can become infected. These helminths have considerable pathologic significance, usually producing a spectacular proliferative lesion in the proventriculus even when only a few worms were present. Dispharynx frequently causes high morbidity and mortality among pen-raised quail *Colinus virginianus*) and has been considered one of the causes of a population decline among blue grouse, *Dendragapus obscurus* (Bendell 1955). Hon (1973) found wild turkey poults in Florida to be frequently infected with *D. nasuta*. He considered this helminth to have a possibly important role in unexplained mortality among young wild poults.

Syngamus trachea, the gapeworm, was found infrequently in young and adult birds. It usually is considered to be a parasite of young poultry. The life cycle of *S. trachea* may be direct or indirect, and earthworms are utilized as transport hosts. A large nodule is produced at the site of attachment in the trachea, and mechanical blockage of the trachea occurs when large numbers of *Syngamus* are present. Gapeworms may be more important as mortality factors for young turkeys than currently recognized.

In summary, wild turkeys examined during this study were parasitized by one or more species of helminths. The parasite fauna of immature turkeys consisted of 1.4 percent trematodes, 61.6 percent cestodes, and 36.8 percent nematodes. In adults, the parasite fauna consisted of 3.6 percent flukes, 15.8 percent tapeworms, and 80.5 percent nematodes. The nematodes *H. gallinarum*

and *A. dissimilis*, were the most prevalent and widely distributed parasites of this host. *Heterakis gallinarum* (vector for *H. meleagridis*), *D. nasuta,* and *S. trachea* potentially are the most important helminths found among southeastern wild turkeys for they adversely affect young poults.

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DISEASES OF TEXAS WILD TURKEYS

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Abstract: There is little difference between the types of diseases in domestic and wild turkeys. However, ascertaining the importance of diseases in wild turkey populations is a major problem.

The tendency of the Rio Grande turkey (*Meleagris gallopavo intermedia)* to form wintering flocks and to become dependent on supplemental feeds makes it a high risk for blackhead, a protozoan disease, and fowl cholera, a bacterial disease. Viral pox appears to be a sporadic disease and is dependent on a mosquito vector for its occurrence.

The role of disease cannot be ignored in the management of present turkey populations.

Key words: Rio Grande turkey, *Meleagris gallopavo intermedia*, disease, protozoan, bacteria

Texas is endowed with relatively abundant wild turkeys compared with other states. The major portion of this resource is the Rio Grande turkey and our disease data have been obtained from this group.

Most of the common diseases of domestic turkeys have been found in wild Rio Grande turkeys. Our biggest problem is to determine how important the diseases are in the wild turkey population fluctuations. At the present time it appears that some populations of the Rio Grande turkey are declining in spite of low annual harvest. It is not known whether the decline is due to disease.

I would like to thank field biologists of the Texas Parks and Wildlife Department who submitted specimens of ill birds to us, and particularly, Mr. Caleb Glazener, who made several trips from Sinton to College Station to submit a single specimen.

The tendency of the Rio Grande turkey to form wintering flocks and the propensity of Texas landowners to feed wild turkeys make this race of turkey a high risk to disease and parasites. In addition, wild turkey freely intermingle with their domestic counterparts, backyard flocks of chickens, and other man-made areas of potential pathogen concentration.

Data are lacking on the exact nature and extent of turkey mortality. It seems appropriate therefore to consider three major diseases of the Rio Grande turkey that have been observed in our laboratory, and to speculate on their possible impact on this species. Each disease is a separate class of pathogen.

Blackhead, a protozoan disease caused by *Histomonas meleagridis*, is a potential problem in wild turkeys because of its severe impact on their reproduction. Transmitted largely by the fowl ascarid, *Heterakis* spp., the disease is exceedingly hard to control. Major losses in domestic turkey are in poults from one to twelve weeks of age, although a 20 percent loss in adults may occur. The disease can lie dormant in ascarid eggs for long periods in the soil, and when eaten by the poults becomes active. Not only can this disease be transmitted between turkeys, but it is reported in bobwhite quail and is very common in the domestic chicken. Recovered adult turkeys may become carriers of the disease and a hen may transmit the disease to her own brood.

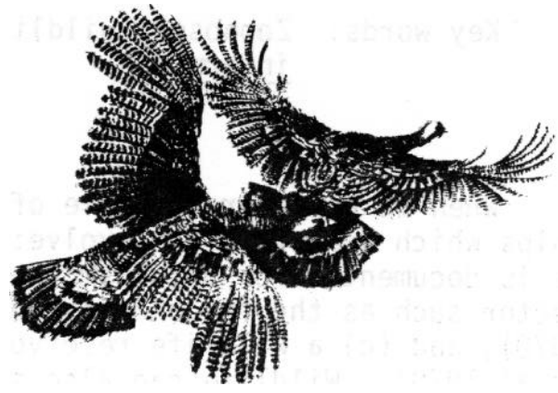
We can then reconstruct a probable route of infection in the wild Rio Grande turkey. At supplemental feeding time in the winter, a few adult individuals come in contact with infected premises and become infected. Most of them recover, but they maintain the infection until flock formation occurs in the fall. At this time the disease may be disseminated through the adult and surviving young of the year with relatively little loss in the wintering flocks. When spring scattering and nesting of the bird occurs, notable losses could be expected, with an 80 to 90 percent loss in poults. Once established in the population, this pattern could be expected to recur, with low survival rates in each succeeding poult crop. This disease is a potential disaster problem in turkey management and may actually be operating at present.

Fowl cholera, caused by bacterial agent *Pasteurella multocida*, is an explosive disease associated with concentrated numbers of birds (or mammals) and, in many instances, physiological stress. The disease is spread by contact. In ill birds the organism is found in nasal and oral exudates in teeming numbers. The disease is acute and the bird may die before loss of body condition is noticed. Depot fat may be seen in the carcass. This disease may cause death whenever the Rio Grande turkeys are concentrated--basically each winter. Entire winter roosting flocks could be reduced to a few birds, leaving few for reproduction the following year. Wintering concentration sites are used by Rio Grande turkeys year after year, often close to water. The disease is common in domestic livestock and waterfowl.

We think this disease is important to turkey populations and some sort of control must be formulated if we are to enhance wild turkey production.

Pox, a viral disease, is the most commonly submitted disease entity in the Rio Grande turkey. This disease is characterized by crusty exfoliations particularly on the head. In severe cases death may occur from the turkey's inability to drink or eat. Because of its bare head the turkey is particularly susceptible to mosquito transmission of this disease, and indeed, most pox lesions in wild turkeys are seen on the head. This disease is commonly reported not because of its lethal effect, but due to its cosmetic effect. An infected bird stands out very plainly--even in a wild population. Lesions also develop on the underside of the wings and the legs. Our impression is that the disease occurs sporadically with low mortality, and it is not a major factor in population fluctuations. Pox is widespread in most wild avian populations, and is observed particularly in the young of the year. The disease may indirectly contribute to poult mortality in concert with other disease entities.

Disease cannot be ignored in wild turkey management schemes. We can no longer just hope that bird production will maintain itself. We must make certain of it. In order to accomplish this goal, we must determine which disease factors are most important, and develop the measures necessary to their control.



WILD TURKEYS AS MONITORS OF INFECTIOUS DISEASES

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Abstract: Wildlife are usually considered vectors, reservoirs, or primary targets of infectious disease. This paper illustrates that they can also serve as sentinels of disease activity. In Texas, the Rio Grande wild turkey (*Meleagris gallopavo intermedia)* is well suited to monitor St. Louis encephalitis, Western encephalitis, and vesicular stomatitis. Criteria essential to the use of wildlife for "sentinel" duty are discussed.

Key words: Zoonoses, wildlife disease, *Meleagris gallopavo intermedia*

When we consider the role of wildlife in diseases, the usual relationships which come to mind involve: (a) specific morbidity or mortality such as is documented for botulism in waterfowl (Davis et al. 1971), (b) a wildlife vector such as the fox and its role as a transmitter of rabies (Davis et al. 1970), and (c) a wildlife reservoir such as the rabbit for tularemia (Davis et al. 1970). Wildlife can also serve as sentinels or monitors for the detection of infectious diseases, and sometimes even the prediction of epidemics. The potential of wild turkeys as monitors of infectious diseases is the specific subject of this paper.

Since 1958, the natural history of a wild turkey population has been studied at the Welder Wildlife Foundation's 3,160 hectare (ha) refuge in south Texas. As a part of this study, turkeys were live-trapped with conventional cannon nets, the Texas drop net, and deer traps. Birds were weighed, sexed, aged, and marked with appropriate bands for population movement, behavior, and survival studies. In addition, serum samples were collected and tested for serologic evidence of virus exposure in a metabolic inhibition test (Trainer et al. 1968). The population of turkeys studied normally gather during the winter on the refuge and disperse each spring over an area with a 20 kilometer (km) radius to nest and raise their broods. Birds trapped during the winter on the refuge, therefore, actually occupy approximately 1,256 km^2 of range.

Since 1963, more than 1,200 wild turkey sera have been tested for disease activity. Serologic results indicate little or no exposure of most of these wild turkeys to the 12 diseases tested. However, the prevalence of St. Louis Encephalitis (SLE), Western Equine Encephalitis (WEE) and Vesicular Stomatitis (VS) was of particular interest.

SLE reactors first appeared in this wild turkey population in 1965. At that time 20 percent of the birds were SLE reactors (Fig. 1). More than half of these reactors were immature birds, suggesting a primary exposure. The percentage of reactors increased to 25 in 1966 and to 27 in 1967. During these two years, the percentage of reactors increased in the adult portion of the population, probably because of the additional opportunity for exposure, whereas the number of reactors in immature birds decreased.

Since 1968 there has been little serologic evidence of SLE infection in wild turkeys, and all reactors were adults. Of the 23 positive turkey sera detected, 13 were birds which had previously been bled and recorded as reactors. These findings suggest that SLE has not been active since 1968. There was no evidence of clinical SLE in turkeys during the studies.

SLE outbreaks have been reported periodically in Texas. In 1964 an epidemic occurred in Houston, 124 km north of the study area. In 1965 human cases were reported in Corpus Christi, 18 km from the Welder Foundation. In the summer of 1966 a SLE epidemic occurred in the Corpus Christi area (U. S. Communicable Disease Center Epidimiological Notes and Reports 1966)

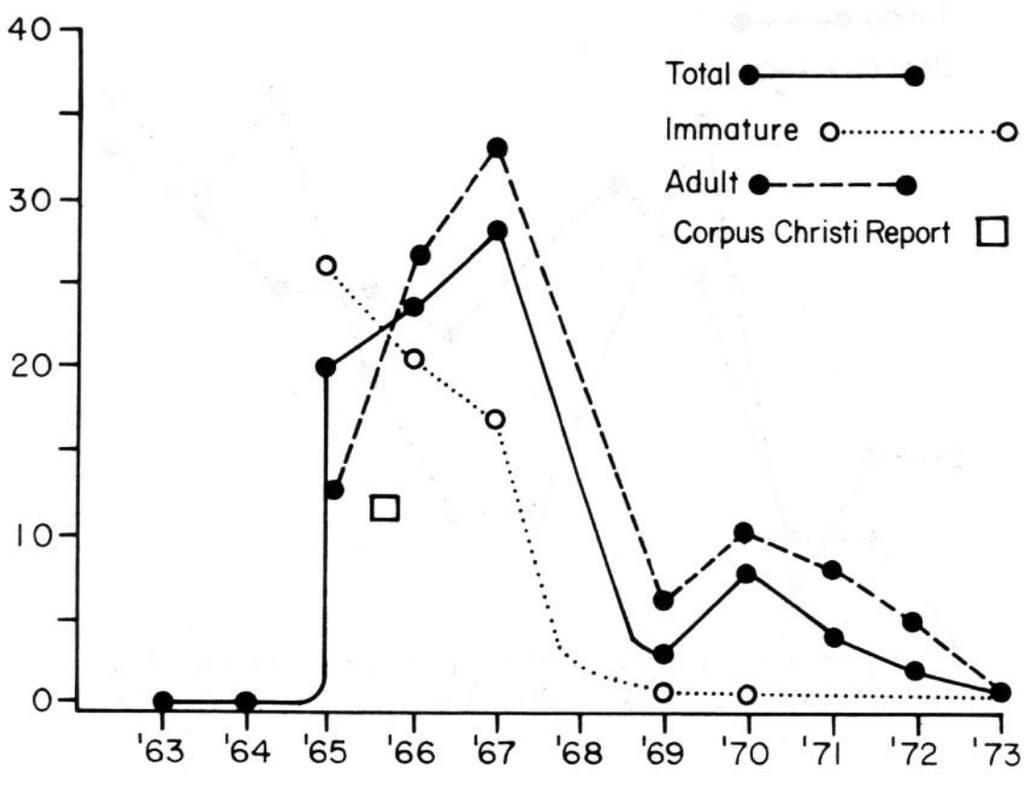

Figure 1. The percent of serologic reactors to St. Louis encephalitis virus in a wild turkey population in south Texas (1963-73).

All turkeys in this study were bled during the winter. Therefore, since SLE is transmitted by mosquitoes during the warm parts of the year, the serologic results reported for a specific year actually indicates virus activity of the previous summer(s). Turkey reactors reported as 1965 had probably been exposed during the summer of 1964 or earlier. In retrospect, serological data of this turkey study predicted the SLE Corpus Christi epidemics of 1965 and 1966 in man.

WESTERN ENCEPHALITIS

There was an increase of WE activity in turkeys during 1966-67 and 1971-72. More than 1,500 white-tailed deer were tested from 1963 to 1973, and their serologic patterns parallel those of wild turkeys with peak activity occurring in 1966-67 and 1971-72 (Fig. 2).

Western encephalitis is known to be endemic in Texas and outbreaks in livestock occurred in south Texas during these same time periods. Results of the turkey and deer sera indicate that these two species could serve as indicators of WE activity.

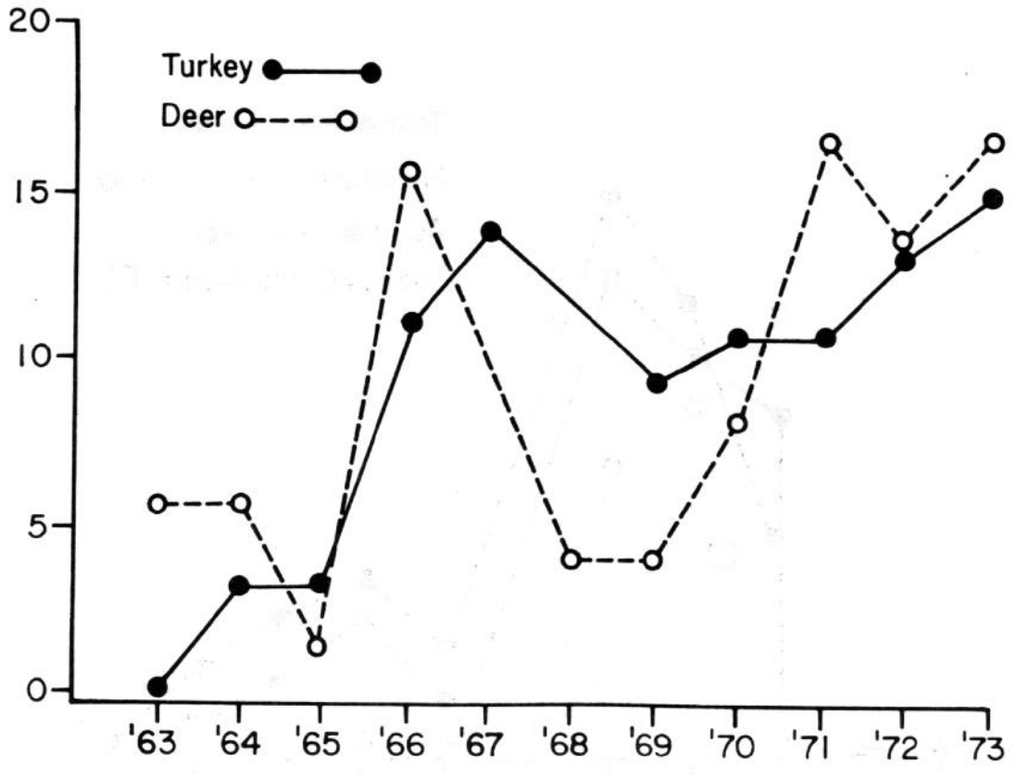

Figure 2. The percent of serologic reactors to Western encephalitis virus in a wild turkey and a deer population in south Texas (1963-73).

VESICULAR STOMATITIS

The first indication of VS activity in the Welder turkey population occurred in 1966 when approximately 35 percent of the birds tested were serologic reactors (Trainer et al. 1968). The following spring, VS was prevalent among horses in San Patricio, Refugio, and Victoria counties. Thereafter, reactors among turkeys decreased markedly and veterinarians in the three counties reported that no further cases developed in horses. Birds are not generally considered to be natural hosts for VS, however, it appears that they could serve to indicate disease activity as reflected in livestock.

DISCUSSION

It appears that serologic studies of wild turkey populations can, under the proper circumstances, be utilized to monitor and sometimes even predict disease outbreaks. Laboratory animals such as hamsters, mice, and chickens have been used to monitor arbovirus activity for some time (Nichols and Bigler 1967), but the use of wildlife as sentinels has certain logistic advantages such as little or no maintenance problems and a more. natural distribution, movement, behavior, and density.

Certain specific conditions must exist for wild populations to be effective as disease sentinels. The animals must have a known limited home range so that the area being monitored can be defined. For example, results from migratory populations would be very difficult to interpret. Animals must be present in good numbers and readily accessible (trappable) so that test sera can be obtained periodically. The population must contain individuals which are easily bled, aged, and sexed. Animals must be susceptible and respond serologically, yet not be decimated by the disease under study.

When the above predisposing factors are properly integrated, such as with the wild turkey and SLE or WE, a natural monitoring system can be organized to serve a local, national, or even continental need. The potential of such a system is unlimited for infectious diseases, and it could be expanded to include non-infectious maladies such as radioactivity, pesticides, heavy metals, and other pollutants.

This study illustrated vividly the value of researchers from different disciplines working together to better utilize specimens and data. The wildlifer, studying the natural history of the turkey by integrating with the epidemiologists can provide data which are useful to not only the wildlife field, but to the veterinary and human health field as well. On the other hand, the disease researcher by utilizing specimens and data of the wildlifer's study will strengthen his findings by acquiring important ecologic data which is essential to epidemiology.

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PRODUCTIVITY OF THE EASTERN WILD TURKEY IN THE MISSISSIPPI DELTA

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Abstract: Eastern wild turkey (*Meleagris gallopavo silvestris)* productivity was determined during the summers of 1968-72 in the Mississippi River Delta, Mississippi. Highest productivity occurred in 1969 and the lowest in 1970. Production was not correlated with rainfall but it appeared to be influenced by extreme river flood conditions. An inverse relationship was found between percentage of hens with poults and total number of adults observed per field day during August.

Key words: *Meleagris gallopavo silvestris*, productivity, rainfall, flooding

Because of the difficulty in collecting meaningful data in the field over an extended period of time, biologists probably know less about the population dynamics of the eastern wild turkey than for almost any other game species. This paper presents data on wild turkey productivity over a five-year period in a uniquely isolated habitat along the Mississippi River. Data on rainfall and river flooding are presented and analyzed for possible aspects of interaction and influence in turkey population dynamics.

Special thanks are given to members of Huntington Point Hunting and Fishing Club, Catfish Point Hunting Club, and Westside Hunting Club on whose lands this study was conducted.

STUDY AREA

The study was conducted on three hunting clubs approximately 9 kilometers (km) north of Greenville, Mississippi. The study area consists of a long narrow band of bottomland hardwood forests located between the Mississippi

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River and the levee. The area east of the levee is largely agricultural land. The land area of the two hunting clubs in which the major portion of the study was conducted is approximately 6,150 hectares (ha).

Overstory composition consisted largely of sugarberry (*Celtis laevigata*), box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), and pecan (*Carya illinoensis*). The levee is maintained by the U. S. Corps of Engineers and is managed as pastureland by farmers who lease it for grazing. The major plant species on the levee are Bermuda grass (*Cynodon dactylon*), crab-grass (*Digitaria sanguinalis*) and Croton *(Croton* spp.).

Annual rainfall averages 128.3 centimeters (cm). Annual temperature is 18.3°C. Lowest minimum average temperature is 2.5°C in January; maximum average temperature is 34.2°C in July (Riley 1960).

METHODS

Field observations on wild turkeys were made from July 1968 to September each year through 1972, except for September 1972.

All wild turkeys sighted on the three hunting clubs were recorded as to location, time of day, sex, and age class (adult or poult).

Most of the observations were made with binoculars or a variable spotting scope from a vehicle on the levee or woods roads. Some sightings were recorded from blinds. No special effort was made to travel the study area in a regular timed route. Field trips and daily activities varied monthly as the investigators trapped or followed patagial tagged wild turkeys for movement studies, but the number of observation days remained basically the same throughout the study period.

The number of poults per hen per day for the five years of study were compared by Duncan's New Multiple Range Test at the five percent level of probability to check for significant differences in turkey productivity.

Harvest records were kept by members of the hunting clubs. Adults were separated from sub-adults by weight at the obvious breaking point, usually 7.2 kilograms (kg).

Wild turkeys trapped for movement studies were aged according to Knoder (1959), and used to determine the peak hatching period.

Rainfall data were obtained from the weather station maintained by the U. S. Department of Commerce, Environmental Science Service Administration, at Scott, Mississippi. The station is located adjacent to the study area.

Mississippi River stage data were obtained from the U. S. Corps of Engineers, Arkansas City, Arkansas. At a river stage of 9.2 meters (m) the study area begins to flood and at 10.4 m flood waters reach the bottom of the levee in some areas.

RESULTS

The high percentage of sub-adult gobblers in the 1970 spring harvest indicates that 1969 was a highly productive year, whereas the low percentage of sub-adults in 1971 denotes a low-production year for turkeys in 1970. Each year the percentage of sub-adults was higher at Huntington Point than at Catfish Point (Table 1).

The average number of poults per field day of observation was 25 for August 1968, 1971, and 1972. Approximately twice as many poults (54) were seen per day in 1969. The fewest number of poults per day were observed in 1970. The number of broods and poults seen during August showed that 1969 was the best year of production during the study period (Table 2).

The number of poults per hen per day observed during August and September were not significantly different between 1969 and 1971. This lack of significance may have been due to the small number of observations recorded in 1970 (Table 3).

The peak hatching period on the study area was May and June, however, the rainfall data for these months were not correlated with the percentage of hens observed with broods (Fig. 1).

Table 1. Spring wild turkey gobbler harvest 1969-72 on Catfish Point and Huntington Point hunting clubs, Boliver-Washington Counties, Mississippi.

Year	Location	Number Adult	Number Sub-Adult	Total	Percent Adult	Percent Sub-Adult
1969	Catfish	9	11	20	45	55
	Huntington[1]					
1970	Catfish	16	32	48	33	67
	Huntington	7	26	33	21	79
	Total	23	58	81	28	72
1971	Catfish	31	6	37	84	16
	Huntington	31	14	45	69	31
	Total	62	20	82	76	24
1972	Catfish	34	45	79	43	57
	Huntington	16	51	67	24	76
	Total	50	96	146	34	66

[1]Data not available.

Table 2. Wild turkey hen and poult observations during August 1968-72 in the Mississippi Delta Area, Bolivar-Washington Counties.

Year	Field Days	Broods	Poults	Poults/ Field Day	Hens With Broods	Hens Without Broods
1968	7	13	183	26.1	28	71
1969	15	50	812	54.1	129	19
1970	16	14	188	11.8	43	174
1971	10	22	236	23.6	60	32
1972	13	26	336	25.8	60	103
Total	61	125	1,755	--	320	399
Avg.	12.2	25	351	28.8	64	79.8

Table 3. Number of wild turkey poults observed per hen per day during August and September 1968-72 in the Mississippi Delta Area, Bolivar-Washington Counties.

Years	Number of Observations	Poults Per Hen Per Day[1]
1968	29	0.3415[a]
1969	107	0.1326[c]
1970	21	0.1042[c]
1971	39	0.1146[c]
1972	27	0.1736[b]

[1]Based on number of poults sighted/number of hens with broods/number of field days. Means not followed by the same letter differ significantly at the five percent level of probability.

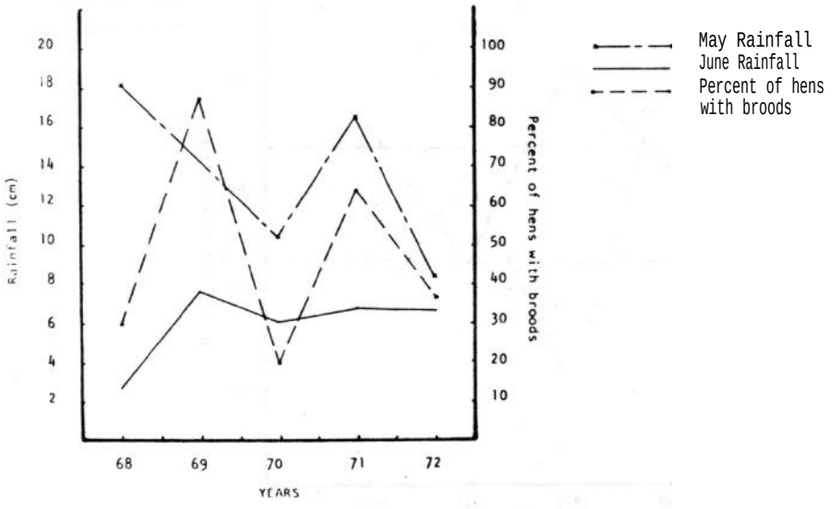

Figure 1. Spring rainfall was not correlated with percentage of hens with broods, Bolivar-Washington Counties, Mississippi.

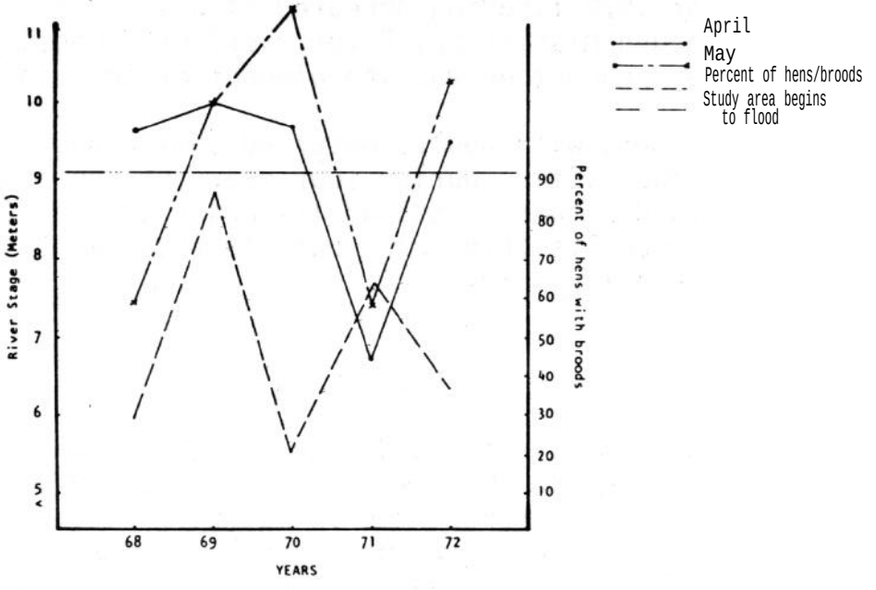

Figure 2. Maximum Mississippi River stage correlated with percentage of hens with broods, Bolivar-Washington Counties, Mississippi.

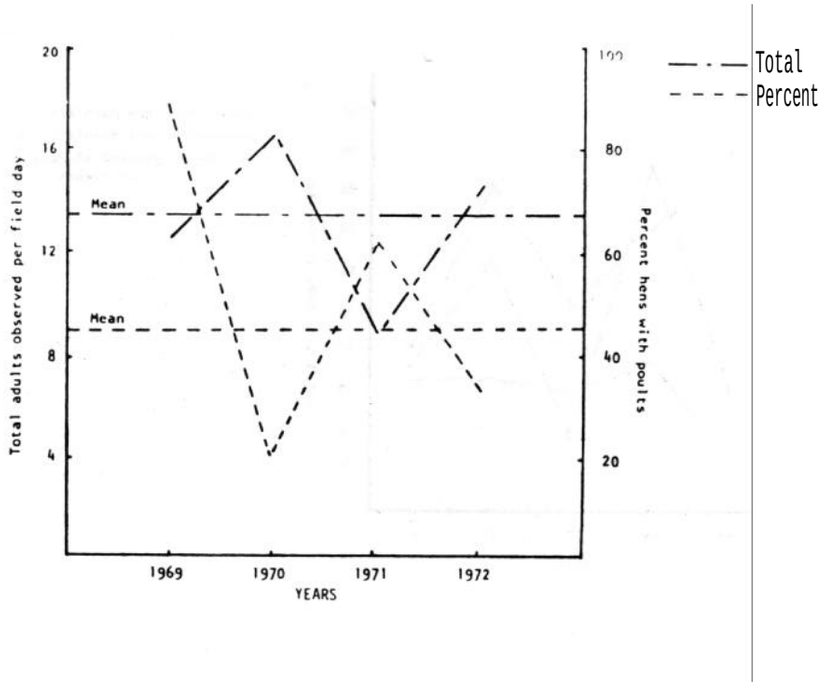

Figure 3. Relationship of adults observed per day and percent hens with poults during August (1969-72), Bolivar-Washington Counties, Mississippi.

During 1970 and 1972 flooding appeared to have adversely effected turkey reproduction. Although Mississippi River overflow flooded parts of the study area in 1969, turkey production was the highest of any year studies (Fig. 2).

The percent of hens with poults observed during August was used as an index of turkey productivity. During four years of the study, an inverse relationship was found between total adults observed per field day and percentage of hens with poults (Fig. 3). Data on total adults observed per field day were not available for 1968.

DISCUSSION

Percent of hens without poults during August indicated that the highest productivity occurred during 1969, with 1971 second, 1972 third, 1968 fourth, and 1970 fifth. These differences cannot be fully explained by rainfall or flooding. May and June rainfall appeared to have no adverse effect on productivity when comparing rainfall with percent of hens with broods. No definite pattern was found between flooding and productivity; however, it should be noted that in 1970 when the highest flood stage occurred, turkey productivity was significantly lower than any other year of the study. It appears that a flooding stage of 11 m or above is necessary to significantly affect turkey reproduction.

CONCLUSION

For well over a decade the study area has maintained a very high turkey population. A high percentage of hens with poults was found in the years when adult turkey observations were low. It is recognized that additional data are needed before definite conclusions can be drawn, however, it is the opinion of the writers that population stress has a possible influence on turkey productivity in the study area.

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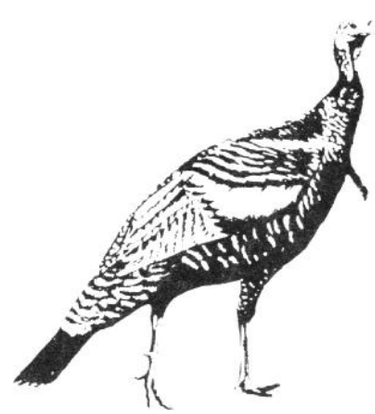

NATALITY AND MORTALITY OF WILD TURKEY POULTS IN SOUTHWESTERN NEW YORK

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Abstract: Initial nesting success for wild turkeys *(Meleagris gallopavo silvestris)* in southwestern New York was 23 percent in 1973 and 42 percent in 1974. In 1974 the juvenal hens were potentially more productive than the adults. Nearly 80 percent of the total hatch was lost by six to eight weeks after hatching in 1974. The greatest poult loss occurred during the first two weeks. Adult hens reared more poults per hen than did the juvenals. Twenty percent annual recruitment is considered enough to sustain the turkey population.

Key words: *Meleagris gallopavo silvestris,* radio-tracking

Several workers in the northeast have collected information on the average number of eggs per clutch, fertility, hatchability, nesting success, and brood size of the wild turkey. The information is limited however because it was collected from a variety of sources over large geographic areas. Further, in many cases the data were collected over a period of years, thereby obscuring yearly variations.

The development of reliable radio-tracking equipment and techniques now allows us to instrument a sample population, track the individuals through an entire breeding season, and obtain representative data that has been denied us in the past.

This paper is a preliminary report of our findings for the 1973 and 1974 breeding seasons. The study is a contribution of Federal Aid in Fish and Wildlife Restoration Project W-81-R.

We would like to thank Lee W. DeGraff and C. W. Severinghaus, New York State Department of Environmental Conservation, and Dr. Stephen W. Eaton, St. Bonaventure University for their advice and support during the course of the study. Many thanks go to the members of the field crew, Frank B. Church, James F. McGinnis, and Bruce D. Penrod. I also want to thank the men of New York State Department of Environmental Conservation Region 9 for their assistance, Frederick M. Evans in particular.

STUDY AREA

The study was conducted on a 476 square kilometer (km^2) area in Cattaraugus County, New York (Fig. 1). The area is a portion of the Allegany Plateau. The terrain is hilly with alternating ridges and valleys. Forests cover about 50 percent of the area and generally follow the pattern of the ridges. The

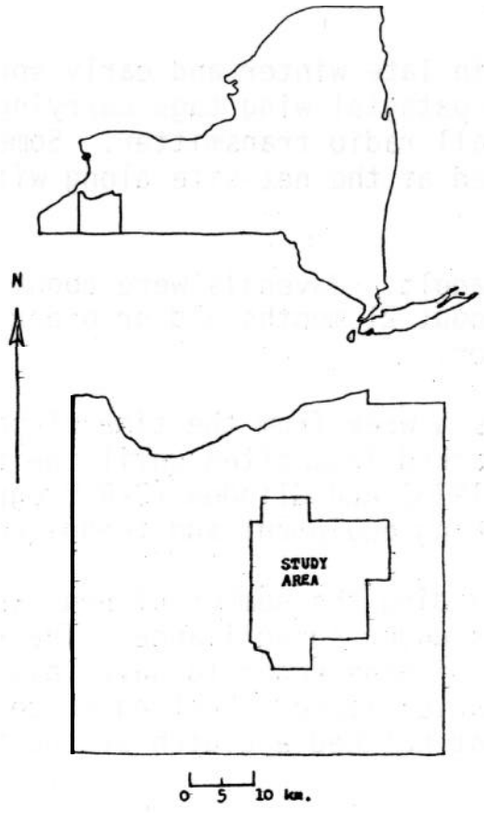

Figure 1. Location of the study area in Cattaraugus County, New York.

major forest type is northern hardwoods but oaks occur on some south- and west-facing flopes. Dairy farming takes place in the valley bottoms where the better soils occur.

TURKEY POPULATION

Wild turkeys returned to New York during the late 1940's. They came north across the Pennsylvania-New York border, into Cattaraugus County, as a result of a natural range extension by wild birds (Eaton, 1964). Although game farm birds were released in the county in the early 1950's, a breeding population of wild birds was established by the mid 1950's.

In 1959 the first fall, either sex, hunting season was held. Spring gobbler hunting started in 1968. The fall season length has subsequently been increased from three days to 20 days and the spring season has been lengthened from six days to 14 days. The bag limit has remained one bird per season.

DeGraff and Austin (1975) report that, based on harvest statistics, the population in the study area reached carrying capacity after 1972. The ratio of adult to juvenal hens in the late winter flocks has been about 60/40 in both 1973 and 1974 (Glidden, P-R annual job progress reports).

METHODS

Flocks of turkeys were rocket-netted in late winter and early spring of 1973 and 1974. Most hens were tagged with patagial wing tags carrying a colored streamer and were fitted with a small radio transmitter. Some hens and all toms were merely tagged and released at the net-site along with the radio-tagged hens.

Birds were aged as either juvenal or adult. Juvenals were about 9 months old at the time of capture. Adults were about 21 months old or older and had experienced at least one breeding season.

Hens were tracked at least three times a week from the time of capture until mid-summer. After July they were tracked less often until the transmitters stopped working. Austin, et al. (1973) and Glidden (P-R Progress Reports) describe in detail the radio-tracking equipment and techniques used.

The nesting rate was calculated by dividing the number of hens known to have laid a clutch by the number of hens under surveillance. The renesting rate was calculated by dividing the number of hens known to have laid a second clutch by the number of hens still under surveillance. Nesting success was computed by dividing the number of hens that hatched a clutch by the number that incubated.

Average clutch size, fertility, and hatchability were calculated for those nests where there was a complete egg count. Eggs were considered fertile if they showed any stage of embryo development. Fertility was calculated by dividing the number of fertile eggs by the number of eggs laid. Hatchability was computed by dividing the number of hatched eggs by the number of fertile eggs.

Poult survival computations were based primarily on flush counts although some observations were made at bait-sites. Usually no attempt was made to flush broods earlier than 18 days after hatching because younger poults seem reluctant to flush. Some broods were counted earlier if the situation favored an accurate count. If a hen was killed after hatching it was assumed that none of the poults survived. When a flushing attempt failed to reveal any poults with a hen the procedure was repeated to be certain that the hen had lost the whole brood.

RESULTS

1973

Fourteen adult and five juvenal hens were radio-tagged in 1973. Contact was maintained with 15 of them long enough to obtain production data through the initial nesting attempt. Premature transmitter package failures and the tendency of the hens to form multiple brood flocks resulted in the loss of renesting and poult mortality data.

Eighty-seven percent of the hens attempted to nest at least once, 10 of 12 adults and all three juvenals. Incubation began during the week of 15-22 April with the peak of onset of incubation occurring during the week of 6-13 May. Three (23 percent) were successful in hatching a clutch - two

Table 1. Nesting rate, nesting success, and renesting of radio-tagged hens.

Items Measured	Adult		Juvenal	
	No.	Percent	No.	Percent
		1973		
Initial Nesting Attempt				
Monitored	12		3	
Nested	10	83	3	100
Successful	2	20	1	33
Renesting Attempt				
Monitored	4		1	
Nested	2	50	0	0
Successful	0	0	—	—
		1974		
Initial Nesting Attempt				
Monitored	18		9	
Nested	17	94	9	100
Successful	7	41	4	44
Renesting Attempt				
Monitored	8		5	
Nested	6	75	2	40
Successful	4	67	1	50

adults and one juvenal. These three hens hatched at least 33 poults. One adult hen was killed during incubation by an avian predator. Five hens were tracked through the period when renesting would normally occur; two adults renested but neither was successful (Table 1).

Adult hens laid an average of 12 eggs per first clutch (Table 2). The small sample size prohibits an accurate assessment of clutch size for either juvenal first clutches or for second clutches.

1974

Twenty-one adults and nine juvenals were instrumented in 1974. Two adult hens were killed by mammalian predators at the beginning of the breeding season. Radio contact with one juvenal was lost in early May. Twenty-seven hens were tracked through the initial nesting attempt. Thirteen hens were tracked long enough to obtain renesting information. Fourteen successful hens were followed long enough to obtain poult mortality data through the third week after hatching and 10 were followed through the sixth week.

Seventeen adult hens and all nine juvenals attempted to nest, resulting in a nesting rate of 96 percent. Seven of the adults and four of the juvenals were successful, an initial nesting success rate of 42 percent. One adult hen

Table 2. Average clutch size of radio-tagged hens.

Items measured	1973		1974	
	Adult	Juvenal	Adult	Juvenal
First Clutches	6	1	10	6
Total Eggs	74	11	123	82
Average Eggs/Clutch	12	11	12	14
Second Clutches	1		5	1
Total Eggs	12		59	12
Average Eggs/Clutch	12		12	12

was killed by a mammalian predator during incubation. Seventy-five percent of the remaining adults attempted to renest, as did 40 percent of the juvenals. Sixty-three percent of the renesting hens were successful - four adults and one juvenal (Table 1).

Clutch size average 13 for juvenals and 12 for adults. The first clutch averaged 13 while the second averaged 12 (Table 2). Incubation began during the week of 28 April - 5 May with the peak of onset occurring during the week of 5-12 May. The peak of the initial hatch occurred during the week of 2-9 June.

Fertility averaged about 93 percent among the hens that nested successfully. Juvenals average 98 percent and adults 90 percent. The first clutch averaged 97 percent fertility and the second clutch 85 percent. Overall hatchability averaged about 98 percent (Table 3).

Table 3. Fertility and hatchability of eggs from successfully nesting radio-tagged hens, 1974.

Condition of Eggs	Adult hens		Juvenal hens	
	Number	Percent	Number	Percent
Initial Nests				
Laid	78		41	
Fertile	74	95	41	100
Hatched	73	99	40	98
Renests				
Laid	47		12	
Fertile	39	83	11	92
Hatched	38	97	10	91

Table 4. Mortality of poults hatched by radio-tagged hens, 1974.

Age of Poults when Counted (days)	Age class of Hens	Hens Counted	Live poults Counted	Percent Mortality
Hatching	Juvenal	4[1]	50	
	Adult	10	107	
8-14	Juvenal	4	17	66
	Adult	10	51	52
15-21	Juvenal	4	14	72
	Adult	10	47	56
22-28	Juvenal	2	0	100
	Adult	9	37	65
29-35	Juvenal	2	0	100
	Adult	9	31	71
36+	Juvenal	2	0	100
	Adult	8	22	79

[1]Includes only a portion of the hens used to calculate fertility and hatchability in Table 3.

The initial nesting contributed 125 (69 percent) poults to the population. Renesting added another 55 (31 percent). Adult hens contributed 118 poults (66 percent) and juvenals added 62 (34 percent). Juvenals hatched 13 poults per hen and adults hatched 11 (Table 4).

In the summer of 1974 adult hens lost 52 percent and juvenals lost 66 percent of the 12 poults the first two weeks after hatching, or an overall average of 57 percent. One adult hen was killed by a mammalian predator during this period and one adult and one juvenal each lost her entire brood. The cause of the brood losses is unknown.

During the third week after hatching another adult was killed by a mammalian predator and a juvenal lost her whole brood. Again, the cause is not known.

By the sixth week after hatching 10 hens could be accounted for, two dead, three broodless, and five that had reared 22 poults. The average brood size for these five hens was 4 poults. The 22 surviving poults represented 20 percent of the poults known to have been hatched by the 10 hens (Table 4).

DISCUSSION

The data illustrate differences in both the gross and the net reproductive abilities of adult and juvenal hens. Juvenals had a higher nesting rate

and higher initial nesting success than adults in both 1973 and 1974. In 1974 they laid more eggs per first clutch than the adults and displayed higher fertility as well. Adult hens, on the other hand, renested more frequently and more successfully than juvenals and hatched fertile eggs at a slightly higher rate.

The differences tended to compensate one another in 1974 so that neither age class enjoyed a significant *gross* reproductive advantage. Sixty-six percent of the poults were hatched by adult hens (69 percent of the successful hens), and 34 percent by juvenal hens (31 percent of the successful hens).

Adult hens, however, seemed to have a *net* reproductive advantage. For the first three weeks at least, adult hens lost 16 percent fewer poults than juvenals.

The results of this study indicate that an established turkey population can be sustained with a poult mortality as high as 80 percent. For example, an 80 percent mortality of the 183 poults hatched in 1974 would result in a survival of about 18 hen poults (assuming a 50/50 sex ratio). Adding these 18 hen poults to the 25 surviving hens (29 minus 5 lost to predation during the spring and summer) results in a total fall population of 42 hens. Assuming 25 percent fall hunting mortality (DeGraff and Austin, 1975) and no winter mortality (we have observed none the past two winters), the hen population the following spring should consist of 31 individuals - 18 adults and 13 juvenals. This adult/juvenal ratio of 58/42 compares favorably with the 60/40 ratio we have been obtaining the past two years.

Of course, these figures represent only one set of circumstances. Another set of mortality factors (predation, hunting, and winter) would call for a different level of recruitment.

The natality and poult mortality rates determined by radio-tracking appear reasonable, but their validity awaits the collection of more data. This production study will be run again in 1975, hens and poults will be tagged again in the summer of 1975, tagged birds will continue to be recovered during the next few years, and a new aging technique developed at this center by Ward B. Stone will allow us to age all adult birds into year classes. This data will allow us to make more accurate evaluations and comparisons in the future.

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WINTER SURVIVAL OF WILD TURKEYS IN THE SOUTHERN ADIRONDACKS

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Abstract: The survival and behavior of an isolated population of wild turkeys (*Meleagris gallopavo silvestris)* was investigated in the southern Adirondack Mountains, 1966-73. Five winters had mild or average weather conditions and the turkey survival averaged 75 percent. Two winters were severe and the survival was only 55 percent. Although the wild turkeys were adaptable to extreme winter weather conditions, the severe winters caused sufficient mortality to limit population growth.

Key words: *Meleagris gallopavo silvestris*, mortality, behavior

Biologists rarely have the opportunity to study a wild animal population which is isolated and at the periphery of its range. Such a situation exists in the southern Adirondacks of New York where live-trapped wild turkeys were introduced in the mid-1960's from established turkey populations in southern New York. This paper presents observations on the winter survival and behavior of this detached population of turkeys from the fall of 1966 through the spring of 1973.

Appreciation is expressed to the following present or former employees of the New York State Department of Environmental Conservation who assisted in the considerable amount of field work that was performed: William Corbett, James Glidden, Ralph Dunmore, and Donald Schierbaum. Also many personnel of Management Regions 5 and 6 assisted on our surveys, in particular Richard Spinks and Martin Ayers. The study is a contribution of Federal Aid to Fish and Wildlife Restoration Project W-81-R.

STUDY AREA

Field studies were concentrated near the towns of Ephratah and Oppenheim in the southwest corner of Fulton County (Fig. 1).

The 259 square kilometers (km^2) study area lies at the transition between the heavily forested Adirondack Mountains to the north and the intensive agricultural lands of the Mohawk River Valley to the south. About half the area is forested with second growth northern hardwoods that are repeatedly lumbered. About l/4 of the area is in cultivated farmlands and the rest is abandoned farmland being invaded by brush and young trees. Two major stream valleys (Caroga and East Canada Creek) and several smaller streams drain south into the Mohawk River. These narrow stream valleys are mostly wooded along their steep sides. The topography is rolling to hilly and elevation ranges between 183 meters (m) in the south to 457 m in the northern portion.

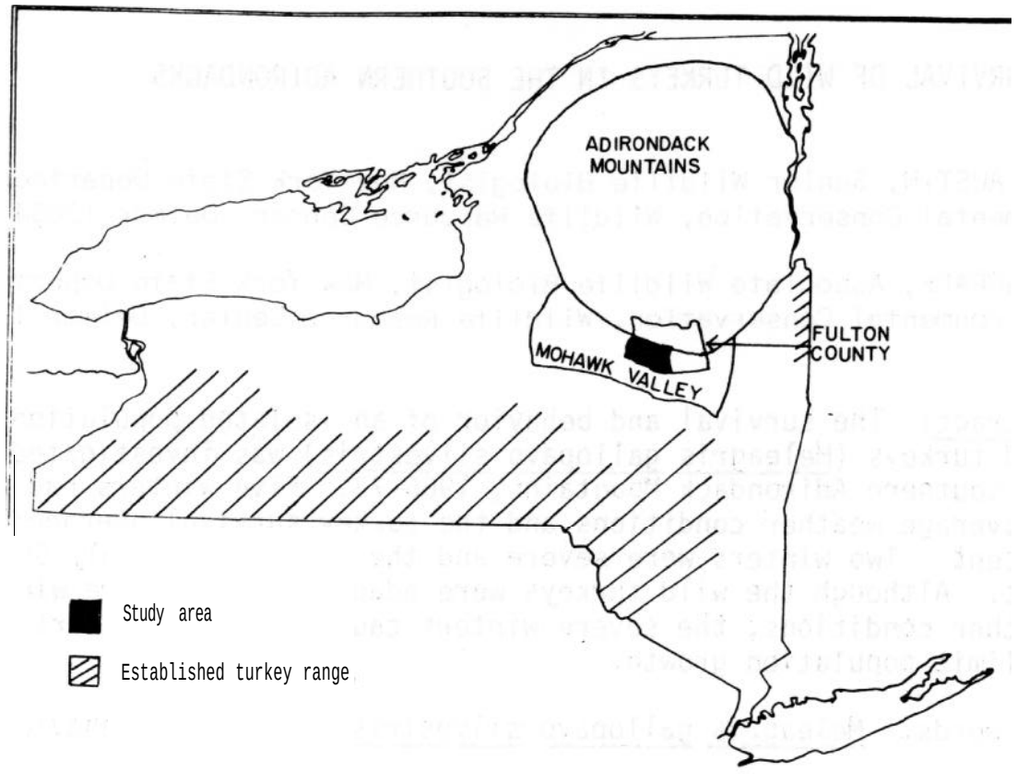

Figure 1. Location of the Fulton County wild turkey study area and established turkey range.

Human population is rural and averages about 10 persons per km^2, including a few small settlements.

CLIMATE

The area has cool, wet summers and cold snowy winters. Average annual precipitation is about 109 centimeters (cm), about l/4 falls as snow. Temperatures average 21°C in July to -7°C in January. Total snowfall during a severe winter (i.e. 1970-71) is about 343 cm and only slightly less, 254 to 305 cm during a mild winter. Snow flurries are frequent.

Weather data for 1965-73 were obtained from the weather station at Gloversville, about 32 km east of the study area at an elevation of 262 m. As a means of comparing the station data with study area conditions, snow depths and maximum and minimum temperatures were recorded during the winters of 1965-66 and 1966-67 near the center of the study area (elevation 366 m). Average minimum temperatures recorded on the area were comparable to the Gloversville station. Average snow depths on the area generally exceeded those for Gloversville by 5 to 20 cm. The difference of snow depths tended to increase during late winter. However, since turkeys tended to seek south slopes at lower elevation during the winter we believe the Gloversville records to be a reasonable representation of winter conditions.

The average monthly snow depth is the average of each day with a depth of 2.5 cm or more. The average monthly minimum temperature is the average of each day's minimum temperature.

METHODS

Eight turkeys were trapped from the western Catskills and released on the study area in the winter of 1964, and 11 birds were transferred from southwestern New York in the winter of 1966. These releases resulted in a self sustaining turkey population that has not been hunted to date.

A comparison of fall and spring populations was the basis for calculating survival rates. Two kinds of population figures were made, known minimums and estimated maximums. Known minimums were based on our observations of flocks or an interpretation of signs obtained by techniques such as baiting, cannon-netting, track counts, gobbling tom routes, and radio tracking (Austin et al. 1973). Estimated maximum populations included the known flocks and unverified reports of turkeys by residents.

A minimum survival rate was calculated from spring minimum population : fall maximum population. A maximum survival rate was calculated from spring minimum population ÷ fall minimum population. Calculation for the last two winters (1971-72, 1972-73) are less accurate because all population estimates were based on reported observations. All survival rates are for the period generally beginning in November and ending the following May.

Seasonal movements by birds migrating out of the study area and back in again occurred frequently. Such flocks were considered as part of the study area population and were included in the population estimates.

RESULTS

Winter Snow Conditions

Five winters were characterized as mild or average and two as severe (Table 1), based on the duration of powder snow sufficiently deep to stop turkey movements.

Table 1. Snow depths and general weather conditions in Fulton County for November-April, 1966-73.

Winters of Measurement	Days with 2.5 cm or more snow	Days with 30 cm or more snow	General Weather Condition
Ten year average	113	37	
1966-67	109	56	average
1967-68	114	16	average
1968-69	112	58	average
1969-70	127	94	severe
1970-71	128	101	severe
1971-72	118	27	average
1972-73	115	0	mild

Mild winter

During the mild winter of 1972-73, snow depths averaged under 20 cm during all winter months. Minimum temperatures averaged warmer than -12°C all months.

The duration of snow cover over 2.5 cm was 115 days, but there were no days with a snow cover over 30 cm. Turkeys had virtually unlimited ability to move about during the entire winter.

Average winters

During the four average winters snow depths averaged under 20 cm during November, December, and April. During mid-winter (January, February, and March) snow depths were usually between 20 and 38 cm. Minimum temperatures averaged between -15°C and -9°C during January and February and above -9°C all other months.

The duration of snow cover over 2.5 cm was 90 to 115 days, and 16 to 58 days for snow cover over 30 cm (Table 1). Snow-free periods of one to three days duration occasionally occurred in early or in late winter.

Powder snow exceeding 15 to 20 cm was uncommon and usually lasted no more than several weeks. It was more common to have less than 15 cm of powder snow on a packed base or crust that could support the weight of a turkey from late December to early March.

Spring seeps were unfrozen during most of these winters.

Severe winters

Snow depths during the severe winters of 1969-70 and 1970-71 averaged 38 to 76 cm for the months of January, February, and March. Average minimum temperatures were about 3" to 6°C below normal during January. Deep powder snow averaged from 30 to 61 cm during a 6-week period from late December to mid-February. Snow cover exceeding 2.5 cm for more than four months, and was in excess of 30 cm for over three months. Most spring seeps were frozen during mid-winter.

Survival

The minimum survival for three of the five average winters ranged from 50 to 82 percent, an average of 61 percent (Table 2). The average maximum survival for all five mild and average winters ranged from 71 to 100 percent, an average of 75 percent. We were unable to document when or how the mortality occurred but some was probably a result of poaching by deer hunters during the fall in the northern part of the area.

Loss due to predation was not observed during the fall or winter but the loss to predators of four out of eleven radio-equipped hens was documented during spring and summer of 1970 and 1971 (Austin et al. 1973).

Table 2. Fall and spring populations and winter survival of wild turkeys in Fulton County from 1966 to 1973.

Winter	Number of Turkeys in the Fall		Number of Turkeys in the Spring	Percent Survival	
	Known Minimum	Estimated Maximum	Known Minimum	Max.	Min.
1966-67	14	17	14	100	82
1967-68	22	31	19	86	61
1968-69	24	34	17	71	50
1969-70	36	60	21	58	35
1970-71	38	50	20	53	40
1971-72	--	38	38[1]	100	
1972-73	--	43	34[1]	79	

[1]Data comparable to estimated maximum fall populations and based on reported sightings.

The calculated maximum survival over the two severe winters was 55 percent and the calculated minimum survival was 37 percent (Table 2). This was a 20 to 24 percent increase in mortality over the five milder winters. We believe that this additional mortality occurred during the winter rather than the fall, and that it was directly or indirectly caused by extremely deep snow and cold temperatures..

Behavior

Our observation while tracking birds on snow indicated that a powder snow of about 15 to 20 cm limited the daily movements of flocks. Powder snow deeper than 30 to 38 cm practically stopped all turkey movement on the ground.

Flocks tended to move in a southerly direction toward the Mohawk River Valley during the winter. Elevations in this winter range were 152 to 244 m lower than their summer range. This movement was two or three km during average winter conditions but up to a maximum of 13 km during a severe winter. The turkeys sought areas near or in the north-south stream valleys and the adjacent farmland, the south facing slopes and the overgrown brush land. Some flocks were observed to begin moving in a southerly direction during late summer or early fall.

Even during average winters, snow prevented the turkeys from scratching to bare ground for several months, hence they depended on buds and fruit of shrubs, farm grains, and ferns which were above snow level. These kind of foods became more plentiful as turkeys moved south toward the Mohawk Valley away from the Adirondacks. Spring seeps were seldom utilized during mid-winter, even when unfrozen, but use was noted during March and April.

During 1969-70 a flock of seven turkeys came near a human residence and was fed grain. After the snow settled, and the turkeys could walk easily, they left the feeding area (mid-February). Even though 61 to 76 cm of snow remained for an additional four to six weeks, six out of seven birds survived on natural foods the remainder of the winter.

During 1970-71 a flock of 15 birds split into groups of one to four during six to eight weeks of deep powder snow. Some of these fed at our bait sites. Three birds disappeared during this period (presumably killed). The remaining 12 joined into a single flock in late February after the snow crusted.

DISCUSSION AND CONCLUSIONS

We concluded that 64 to 87 percent of a fall population of wild turkeys could survive without any artificial feeding under average or mild winter weather conditions in the southern Adirondacks. Turkeys moved to lower elevations and to open south exposure slopes where powder snow was not as deep nor lasted as long as at high elevations. Even with snow depths exceeding 30 cm and lasting for one to two months turkeys could move freely on snow and find sufficient food. Short periods of powder deeper than 15 to 20 cm and lasting several weeks hindered turkey movements but did not cause any significant loss.

During two severe winters survival was about 20 to 24 percent less than during milder winters. Although direct evidence was lacking the greater mortality was probably related to the weather, directly to starvation or indirectly to increased vulnerability to predation or illegal shooting. During periods when a powder snow depth of 30 to 61 cm lasted six to eight weeks, turkeys readily accepted and benefited from feed put out by rural residents of the area.

Mortality occurring during severe winters in Fulton County about equals annual mortality rates given for turkeys (Mosby 1967) in Virginia. Productivity in the Fulton County population does not exceed and may be lower than other turkey populations (Austin et al. 1973), probably because of the mortality during the occasional severe winters.

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WINTER MORTALITY AND SUPPLEMENTAL FEEDING OF TURKEYS IN PENNSYLVANIA

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Abstract: During a 12 year study in northcentral Pennsylvania, wild turkeys (*Meleagris gallopavo silvestris*) starved in four winters when extended periods of deep powder snow prevented their foraging for food. More than half the turkeys at higher elevations died, even when supplemental food was provided. Turkey populations usually recovered in one breeding season and appeared more dependent upon the previous summer's reproductive success than upon the mildness of the preceding winter or the number of breeders available.

Key words: *Meleagris gallopavo silvestris*, winter starvation, population losses and recovery, supplemental feeding

The natural movement of wild turkeys northward to Pennsylvania's vast Allegheny Plateau occurred during the late 1940's and early 1950's (Wunz 1973). None were known to exist there historically (Wunz and Hayden 1967). It is not known whether the eventual acceptance of this region by turkeys was due to changes in vegetative composition or to a micro change in winter climate that resulted from logging and partial clearing of the original conifer forest. Because periodic severe winters occur in this region, the Pennsylvania Game Commission started a supplemental winter feeding program that reached a peak in the 1950's and early 1960's. At that time the Commission was spending more than $60,000 annually for corn to fill more than 2,000 feeding stations. Rising costs and a growing suspicion that feeding was impractical caused the Commission to discontinue the program, except for emergencies, in 1970.

Two experiments with penned birds (Gerstell 1942, Hayden and Nelson 1963) demonstrated that turkeys could live for two weeks without any food and lose 40 percent of their normal body weight before succumbing. The fasts did not seriously reduce fecundity of the surviving birds. As a follow-up to these tolerance tests, we started a long term field study in 1962 to determine the extent and causes of winter mortality and if losses could be prevented by supplemental feeding.

The authors thank all Game Commission biologists and officers that helped census the turkeys. Special thanks go to Game Protectors John Putnam and Denver McDowell for their help in initiating and carrying out various phases of the study, and to William Drake for computing the weather severity index. Glen Bowers, Harvey Roberts, Dale Sheffer, and John B. Lewis reviewed the manuscript and made helpful suggestions. The study was financed through Pennsylvania's Federal Aid Project W-46-R.

STUDY AREA

The 263 square kilometer (km^2) study area was in the Potato creek drainage upstream from the town of Smethport in McKean County. The area was divided into three units, the headwater, middle, and downstream. All units are forested with northern hardwoods of cherry (*Prunus serotina* Ehrh.), maples (*Acer saccharum* March, *A. rubrum* L.), beech (*Fagus grandfolia* Ehrh.) and associated species, with some red oak (*Quercus borealis* Michx. occurring on a few of the drier ridges of the two downstream units. The understory is sparse due mainly to overbrowsing by deer (*Odocoileus virginiana*).

Elevations ranged from 460 meters (m) on the stream bottom up to 760 m on the highest plateau. Relief was least on the headwater unit and most precipitous on the downstream unit. Seventy-four percent of the land was above 610 m elevation on the headwater unit, 51 percent on the middle unit, and 43 percent on the downstream unit. Agricultural lands and reverting fields, mostly in stream bottoms and lower slopes, comprised 4 percent on the headwater unit, 10 percent on the middle unit, and 25 percent on the downstream unit. Human activity was greatest on the downstream unit, but due to a greater proportion of farmed and reverting fields and to a more varied forest, it was considered superior to the other units as turkey habitat.

METHODS

Winter mortality was measured by comparing results between early and late winter censuses. Supplemental feeding was evaluated by dividing the study area into units and comparing turkey populations and mortality between units where feeding was in progress with those where the practice had been discontinued. The chance of results being influenced by ingress or egress was minimized by selecting a study area nearly surrounded by a high ridge which turkeys were unlikely to cross during periods of deep snow.

Feeding stations on the study area consisted of hoppers or cribs, which were filled with ear corn and mounted on a latticework arrangement of poles to discourage deer use. Artificial feeding was stopped at all stations on the headwater unit at the start of the study. Feeding continued on the middle unit for two years until 1964 and on the downstream unit until 1965. Stations have not been operated on the entire study area since 1965.

Turkey populations were estimated from tracks in the snow. This snow track census has proved reliable in Pennsylvania provided no snow falls for at least two days before censusing, and sufficient snow covers the higher elevations to force turkeys down to lower slopes and valley bottoms. With turkeys concentrated on their winter ranges, one man on snowshoes could census more than 12 km^2 per day. Snowmobiles were used where the terrain was suitable. When snow conditions permitted, the area was censused in early January and again in late March.

No special searches were made for dead or weakened turkeys. Those found were picked up incidentally by woods workers or by project personnel during census work. To be counted as a starvation victim, the carcass had to be emaciated and other primary causes of death ruled out by autopsy or circumstances.

Weather records were taken from nearby U. S. Department of Commerce weather stations. Winter severity, indices were obtained by adding days of minimum temperatures less than -13°C to days of snow cover over 15 centimeters (cm). Data for the past 23 years were included to determine the frequency of severe winters over a longer time span than this study represented.

RESULTS

Weather Conditions

Weather records show that about one out of three winters is harsher than usual (above the index level of 100) in this section of northern Pennsylvania (Table 1). Chances of a very severe winter (exceeding an index of 130) are approximately one per five years. During the 12 years of this study four winters exceeded the index level of 100, and two of these (1963 and 1970) were rated the most severe during the 23-year period that indices have been computed.

Table 1. Weather data from Kane, Pennsylvania weather station, 26 km west of study area.

Winter	Number Days With Min. Temp. < -13°C	Number Days With Snow Accumulation > 15 cm	Severity Index
1952	28	53	81
1953	14	4	18
1954	24	15	39
1955	29	61	90
1956	36	70	106
1957	25	37	62
1958	40	71	111
1959	52	82	134
1960	29	55	84
1961	48	84	132
1962	39	9	48
1963	52	105	157
1964	40	93	133
1965	29	22	51
1966	30	20	50
1967	28	36	64
1968	43	39	82
1969	29	32	61
1970	54	113	167
1971	36	68	104
1972	40	44	84
1973	29	26	55
1974	22	11	33

Snow covered the ground continuously from 6 December 1962 until 25 March 1963 and accumulated to more than one meter (m) depths at higher elevations. Low temperatures (down to -32°C) helped raise the index level to 157. An index of 133 was recorded for the next winter (1964). Then a series of five mild winters followed. The 1970 winter, with an index of 167 was similar to the 1963 winter in severity. The 1971 winter was somewhat less severe (104 rating) and the three that followed have been progressively milder.

Turkey Population Trends

At least one census was conducted on the headwater and middle units during 10 winters and during 6 winters on the downstream unit. Due to personnel shortages or snow conditions, planned counts in early and late winter could not be run during most winters, however, both counts were completed during three of the severe winters. Unfortunately, the first count in 1970 could not be done until after severe early winter weather had already affected the population.

Turkey densities were at a low level on the headwater and middle units until 1968 when phenomenal reproduction occurred and populations soared (Fig. 1). The population peaked again in 1971, following good reproduction in 1970. By 1972, however, the population had dropped to previous low levels. Turkey populations tended to follow similar trends on all units.

Mortality

Twenty-five starved turkeys were found on the area during the four hard winters (Table 2). Most of these (17) were found in 1963 and 1970, the two

Table 2. Overwintering turkey loss on the McKean County area.

Year	Number of Dead Turkeys				Percent Population Change from Early to Late Winter	
	Headwater Unit	Middle Unit	Downstream Unit	Total	Headwater Unit	Middle Unit
1963	4	5	0	9	-63	-57
1964	1	3	0	4	—	—
1965 to 1968	0	0	0	0	—	—
1969	0	0	0	0	+29	—
1970	5	3	0	8	—	—
1971	4	0	0	4	-56	—
1972 to 1974	0	0	0	0	—	—
Total	14	11	0	25		

worst winters. None were found during eight milder winters. Fourteen dead turkeys were found on the headwater unit, 11 on the middle unit, and none on the downstream unit. Most mortalities were located near 550 m in elevation. All sex and age classes of dead turkeys were similar to their proportion in the population.

All starved turkeys died during prolonged periods (two weeks or longer) of low temperatures and deep snow. Most of them were found under conifer groves, which are typical roosting cover during harsh winter weather. Crops of dead birds usually contained only a few buds or conifer needles, which indicated that they preferred to remain in roosting trees rather than risk foundering in a powder snow.

The bulk of starvation cases were in high valleys where deep and fluffy snow conditions persisted longer than at lower elevations. Turkeys attempting to winter above the 550 m elevation level in gradual gradient valleys, such as on the headwater unit, were liable to be trapped by sudden deep snowfalls. This was evident in the comparison of census results from four drainages on the headwater unit during two severe winters (Table 3). All drainages lost birds from January to March, but losses were far greater on the East Branch and Havens Brook valleys which are at higher elevations and more densely forested than Potato Creek and West Branch. All but two of the dead turkeys found on this study unit were from East Branch and Havens Brook.

Effects of Mortality on Populations

During the severe winter of 1963, the decrease in turkey counts was 63 percent on the headwater unit and 57 percent on the middle unit (Table 2). A large overwinter drop (56 percent) also occurred on the headwater unit during the harsh winter of 1971. But during the one mild winter (1969) that two counts were made, the late winter census turned up 29 percent more turkeys than in early winter. Finding more birds in the second census was a likely

Table 3. Census results from four drainages in the headwater unit of the McKean County study area during the 1963 and 1971 winters.

Drainage	Month of Census	Number of Turkeys	
		1963	1971
Havens Brook	January	12	26
	March	0	5
East Branch	January	10	32
	March	4	6
West Branch	January	5	46
	March	2	30
Potato Creek	January	8	25
	March	7	22

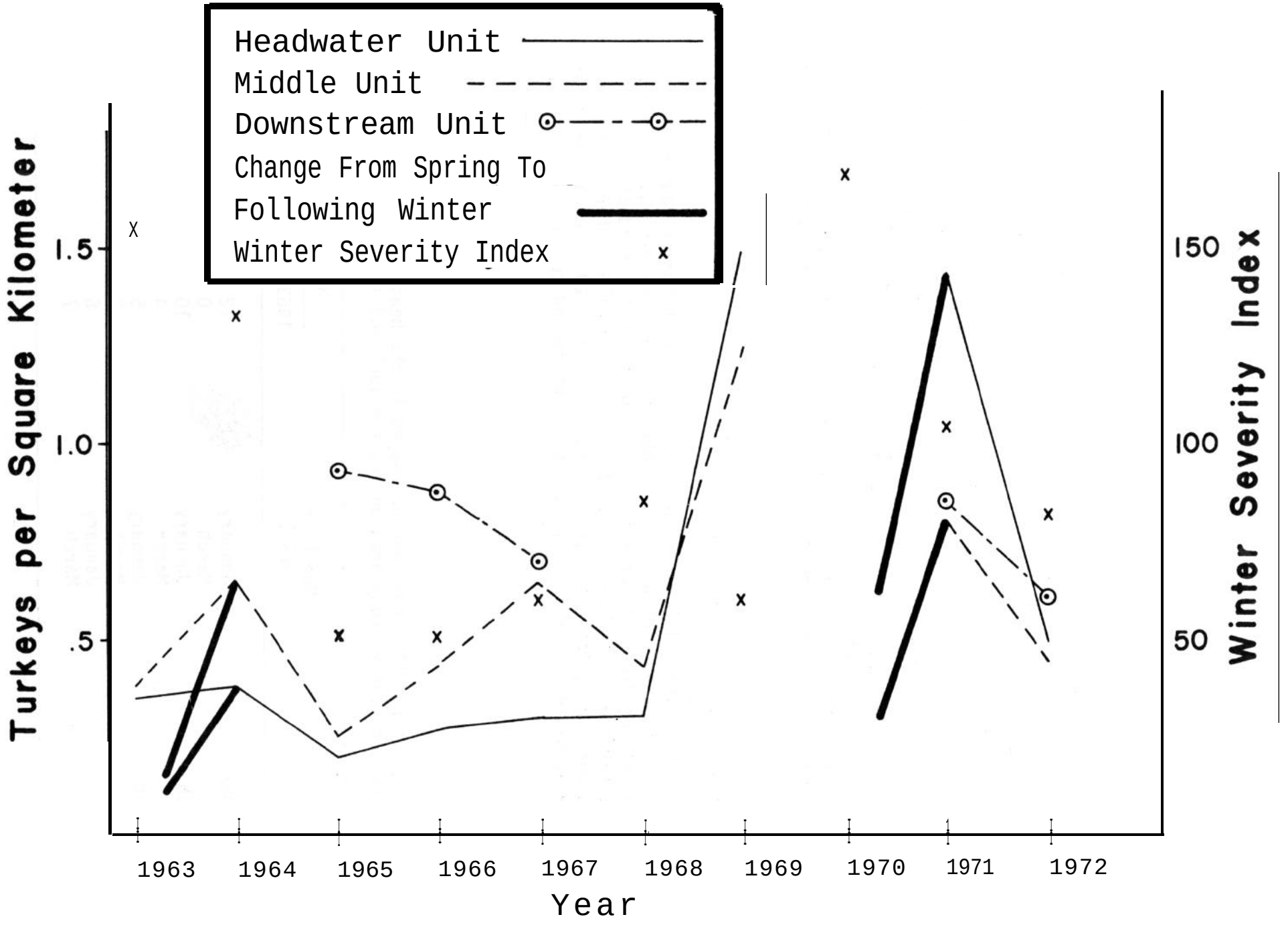

Figure 1. Winter turkey population trends on the McKean County study area.

occurrence in a mild winter when all flocks had not yet drifted down to their winter range and were sometimes missed in the first census.

The rate of population recovery from the periodic winter kills varied. Populations bounced back in only one breeding season following the severe 1963 and 1970 winters. But following the 1964 winter there was no immediate recovery. The low populations that persisted from 1964 until 1968, in spite of the series of mild winters, and the dramatic increases that occurred after only one breeding season in 1963, 1968 and 1970 suggested recovery rates and subsequent populations were independent of the number of breeders surviving the winter (Fig. 1). For example, the highest turkey populations on the study area were produced by low or average number of breeders in 1968 and 1970, whereas the large breeding densities in the spring of 1969 resulted in poor reproductionand decreased populations.

Feeding Evaluation

Despite supplemental feeding on the middle unit, the overwinter population loss of 57 percent during the 1963 winter was similar to the 63 percent loss on the headwater unit where there were no feeding stations. Also, eight starved turkeys were found on the middle unit during the winters 1963 and 1964 when feeding stations were operated. In comparison, five dead turkeys were found on the headwater unit (Table 2). Even though the number of feeding stations was increased to 12 in 1964, mortality still occurred on the middle unit, and the population the following years was essentially the same as on the headwater unit. Populations on both units had decreased by 1965 (Fig. 1).

DISCUSSION

Extent of Winter Loss

Due to the paucity of published information about weather-caused mortalities of wild turkeys, a questionnaire was sent to selected states and Canadian provinces. Among 22 replies, only Arizona, Utah, Wisconsin, Massachusetts, and New Hampshire had evidence of significance winter losses (L. Packard, F. Coles, C. Smith, J. Cordoza, D. Allison, personal communications 1974). The latter three indicated lasting harm to their turkey populations. New Hampshire's flock of introduced West Virginia wild birds may even face extirpation, while transplanted New York turkeys seem unaffected by Vermont's winter weather. Hard winters decimated Wisconsin's farm-origin turkey flocks, whereas Michigan's turkeys from the same stock have experienced little loss (Ignatoski 1973; V. Janson, personal communication 1974).

The respondents from Arizona and Wisconsin generally agreed with our observations that powder snow in excess of 0.5 m and low temperatures that kept the snow fluffy for more than two weeks were the main causes of turkey starvation. None of the respondents indicated that low temperatures alone caused turkey deaths.

Our observations on the study area and throughout northern Pennsylvania indicate that most wild turkey starvations occur in the higher valleys or on broad plateau tops where powder snow persists and turkeys are apt to be trapped by snowstorms. Only a few starvation losses have been reported from more rugged terrain where turkeys could reach lower elevations with a

relatively short downhill flight. In these deeper valleys, turkeys have access to spring seeps, plowed roads, and cleared hillsides where sun- and wind-packed snow can support foraging turkeys. Neither has significant loss been reported from the dairy-farmed land extending along the New York border. Here turkeys commonly feed on south facing hillside fields or where cow manure has been spread. A similar situation exists in Vermont (J. Wallin, personal comnunications 1974).

Preventing Winter Loss

Periodic winter culling may be biologically desirable and tolerable in an under-hunted population. But we expect that maximum turkey harvest limits will eventually be reached as a result of rapidly growing hunting pressure in Pennsylvania. Then any additional loss from starvation could suppress the population or delay its recovery. Even now, severe winters lessen the spring hunting success over large areas of the Allegheny Plateau, and this reduced success may linger into the fall season. Our management aims are to stabilize, as well as raise, this fluctuating northern Pennsylvania turkey population. Since brood raising habitat is generally adequate and no other means of influencing reproduction are within our control, options seem limited to finding ways to decrease winter loss.

A number of states had winter feeding programs, but the effects on turkeys were often uncertain. In West Virginia, some turkey losses were expected in high mountain basins during a severe winter despite supplemental feeding (Lindzey 1947). In Massachusetts, supplemental feeding apparently reduced turkey losses (Pierce 1967), but statewide application was considered impractical and feeding was stopped in 1970 with no apparent effect on the population (J. Cordoza, personal communications 1974).

Supplemental feeding may have prevented starvation of some turkeys in our study, but substantial losses occurred among flocks that were not close to a feeding station at the onset of snowstorms. Turkeys were reluctant to fly down from their roosts into deep snow even when emergency food was provided. Thus, the stations often remained isolated from turkeys just when they were needed most. Similar observations have been made in Wisconsin (Dreis, Smith and Myers 1973).

The importance of access to food was further demonstrated on the North Fork hunting preserve in Elk County. Five kilograms (kg) of grain were sprinkled daily during the winter along four km of road frequented by 150 to 200 turkeys. No starved turkeys have been found in this area. The plowed road provided the turkeys access to both natural and supplemental food in the worst of winters (T. McKeon, personal communications 1974). Because the feeding was done in conjunction with routine maintenance activities, its cost was less than $1.00 per bird. The additional costs of plowing roads and daily applying feed would be prohibitive on public lands, however, except perhaps where wild stock is trapped for transplanting.

Experience in Pennsylvania showed that feeders need to be filled even in mild winters to keep the turkeys aware of the locations of food. This explains why emergency feeding, not started until the onset of severe winters, is usually ineffective. The vast network of annually operated feeding stations that would be needed to appreciably lessen periodic winter losses in Pennsylvania, however, would be unrealistically expensive to maintain.

Observations of turkey habitat use during our study suggested that longlasting land management practices, concentrated in areas where turkeys are most apt to starve, may be more feasible than artificial feeding for reducing losses. These include improvements to increase forage production in spring seeps, creating clearings or food plots on southern exposures, planting trees and shrubs which retain fruit during the winter, and maintaining conifer plantations for roosting cover.

CONCLUSIONS

During severe winters, which occur an average of one per three years, up to 60 percent of the wild turkeys may die on the Allegheny Plateau of Pennsylvania. Turkeys starve even when supplemental food is provided if extended periods of deep powder snow prevent their foraging for food. No practical way has been demonstrated to prevent starvation, but some comfort can be taken in the fact that an acclimated wild turkey population possesses a remarkable capacity to recover.

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INSECT AVAILABILITY AND USE BY TURKEYS IN FOREST CLEARINGS

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Abstract: Insect availability in forest wildlife clearings and under the forest canopy was evaluated in southwest Virginia from May to October 1971. Three age-groups of 120 domestic turkey poults were allowed to feed in four forest wildlife clearings and four matching plots under a nearby forest canopy. Crop and gizzard contents revealed no significant difference in the amount of insects eaten by the poults in clearings and forest plots, but showed that more vegetation was eaten in clearings by the oldest poults. Protein and calories were higher in insects than in the other food items examined. There were 25 times more insects present in the clearings than beneath the forest canopy.

Key words: *Meleagris gallopavo silvestris,* clearings, insects, turkey poults

Several authors have concluded that clearings are important in the management of eastern wild turkeys (*Meleagris gallopavo silvestris*) (Stoddard 1931, Mosby and Handley 1943, Wheeler 1948, Latham 1958). McGinnes and Ripley (1962) found that clearings in a wildlife area in Virginia played an important role in a tenfold increase of wild turkeys in five years. Lewis (1964) reported that clearings were extremely important to wild turkeys since the birds he saw were seldom found far from an opening.

Little information is available on foods eaten by young wild turkeys. Korschgen (1967) combined raw data from Michigan, Missouri, and Pennsylvania to come up with a 9.0 percent average animal matter of ingested foods, mostly insects. A study on the King Ranch in Texas (Beck and Beck 1955) showed the nutritive importance of insects in the diet of turkeys. The crops of 21 juvenile wild turkeys examined by Hamrick and Davis (1971) in Alabama substantiated their field observations that grassy openings are important in producing insect food for young turkeys.

Clearings are most often used by hens with broods in summer. In domestic turkey production, the recommended diet for poults during the first four weeks includes 25 percent protein (Marsden and Martin 1949). Insects are thought to be the major source of protein for young wild turkeys.

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This study evaluated insect availability for wild turkey poults in forest wildlife clearings and under the forest canopy and analyzed the protein and caloric content of food eaten by domestic turkey poults.

The study was cooperative among Virginia Polytechnic Institute and State University, Virginia Commission of Game and Inland Fisheries, and the Wildlife Management Institute. Financial support came from the U. S. Fish and Wildlive Service and a National Defense Education Fellowship. The paper is release number 72-17 of the Virginia Cooperative Wildlife Research Unit.

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MATERIALS AND METHODS

In early May 1971, 30 adult domestic turkey hens were moved from indoor facilities and placed in 40 x 40 meter (m) outdoor rearing pens on the University's turkey research farm near Blacksburg. Commercial poultry food was fed initially but gradually reduced to 50 percent normal daily/ration over a two-week period to force the hens to take native range foods. An adequate supply of water was provided near sheltered nesting boxes.

Initially, we attempted to use poults from partially wild pen-reared turkeys obtained from the Pennsylvania Game Commission. The stock died from unknown causes soon after hatching, therefore, we used a strain of bronze domestic turkey poults that were introduced to broody turkey hens in the open pens immediately following hatching. Rations were also reduced for the poults so they would learn to take natural food. Survival rate of these poults was satisfactory.

Four similar clearings, 0.8 to 1.2 hectares (ha) in size, were chosen for study on the Broad Run Wildlife Research Area of the Jefferson National Forest, Craig County, Virginia. Within each clearing two 6.1 x 7.6 m plots were marked and fenced. These plots contained some ladino clover *(Trifolium repens* L.) and panic grass *(Panicum* spp.), but orchard grass *(Dactylis glomerata* L.) was the predominant species.

Paired matching plots of identical size, but located beneath the forest canopy, were marked and fenced beyond the ecotone associated with the boundary of the clearings.

Six of the 2-week old poults that were reared at Blacksburg were released in each plot on 27 August, five were released on 14 September at 4 l/2-weeks of age, and four were released 4 October at 7 l/2-weeks of age. Each group was accompanied by one hen from the poultry farm. Birds were permitted to feed without disturbance for five to six hours before being killed. The crops and gizzards were then removed and preserved in formalin. During the initial sampling, a l/2-day period of acclimation was allowed prior to the feeding period and only the crops were collected. Most of the crops were empty in this first sampling, therefore, the adjustment period was discontinued and gizzards were also collected in the two subsequent samplings.

In the laboratory, crop and gizzard contents were washed and stored in a 10 percent formalin-rose bengal dye solution. This dye was primarily animal-matter specific and aided in identification of masticated insect material from the gizzard (Lackey and May 1971). Certain seed cotyledons and other vegetation also became dyed.

Vegetation, insects, grit, and unidentifiable material were sorted by a flotation technique (Lackey and May 1971). A table sugar solution having a specific gravity of 1.125 was used.

The separated material was dried at 60° to 62°C for 48 hours, weighed, and ground in a Wiley Mill with a 40 mesh screen. Proximate analysis tests were run to determine the percentage of crude protein (total nitrogen). Caloric values were determined with a Parr oxygen-bomb calorimeter.

A D-Vac vacuum machine was used to determine the relative abundance of insects on plots in the clearings and beneath trees. The nozzle of the D-Vac was passed slowly about 15 to 23 centimeters (cm) above the ground and the material was collected in nylon bags. This method of sampling seems to provide a very efficient means of obtaining those insects available to turkey poults. Inspection of the sampled areas revealed practically no insect activity after sampling. The D-Van samples were collected nearby while the poults were feeding. The insects and debris were placed in Berlese funnels for separation.

Steel and Torrie (1960) and Sokal and Rohlf (1969) recommended a transformation of data when percentages fell outside the 30 to 70 percent range. Thus, the percentages of insects and vegetation within the crop or gizzard were transformed to the arcsin and analysis of variance tests were calculated to compare their means. The means and analysis of variance were summarized by Martin (1972).

Table 1. The percent of insect material and vegetation in domestic turkey crops and gizzards August-October, 1971.

Date	Number of Poults	Habitat Type	Gizzard		Crop	
			Insects	Vegetation	Insects	Vegetation
8-27	24	Clearing			14.7	37.6
8-27	24	Forest			31.7	19.4
9-14	20	Clearing	2.3	81.4	14.2	58.1
9-14	20	Forest	3.6	78.3	25.7	45.0
10-4	16	Clearing	2.5	86.1	24.5	34.3
10-4	16	Forest	1.3	71.9	4.5	13.0

RESULTS

Table 1 summarizes the percent of material ingested by poults during the sampling periods.

Even though almost 25 times as many insects were collected in the clearings as under the forest canopy, the volume of insects eaten by domestic turkey poults was not significantly different between locations ($P \leq 0.10$), except in October. However, this final sample included poults that had fed heavily on a limited but concentrated supply of unidentified insect larvae.

Analysis of crops and gizzards collected during September and October revealed that significantly ($P \leq 0.05$) more vegetation was eaten by poults feeding in clearings than those in forested plots.

Crude protein content was 54 percent for insects collected in the D-Vac and 46 percent for insects collected in crops and gizzards. This was more than twice the crude protein content contained in plant material (15 percent) and unidentified material (20 percent). By comparing samples of insect material collected from crops, gizzards, and the D-Vac machine, we concluded that the softer body parts of insects would pass through the gizzard first and contain a higher percentage of protein than do the harder parts.

The caloric content of the insects was 5.3 kilocalorie/gram (Kcal/g), about 20 to 25 percent greater than the caloric content of the vegetation or unidentifiable matter.

DISCUSSION AND CONCLUSION

The peak of insect abundance is from late spring to early fall. Dalke et al. (1946) reported insects were at maximum numbers during June, which is close to the peak hatch time of the wild turkey (Mosby and Handley 1943). Perhaps this is the period during which the experiment should have been conducted, however, problems with the wild turkey poults prohibited sampling at that time. We found numerous insects in the clearings during the sampling period of late summer and early fall, as have other investigators (Hoffman 1962, Eaton et al. 1970). Therefore, we feel that the lateness of the sampling period did not detract from the usefulness of the study.

Although the results show no significant difference between forest and clearings in the volume of insects consumed by domestic poults, the D-Vac machine revealed many more insects in the clearings than under the forest canopy. Obviously, birds need less feeding time in clearings to obtain equal numbers of insects.

The highly significant difference between forest and clearings in the amount of vegetation in both crops and gizzards in the October sample, suggests that vegetation may be an additional attraction of clearings.

Animals eat foods that are available, palatable, and that supply their nutritional needs. It is possible that wild poults could obtain sufficient protein from insects captured in the woods, but they probably prefer to forage in clearings because of the much greater abundance of insects and grassy vegetation there.

In future studies of this nature, poults and their guardian hens should be forced to depend wholly upon native foods for sustenance. Large open, grassy runways with associated woodland would be ideal. Barnyard turkey hens would be best as brooding stock. Sample plots of at least 0.45 hectares are recommended to simulate natural feeding conditions. The birds in this study spent a considerable time inspecting and pacing the fences. The length of the pre-sample period should be increased to several days to enable the poults to become adjusted to the plots. Differences in insect and plant life between rearing and sampling areas probably affect feeding behavior. Rearing on the sampling area could alleviate this problem.

Results of this study indicate that forest wildlife clearings planted to grasses and clover can supply an abundance of insects and vegetation which are nutritious and readily consumed by turkey poults. Clearings may be justified solely on the basis of turkey use, although they may also be of value to other kinds of wildlife such as deer, songbirds, and grouse.

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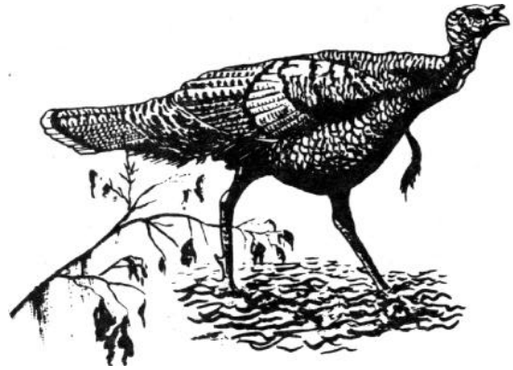

FOOD HABITS OF WILD TURKEY POULTS IN MISSISSIPPI

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Abstract: Eastern wild turkey (*Meleagris gallopavo silvestris*) poults, age 3-38 days, fed on a variety of habitats, but mostly along the edges of hayfields, pastures, or roadsides and in various forest types. The ratio of animal to plant food was 79:21 for poults in the 3-to-7-day age class, 54:46 in age class 8 to 14 days; 37:63 in age class 15 to 21 days; and 13:87 for poults 22 to 38 days old. Insects such as beetles, true bugs, and grasshoppers accounted for 83 percent of the total animal food, followed by snails, spiders, and pill bugs. Seeds from *Carex* spp. and *Rubus* spp. were the most important plant food items. Of lesser importance were seeds from *Scleria* spp., *Vicia* spp., miscellaneous grasses, and forbs.

Key words: *Meleagris gallopavo silvestris*, animal foods, food preferences, insects, invertebrates, arthropods, plant foods, seeds

The first few weeks of a wild turkey poult's life are probably the most critical, but little is known about their food requirements (Korschgen 1967). Insects appear to be important in the poult's diet (Wheller 1948, Latham 1956, Stoddard 1963, Schorger 1966, Healy 1974). The purpose of this paper is to present data on the food habits of wild turkey poults.

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STUDY AREA

The study was conducted on the Noxubee National Refuge and the adjacent Tombigbee National Forest and Mississippi State University Experimental Forest in east-central Mississippi. This general area has an established wild turkey population.

Several habitat types were present on the study area.

Upland Hardwoods Forest. Mature forests occurred on both well and poorly drained sites and were dominated by combinations of oak *(Quercus* spp.),

hickory *(Carya* spp.), and loblolly pine (*Pinus taeda*). The herbaceous layer was sparse, containing a few grasses, forbs, and vines.

Pine Forests. Pine-dominated forests ranged in stage of development from seedlings (pine plantation) to sawlog. The pine plantations were in the second and third growing season following clearcutting, site preparation, and planting. The vegetation was very dense and was dominated by grasses, vines, and hardwood sprouts. The small and large pole pine forests had very little herbaceous material on the forest floor, just a few scattered vines, grasses, and hardwood seedlings. The sawlog stands had a moderately dense herbaceous layer, mostly grasses, forbs, and vines. These stands were prescribe burned every third or fourth year.

Bottomland Hardwood Forest. Mature forests were dominated by red oaks in association with hickories and sweetgum (*Liquidambar styraciflua*). The herbaceous layer was very sparse, consisting of a few scattered forbs and vines. Winter and spring flooding was common and a lot of mineral soil was exposed.

Forest Openings. This habitat included a power line right-of-way, a refuge camping area, and an opening which was a remnant of an old field kept open by fire. The right-of-way and camping area were mowed annually and the camping area was also partially burned. Various forest types and ages surrounded the openings. The herbaceous layer on the openings was dense and was dominated by grasses and forbs, with some vines and hardwood sprouts.

Hayfields. These included fields of various sizes with combinations of native grasses, sedges, and forbs. Low sites had more sedges than grasses. Most fields were mowed twice a year.

Pastures. The vegetation consisted of various combinations of grasses, forbs, sedges, and some vines. The pastures were not improved and were only moderately used by cattle.

Roadsides. The roadsides were in the experimental forest. The vegetation was dense, low, and was dominated by grasses and forbs. Mowing was irregular, from early May to late summer.

The more common herbaceous plants in the study area were: panic-grass *(Panicum* spp.), Paspalum (*Paspalum* spp.), broom-sedge *(Andropogon* spp.), spike-grass *(Uniola* spp.), nut-rush *(Scleria* spp.), sedge(*Carex* spp.), lespedeza *(Lespedeza* spp.), vetch *(Vicia* spp.), fleabane *(Erigeron* spp.), goldenrod *(Solidago* spp.), thoroughwort *(Eupatorium* spp.), and sunflower *(Helianthus* spp.). Vines included poison ivy *(Rhusradicans),* honeysuckle (*Lonicera japonica*), dewberry and blackberry *(Rubus* spp.), and greenbrier *(Smilax* spp.).

METHODS

A captive flock of wild turkey mostly of Pennsylvania game farm origin, and a few wild turkey nests found in the study area were the sources of eggs. Upon hatching, the poults were banded and placed with a broody domestic chicken or a wild turkey hen. The poults were offered Purina Startena and water *ad lib.*

On the second day of adoption the hen and poults (brood) were released on a weedy pasture for an "educational" run. The poults learned to move with the hen, hunt for food, and follow the hen back into the brood cage. Conditions permitting, the poults education continued daily.

On the day of a food habits run, the brood was starved about six hours, transported to a sample habitat, released, allowed to feed three hours, herded back into the brood cage, and a certain number of poults were killed. Usually the poults were killed on a random basis, but sometimes the poult with the fullest crop was selected first. Most food habit runs were made on areas where either wild turkey nests, repeated single hens, or broods had been observed.

The gastro-intestinal tract from the base of the mouth to, and including, the gizzard was removed and placed in 10 percent isopropyl alcohol. In the laboratory, the esophagus and crop were treated as one unit and the proventriculus and gizzard were handled as another unit. The contents were air dried, separated, identified, counted, oven-dried at 87°C for eight hours, and weighed.

During 1973 the poults fed for 3 to 7 hours and the brood was not kept moving. The chicken was allowed to scratch for and capture food for the poults. In 1974, the chicken was not permitted to scratch for or capture food for the poults and the brood was kept moving. Also, two broods were often run on the same habitat to give a better sample. The data for 1973 and 1974 are presented separately.

A field assistant made sure the brood stayed on the specified habitat. On runs in fields, pastures, forest openings, or roadsides the field assistant kept the brood within 14 meters (m) of the forest-field edge. The poults fed in both field and forest.

Some wild turkey hens in the captive flocks incubated eggs and hatched poults. These hens and their poults, plus poults hatched in the incubator, were used on experimental food habits runs. When this method proved successful radio-transmitters (S. L. Markusen, Esko, Minn.) were placed on broody turkey hens and the hen and brood were released without a human attendant. At the end of the day, when the poults had stopped feeding and were being brooded, the hen would be located and several poults caught and killed. This method allowed the hen to choose the feeding area.

RESULT

Foods eaten in 1973

Data were obtained on 74 poults, 3 to 24 days old, from 15 May to 9 July 1973. The poults fed on 18 areas. The ratio of animal to plant foods eaten and the average amounts eaten, by poult age and habitat, are presented in Table 1.

The average animal to plant food ratio for all habitats was 70:30 for poults 3 to 7 days old, 43:57 for 8 to 14 days, 34:66 for 15 to 21 days, and 13:87 for poults 22 to 24 days old. Poults that fed on the coastal Bermuda grass hayfield and grazed pasture ate more animal than plant food regardless of age.

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Table 1. The amount and proportion of animal and plant foods eaten by turkey poults in relation to age and habitat, 1973.

Habitat	Age of Poult (days)	Number of Poults	Food Intake Per Poult			
			Animal		Plant	
			Gram	Percent	Gram	Percent
Pine Plantation	6 & 7	6	0.067	42	0.091	58
Pine[1] Forest	5 & 7	7	0.181	58	0.132	42
	10 & 13	4	0.057	18	0.253	82
	15 & 19	2	0.346	23	1.170	77
Forest Opening	6	2	0.077	25	0.230	75
	9	3	0.020	4	0.429	96
	19 & 21	2	0.201	20	0.800	80
Hayfield	4 & 7	4	0.460	92	0.039	18
	8 & 13	10	0.067	41	0.096	59
	19	1	0.000	0	0.695	100
Hayfield[2]	5	2	0.253	89	0.030	11
	8 & 10	8	0.285	68	0.131	32
	15	2	0.492	79	0.134	21
	22 & 24	2	0.510	87	0.076	13
Grazed Pasture	6	2	0.257	94	0.017	6
	11 & 12	2	0.687	74	0.238	26
	16	2	0.252	81	0.060	19
Clover[3] Patch	3	2	0.456	80	0.116	20
	8&9&13	5	0.517	63	0.306	37

[1] Large pole and sawlog stands.
[2] Dominated by coastal Bermuda grass.
[3] Plots of various red and white clovers (Trifolium spp.).

Insects made up a majority of the animal food on all runs except four, and accounted for 80.2 percent of the total animal food eaten. Snails contributed 10.6 percent, pill bugs (*Asellus oniscus*) 5.8 percent, and spiders 3.4 percent. Insects were eaten by every poult, but the frequency of occurrence was 37.5 for snails, 13.9 for pill bugs, and 86.1 for spiders.

On the basis of all identifiable insects, the percent dry weights were Homoptera 23.1, Coleoptera 22.3, Orthoptera 20.6, Lepidoptera 14.1, Hemiptera 13.2, Hymenoptera 4.1, and Diptera 2.6. Homoptera rated first by virtue of the large amount of leafhoppers eaten on the clover patches, however, Coleoptera was highest in all other habitats.

Seeds eaten by poults, in order of importance (percent of total dry weight), were sedge, dewberry, miscellaneous forbs, buttercup *(Ranunculus* spp.), wood-sorrel *(Oxalix* spp.), chickweed *(Stellaria* spp.), vetch, and miscellaneous grasses panic-grass, Paspalum).

Foods eaten in 1974

Food habits data were gathered on 312 poults, age 3 to 38 days. Poults were run from 30 April to 27 June and on 19 different areas.

A comparison of average animal and plant food, by age class and habitat, for all poults (240) run with chicken brooders is presented in Table 2. The average animal to plant food ratio for all habitats was 79:21 for poults 3 to 7 days old; 54:46 for 8 to 14 days, 37:63 for 15 to 21 days, and 13:87 for poults 22 to 38 days old. Poults 3 to 7 days old run on the same or very similar habitats, but on different (later) dates, exhibited similar animal to plant food ratios.

Table 2. The amount and proportion of animal and plant foods eaten by wild turkey poults run with chicken brooders in relation to age and habitat, 1974.

Habitat	Age Class (days)	Number of Poults	Food Intake Per Poult			
			Animal		Plant	
			Gram	Percent	Gram	Percent
Pine Plantation	3-7	0	--	--		
	8-14	7	0.020	6	0.299	94
	15-21	5	0.010	1	0.845	99
	22-38	5	0.063	12	0.467	88
Pine Forest (small pole)	3-7	22	0.068	60	0.045	40
	8-14	0	--	--	--	--
	15-21	0	--	--	--	--
	22-38	0	--	--	--	--
Pine Forest (sawlog)	3-7	20	0.052	76	0.017	24
	8-14	2	0.102	59	0.070	41
	15-21	4	0.064	20	0.323	80
	22-38	2	0.030	11	0.239	89
Mixed-Hardwoods and Pine (sawlog)	3-7	30	0.130	86	0.020	14
	8-14	0	--	--	--	--
	15-21	0	--	--	--	--
	22-38	0	--	--	--	--
Bottomland Hardwoods Forest (sawlog)	3-7	4	0.005	42	0.006	58
	8-14	12	0.054	32	0.117	68
	15-21	1	0.050	26	0.143	74
	22-38	5	0.021	5	0.397	95
Forest Openings	3-7	23	0.038	55	0.030	45
	8-14	10	0.143	53	0.125	47
	15-21	0	--	--	--	--
	22-38	0	--	--	--	--
Hayfields, Pastures,	3-7	31	0.245	84	0.046	16
	8-14	41	0.190	58	0.137	42
	15-21	9	0.183	42	0.248	58
	22-38	5	0.244	15	1.374	85

Table 3. The amount and proportion of animal and plant foods eaten by poults run with wild turkey hens with relation to age and habitat, 1974.

Habitat	Age (days)	Number of Poults	Food Intake Per Poult			
			Animal		Plant	
			Gram	Percent	Gram	Percent
Bottomland Hardwoods	8	6	0.071	60	0.047	40
Bottomland[1] Hardwoods	6	4	0.036	30	0.085	70
Hayfield	6	4	0.062	52	0.057	48
Hayfield	5	7	0.274	80	0.069	20
Pasture	7	6	0.434	87	0.065	13
	10	2	0.408	81	0.098	19
Roadside	3	6	0.092	87	0.014	13
Forest Opening	5	4	0.030	90	0.003	10
Pine Forest (small pole)	6	7	0.092	99	0.001	1
Pine Plantation	20-23	3	0.061	13	0.415	87

[1]Four poults killed after feeding in bottomland hardwoods for two hours and then four more killed after two more hours of feeding in a low, wet hayfield.

The food habits of 49 poults, age 3 to 23 days, that were run with wild turkey hens are presented in Table 3. Most of the poults were in the 3- to 7-day age class and animal to plant food ratio was 77:23.

Three four-day-old poults, run with a radio-tagged wild turkey hen ate 90 percent animal matter. The next day, two five-day-old poults, ate 97 percent animal food. Five poults, 26 and 27 days old, run with a radio-tagged wild turkey hen ate mostly (66 percent) plant food.

The total amount of food eaten by a poult in a three hour period in 1974 increased with poult age and was affected by the habitat on which the poult fed. Average total food intake by age class for poults run with chickens and on hayfields, pastures, and roadsides was 0.291 g (3-7 days), 0.327 g (8-14 days), 0.431 g (15-21 days), and 1.618 g (22-38 days). This was considerably higher intake than that by poults feeding on other habitats. Poults that fed on forest habitats showed similar gains in total consumption with age, but less than in hayfields, roadsides, or pastures.

The poults that were with a radio-tagged wild turkey hen all day ate very little at three days of age but averaged 0.292 g of animal and 0.032 g of plant food on the fourth day, and 0.536 of animal and 0.017 g of plant food after the fifth day of life.

Insects made up 87.4 percent of the animal food eaten, snails 6.4 percent, spiders 3.4 percent, and pill bugs 2.6 percent. Insects had the highest percent dry weight on all habitats. Insects had a frequency of occurrence of 100 percent, spiders 39 percent, snails 33 percent, and pill bugs 6 percent. Other animal types, such as ticks and centipedes, were occasionally eaten. Poults with wild turkey hens ate mostly insects, but they also ate snails, pill bugs, and spiders.

The types of insects eaten by poults with chicken brooders on all habitats were Coleoptera 30.2 percent, Hemiptera 27.2 percent, Orthoptera 14.1 percent, Homoptera 12.9 percent, Lepidoptera 9.8 percent, Hymenoptera 5.3 percent, and Diptera 0.5 percent. The percentages of insect types eaten by poults with wild turkey hens were Orthoptera 38.6, Coleoptera 24.6, Hemiptera 12.5, Homoptera 9.6, Lepidoptera 9.1, Hymenoptera 4.1, and Diptera 1.3.

The flies eaten were not identified. Larval forms made up most of the Lepidoptera dry weight. The negro bug (Corimelaenidae) and stink bugs (Pentatomidae) were the most important Hemiptera. Hymenoptera dry weight was about half ants and half small wasps. Shorthorned grasshoppers weighed more than other Orthoptera types, with crickets (Gryllidae) being second. Homoptera dry weight was divided between treehoppers (Membracidae) and leafhoppers (Cicadellidae). Ground beetles (Carabeidae) exceeded all other types in the order Coleoptera. Other important beetles were leaf beetles (Chrysomelidae), weevils (Curculionidae), beetle larvae, and click beetles (Elateridae).

The poults plant food consisted mostly of seeds, but other vegetative material, such as small leaves of wood-sorrel were eaten. The species or group of species eaten, from all habitats and by brooder type, are presented on a percentage basis in Table 4. Dewberry and sedge were the most important

Table 4. Plant food (seeds) eaten by poults run with chickens and wild turkeys, 1974.

Species	Percent of Total Dry Weight		
	Poults with Chickens	Poults with Wild Turkey	Poults with Wild Turkey (radio)
Dewberry	27.4	26.6	22.8
Sedge	27.2	52.1	33.9
Nut-rush	15.2	[1]	19.1
Panic grass	10.4	[1]	2.2
Misc. grass	8.2	[1]	[1]
Vetch	5.5	5.8	21.6
Misc. forbs	3.8	9.3	[1]
Misc. woody plants	2.3	4.2	0.0

[1]Less than one percent.

seeds on all habitats except one pine plantation, where nut-rush accounted for 58 percent of the total dry weight. Dewberry contributed 21 percent and sedge 14 percent of the poult plant food on the pine plantation.

Six wild (native) poults, 13 to 17 days old, that were run with a chicken ate sedge (57 percent), dewberry (35 percent), vetch (4 percent), forbs (2 percent), and trace amounts of grasses and woody species. A three day old poult (native), found in a small pole pine forest, had eaten sedge (52 percent) and dewberry (48 percent). Another wild poult, about 14 days old, was found in the Mississippi Delta (Washington County). This poult had eaten mostly dewberry.

Grit averaged 0.209 g for all 312 poults in 1974. Debris or unidentifiable material was generally also present in the gizzard.

DISCUSSION

Wild turkey poults ate mostly insects in the first week of life, but the insects diminished in percent of the total diet as poult age increased. Poults preferred insects (animal food), but ate what was present (animal or plant). These results agree with earlier authors who thought that insects were an important part of the poult's diet. However, the results differ substantially with those of Healy (1974), who said poults fed almost entirely upon insects, flies, and leafhoppers, during the first month of their lives. We found that beetles, true bugs, and grasshoppers were the most important insect types. Flies were the least important insect type. Leafhoppers rated high in 1973 because the poults fed on experimental clover plots, otherwise Homoptera was relatively unimportant. Poults ate seeds at age three days, and seeds became more important as poult age increased. The ratio of animal to plant was about equal when the poults were two weeks old. This change from high animal-low plant, to low animal-high plant food intake has been reported for the bobwhite quail (Handley 1931), and other gallinaceous birds.

Turkey poults have an unusually high, 28 percent, protein demand (Marsden and Martin 1955). They can meet this protein demand only by eating large amounts of animal food, particularly insects. Poults that fed upon pastures, roadsides, or hayfields obtained much more animal food, insects and all the other types, than poults on other habitats. Grazed permanent pastures and adjacent grazed woodlands were found to be preferred brood range in Alabama (Hillestad and Speak 1970).

Barwick et al. (1973) reported that poults, age 1-14 days, ate 75 percent plant matter and 25 percent animal matter in south Florida. An earlier phase of that study (Williams et al. 1973) showed that newly hatched broods went to cypress woods the first weeks of life. The absence of insects was probably the reason why the poults ate mostly plant material. Our poults that were run on bottomland hardwoods ate mainly plant food, due to the lack of insects.

In another Alabama study, juvenile wild turkeys, age 45-105 days, ate 75 percent plant matter and 25 percent animal matter (Hamrick and Davis 1971). This ratio agrees with the data for our 38-day-old poults. However,

one exception was found in a 45-day-old poult (native) that was killed on the refuge. This poult had eaten 1.208 g animal and 0.479 g plant material, and had apparently been feeding on a roadside right-of-way.

After observing many poults and analyzing the food habits data, we concluded that the type of brooder used made no difference in food intake.

By knowing the food habits of a species during all phases of its life the manager can alter the plant community to improve the insect and plant food conditions for wild turkey poults. Brood habitat management should be a major concern for the wild turkey just as for other gamebird species (Hurst 1972).

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AVAILABILITY AND UTILIZATION OF SUMMER FOODS BY EASTERN WILD TURKEY BROODS IN LEE COUNTY, ALABAMA

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Abstract: In Lee County, Alabama, grassy openings provided the greatest amounts of available food for wild turkey *(Meleagris gallopavo silvestris*) poults during the summer.

The percent of vegetative matter in the poults diet increased from 42 in June to 92 in September, whereas the percent of animal matter decreased from 54 in June to 3 in September. The four most important food items were carpet grass, crab grasses, bahia grass, and blackberries.

Key words: Poult food habits, seasonal foods, plant-animal food ratio, *Meleagris gallopavo silvestris*

The objectives of this study were to determine the principal plant species and insect orders available as food items to wild turkey poults and to find which food items were utilized during the summer.

Lindzey (1967) indicated that the brood rearing season was the most critical period for wild turkeys, thus the most significant research should be directed toward factors which affect poult productivity.

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STUDY AREA

The study area is near the northwestern corner of Lee County, Alabama, 11.3 kilometers (km) northwest of Auburn. It comprises 447 hectares (ha) within the Saugahatchee Wildlife Research Area described by Speake *et al.* (1969) and lies within the Pidemont Plateau. Major vegetative types are pine representing 7 percent of the study area; mixed pine and hardwood, 52 percent; upland hardwood, 18 percent; bottomland hardwood, 4 percent; and permanent openings of pastures, abandoned cropland, and old fields, 19 percent.

Most of the forested area is cut over at irregular intervals for pulpwood. Agricultural land use is primarily cattle grazing. Approximately 50 head of cattle were on the study area until the late summer of 1971. All but 20 head were removed and these remained in one improved pasture.

Extensive surveys in 1940 and 1941 revealed that wild turkeys had been extirpated from the study area and that other areas of Lee County contained few wild turkeys (Barkalow 1949). The study area was restocked in 1965 and 1966 with ll gobblers and 15 hens (Speak et al. 1969). The turkey population had increased to an estimated 143 birds by October 1970 and hunting was prohibited until the spring of 1971 (Gardner et al. 1972). Generally, 60 to 80 poults were present on and immediately surrounding the study area when this study was conducted.

METHODS

The study area was delineated into 11 vegetative types by aerial photographs and on-site reconnaissance. Upland hardwood, pine, and pine-hardwood areas were divided into vegetative types with less than 4.645 square meters (m^2) of basal area per hectare (ha) and those with more than 4.645 m^2 of basal area per ha to increase homogenity within these types. A representative area within each of the 11 vegetative types was selected at random for sampling of available food items on a monthly basis.

Seedheads in permanent openings and available food items in the duff in forested areas were collected from ten 0.0929 m^2 samples. Soft fruit and mast or other possible food items on the forest floor were collected from five 4.0427 m^2 samples. Food items in June and July were collected up to a height of 30.48 centimeters (cm) above the ground, and in August and September up to 45.72 cm. Four sweep net samples, each 15.24 m in length, were used to collect available insects. Food items were dried in a drying cabinet at a temperature of 48°C, weighed, and projected to give yields in kilograms per hectare (kg/ha).

Fresh droppings from poults were collected during June, July, August, and September of 1971 and 1972 in areas where the investigators had observed poults. This usually involved waiting 30 to 45 minutes until the brood group and their accompanying hen(s) had moved out of sight. The method of analysis was essentially that described by Glover and Bailey (1949). The collection of poults for food habit analysis was precluded because the study area was privately owned.

Food items were verified with a referenced seed collection from the study area. Plant nomenclature is that of Radford et al. (1964).

RESULTS

Food Availability

June 1971 and 1972

Seedhead production ranged from less than 1.00 kg/ha in the abandoned row-crop to 94.71 kg/ha in the improved pasture (Table 1). This pasture was not grazed during June 1971 when samples were collected. Cattle were introduced

Table 1. Average yields of food items in kg/ha by vegetative types, during June 1971 and 1972 in Lee County, Alabama.

Vegetative Type	Seedheads	Insects	Food in Duff	Soft Fruit or Mast
Old Field Succession	51.56	0.03	_[2]	5.04
Unimproved Pasture	35.31	0.08	_[2]	_[1]
Improved Pasture	94.71	0.07	_[2]	_[1]
Abandoned Rowcrop	0.05	0.13	_[2]	_[1]
Upland Hardwood -4.6 m^2/ha BA	15.40	0.03	_[2]	0.32
Upland Hardwood +4.6 m^2/ha BA	_[1]	_[2]	0.37	0.07
Bottomland Hardwood	_[1]	_[2]	13.51	_[1]
Pine -4.6 m^2/ha BA	2.51	_[2]	_[2]	0.69
Pine +4.6 m^2/ha BA	_[1]	_[2]	0.54	1.12
Pine-hardwood -4.6 m^2/ha BA	7.28	_[2]	_[2]	1.12
Pine-hardwood +4.6 m^2/ha BA	_[1]	_[2]	0.17	_[1]

[1]No results.
[2]No sampling.

shortly thereafter and remained there for the duration of the study. Bahia grass (*Paspalum notatum*) in the unimproved pasture and low density upland hardwood types, fescue *(Festuca* spp.) in the improved pasture, low hop clover *(Trifolium* spp.) in the old field succession and low density pine-hardwood, panic grass *(Panicum* spp.) in the low density pine, and plantain *(Plantago aristata)* in the abandoned rowcrop were the major seed producing species.

Insect production mainly grasshoppers, was less than 0.13 kg/ha in permanent openings (Table 1). Samples were restricted to vegetative types where no understory was present to interfere with the sweep net.

Mast from American beech (*Fagus grandifolia*) was the major food item found in the duff and occurred only in the bottomland hardwood type. Millipedes (Diplopoda) in the high density pine-hardwood, snails (Stylommatophora) in the high density upland hardwood, and greenbrier *(Smilax* spp.) seeds in the high density pine were the major food items found in the duff (Table 1).

Blackberries *(Rubus* spp.) were the main source of soft fruit or mast in the old field succession, low density upland hardwood, both pine, and low density pine-hardwood types. Mast from hickory *(Carya* spp.) was the major item in the high density upland hardwood type.

July 1971 and 1972

Seedhead production was greatly reduced from the previous month in two of the six vegetative types where food items were found. Bahia grass in the unimproved pasture and low density upland hardwood types, fescue in the improved pasture, low hop clover in the old field succession and low density pine-hardwood, panic grass in the low density pine, and Johnson grass *(Sorghum halepense)* in the abandoned rowcrop were the major seed producing species (Table 2).

Table 2. Average yields of food items in kg/ha by vegetative types, during July 1971 and 1972 in Lee County, Alabama.

Vegetative Type	Seedheads	Insects	Food in Duff	Soft Fruit or Mast
Old Field Succession	24.66	0.07	_[2]	2.72
Unimproved Pasture	31.38	0.05	_[2]	_[1]
Improved Pasture	31.38	0.08	_[2]	_[1]
Abandoned Rowcrop	2.24	0.16	_[2]	_[1]
Upland Hardwood -4.6 m^2/ha BA	14.01	0.04	_[2]	_[1]
Upland Hardwood +4.6 m^2/ha BA	_[1]	_[2]	0.44	0.35
Bottomland Hardwood	_[1]	_[2]	0.73	0.79
Pine -4.6 m^2/ha BA	0.40	_[2]	_[1]	1.37
Pine +4.6 m^2/ha BA	_[1]	_[2]	_[1]	0.12
Pine-hardwood -4.6 m^2/ha BA	14.57	_[2]	_[1]	1.68
Pine-hardwood +4.6 m^2/ha BA	_[1]	_[2]	6.85	0.15

[1]No results.
[2]No sampling.

Grasshoppers constituted the majority of insect production and increased from the previous month in four of the five vegetative types. Production ranged from 0.04 kg/ha in the low density upland hardwood type to 0.16 kg/ha in the abandoned rowcrop type (Table 2).

Millipedes in the high density upland hardwood, snails in the high density pine-hardwood, and mast from American beech in the bottomland hardwood type continued to comprise the major food items found in the duff. Production varied from 0.44 kg/ha to 6.85 kg/ha (Table 2).

Soft fruit continued to rank second to seedheads as the most important source of available food even though production declined from June. Blackberries were the major food items in the old field succession, low density pine, and the low density pine-hardwood types. Wild grapes *(Vitis* spp.) in the high density upland hardwood and pine, oak mast *(Quercus* spp.) in the bottomland hardwood, and mushrooms (Agaricales) in the high density pine-hardwoods appeared for the first time as major food items. Production ranged from 0.12 kg/ha to 2.72 kg/ha (Table 2).

August 1971 and 1972

Seedhead production continued to decline in a majority of the vegetative types. Bahia grass was the major food item in the old field succession, unimproved and improved pasture types. Crab grasses *(Digitaria* spp.) were second in importance and were the leading food items in the low density upland hardwood and low density pine. Low hop clover was the major food item found in the low density pine-hardwood type (Table 3). Yields varied from 4.48 kg/ha in the open pine stand to 25.78 kg/ha in the unimproved pasture. Sampling was terminated in the abandoned rowcrop due to the vigorous vegetative growth.

Insect production continued to consist primarily of grasshoppers. Production ranged from 0.06 kg/ha in the unimproved pasture to 0.14 kg/ha in the old field succession type (Table 3).

Snails were the predominant food items in the duff in the high density upland hardwoods and pines. Millipedes and American holly (*Ilex opaca*) seeds were the major food items found in dense pine-hardwoods and bottomland hardwoods, respectively. Production ranged from 0.11 kg/ha to 1.84 kg/ha (Table 3).

Soft fruit production continued to decline. Major food items were much the same as the previous month. Wild grapes in the high density upland hardwoods and pines, mushrooms in the bottomland hardwood and high density pine-hardwood, and blackberries in the low density pine-hardwood type were major food items. Production was less than 1.00 kg/ha in each of the vegetative types where food items were collected (Table 3).

September 1971 and 1972

Seedhead production increased in all vegetative types which yielded results. Carpet grass (*Axonopus affinis*) appeared as the major food item in the open pine type and purple top (*Tridens flavus*) in old field succession. Crab grasses continued to gain in production and were the major food items in the improved pasture and the low density upland hardwood type. Bahia grass

Table 3. Average yields of food items in kg/ha by vegetative types, during August 1971 and 1972 in Lee County, Alabama

Vegetative Type	Seedheads	Insects	Food in Duff	Soft Fruit or Mast
Old Field Succession	8.97	0.14	_[2]	_[1]
Unimproved Pasture	25.78	0.06	_[2]	_[1]
Improved Pasture	15.13	0.08	_[2]	_[1]
Abandoned Rowcrop	_[3]	_[3]	_[3]	_[3]
Upland Hardwood -4.6 m^2/ha BA	7.85	0.13	_[2]	_[1]
Upland Hardwood +4.6 m^2/ha BA	_[1]	_[2]	1.84	0.04
Bottomland Hardwood	_[1]	_[2]	0.75	0.55
Pine -4.6 m^2/ha BA	4.48	_[2]	_[1]	_[1]
Pine +4.6 m^2/ha BA	_[1]	_[2]	1.04	0.46
Pine-hardwood -4.6 m^2/ha BA	6.16	_[2]	_[1]	0.78
Pine-hardwood +4.6 m^2/ha BA	_[1]	_[2]	0.11	0.06

[1]No results.
[2]No sampling.
[3]Sampling terminated.

was the major food item in the unimproved pasture. Production varied from 7.28 kg/ha in the open pine stand to 80.14 kg/ha in the unimproved pasture (Table 4).

Insect production in permanent openings continued to consist primarily of grasshoppers. Yields were greater in all types than for the previous month. Production varied from 0.08 kg/ha in the unimproved pasture to 0.22 kg/ha in the old field succession type (Table 4).

Sampling was terminated in the high density upland hardwood type during 1971 as the area was harvested for pulpwood. Consequently, production figures are based solely on samples collected in 1972.

Food production in the duff ranked second to seedheads for the first time. New major food items were partridge berry (*Mitchella repens*) in the bottomland hardwood type, flowering dogwood (*Cornus florida*) in the low density pine-hardwood type, and sumac *(Rhus* spp.) in the high density pine-hardwood

type. Snails were the major food item in the high density upland hardwood type. Production ranged from 0.32 kg/ha to 3.36 kg/ha (Table 4).

Soft fruit and mast food items were essentially the same as the previous month. Major food items were wild grapes in the high density upland hardwoods and pines, oak mast in the bottomland hardwoods, mushrooms in the high density pine-hardwoods, and pomes from hawthorn *(Crataegus* spp.) in the low density pine-hardwoods (Table 4).

Intensity of grazing management practices and the stage of vegetation succession directly affected the amount of seedheads available to poults in permanent openings. Seedhead production was typically greater in permanent openings than in forested vegetative types.

Table 4. Average yields of food items in kg/ha by vegetative types, during September 1971 and 1972 in Lee County, Alabama.

Vegetative Type	Seedheads	Insects	Food in Duff	Soft Fruit or Mast
Old Field Succession	21.30	0.22	_[2]	_[1]
Unimproved Pasture	80.14	0.08	_[2]	_[1]
Improved Pasture	24.66	0.12	_[2]	_[1]
Abandoned Rowcrop	_[3]	_[3]	_[3]	_[3]
Upland Hardwood -4.6 m^2/ha BA	21.86	0.17	_[2]	_[1]
Upland Hardwood +4.6 m^2/ha BA	_[4]	_[4]	0.32	0.02
Bottomland Hardwood	_[1]	_[2]	3.36	0.46
Pine -4.6 m^2/ha BA	7.28	_[2]	_[1]	_[1]
Pine +4.6 m^2/ha BA	_[1]	_[2]	_[1]	2.09
Pine-hardwood -4.6 m^2/ha BA	_[1]	_[2]	0.77	0.31
Pine-hardwood +4.6 m^2/ha BA	_[1]	_[2]	1.68	0.35

[1]No results.
[2]No sampling.
[3]Sampling terminated.
[4]Area was clearcut in 1971. Production based on 1972.

Insect production varied widely between and within vegetative types by month and by year.

Poult food items in the forest litter were generally scarce and difficult to distinguish and retrieve. It is thought that food items in the litter are only marginally available to poults because of the time and effort required to locate them.

During the early summer months there was an abundance of soft fruits, but they became scarce in August. The forested types became the major producers of this type food item after July.

Food Utilization

Due to the secretive nature of hens with young poults, few droppings were collected during June and July. As the poults matured, sightings and the number of collected droppings increased.

A total of 74 droppings were collected in 1971: one in June, 20 in July, 24 in August, and 29 in September. A total of 143 droppings were collected in 1972: 14 in June, 24 in July, 50 in August, and 55 in September.

The poult droppings suggested a gradual change in major vegetative food items as the season progressed. Blackberries were the most important vegetative food items during June and July, averaging 34 and 48 percent, respectively, of the total volume (Table 5).

Carpet grass had become the major vegetative food item in August, constituting 51 percent of the total volume. In September, crab grasses were the major vegetative food items, contributing 26 percent of the total volume. (Table 5).

Plant foods of 30 species and animal foods from three insect orders were identified from 217 poult droppings collected from June through September of 1971 and 1972 (Table 5).

On a seasonal basis vegetative components comprised 91 percent of the poult droppings, animal matter five percent, and mineral components four percent (Table 5). The high percentage of vegetable material was probably due to the larger number of droppings collected in late summer. Other studies have shown a greater percentage of insects in the diet of young gallinaceous birds. Bobwhite quail (*Colinus virginianus*) chicks under two weeks of age utilized 83.7 percent animal matter (75.2 percent insects), and changed to the usual high vegetable diet of the adult during the third week (Handley 1950). Similar results have been reported for juvenile sage grouse (*Centrocercus urophasianus*) by Peterson (1970) and spruce grouse *(Canachites canadensis)* by Pendergast and Boag (1970). Poult droppings collected during June substantiate high utilization of animal material, largely insects, during the early weeks of the poults life (Table 5).

Grass seedheads of carpet grass, crab grasses, and bahia grass accounted for 59 percent of poult droppings (Table 5). Hamrick and Davis (1971) found grass seedheads constituted 61.5 percent of crop contents during July-September in an earlier study in Clarke County, Alabama.

Table 5. Percent volume and percent occurrence of food items collected in 217 poult droppings from June through September, 1971 and 1972.

Food Items	Percent Volume — Time of Collections					Percent Occurrence — Time of Collections				
	June	July	Aug.	Sept.	June-Sept.	June	July	Aug.	Sept.	June-Sept.
Vegetative	42	84	94	92	91	100	100	100	100	100
Axonopus affinis		7	51	22	30		18	78	59	53
Callicarpa americana			tr[1]	1	tr			1	13	6
Cyperus compressus	tr	tr			tr	13	2			1
Cyperus odoratus				tr	tr				1	1
Cyperus strigosus			tr	1	tr			5	19	9
Cyperus spp.		tr	tr		tr		2	2		1
Digitaria ischaemum		tr	10	9	7		7	70	67	51
Digitaria sanguinalis			3	17	9			28	64	35
Digitaria spp.		tr			tr		2			1
Diodia teres			tr	tr	tr			1	5	2
Festuca spp.		1	tr	tr	tr		11	3	2	4
Galium spp.			tr		tr			1		1
Helianthus spp.			tr		tr			1		1
Lespedeza spp.	tr	tr		tr	tr	7	2		2	2
Melia azedarach		tr			tr		2			1
Oxalis stricta	1	tr	tr		tr	40	18	4		8
Panicum spp.	2	1	tr	tr	tr	53	18	3	2	9
Paspalum notatum	tr	12	19	6	12	7	73	62	37	51
Paspalum spp.	2	2	1	1	1	53	32	24	26	29
Polygonum spp.			tr	tr	tr			1	2	1
Prunus serotina		5	tr	tr	1		41	1	1	9
Prunus umbellata			tr		tr			1		1
Prunus spp.	tr	1	3	2	2	7	36	72	55	53
Ranunculus spp.	1	tr	tr		tr	33	9	7		6
Rhus glabra			tr	tr	tr			7	2	3
Rubus spp.	34	48	1	tr	9	100	91	18	6	34
Smilax spp.			tr		tr			1		1
Solanum spp.			tr		tr			1		1
Trifolium dubium	tr	tr		tr	tr	33	2		1	3
Viola spp.	tr				tr	7				1
Unidentified seeds	tr	tr	tr		tr	7	20	5		9
Grass blades	tr	4	1	19	9	7	27	12	35	24
Unidentified matter		3	4	15	9		20	15	26	19
Animal	54	11	2	3	5	100	89	51	67	68
Coleoptera	7	2	tr	tr	1	33	27	11	3	13
Mallogapha		tr			tr		5			1
Orthoptera	12	2	tr	tr	1	60	14	3	11	12
Unidentified	35	7	2	3	3	73	80	42	57	58
Mineral	4	5	4	5	4	100	100	93	100	98
Total Volume (ml)	15.2	148.4	331.8	385.8	881.2	15	44	74	84	217

[1]Less than 1 percent

Vegetative matter increased from 42 percent in June to 92 percent in September while animal matter decreased from 54 percent in June to three percent in September (Table 5). This decline of animal matter has been documented in other juvenile gallinaceous species and perhaps reflects a diminishing protein requirement in the young birds' diet (Bump et al. 1947, Handley 1950, Kirk 1973, Pendergast and Boag 1970, Peterson 1970, and Stewart 1956).

Poult droppings collected from June through September contained few food items from the forest floor. Possible explanations are low production, marginal availability, complete digestion of food items, and a distinct preference of poults for other vegetative types.

The four most important food items during the study period, based on volumetric percentage and frequency of occurrence, were carpet grass (30 percent), crab grasses (16 percent), bahia grass (12 percent), and blackberries (9 percent) (Table 5). All other identifiable food items represented, individually, less than 5 percent of the total volume.

DISCUSSION

Generally, poult food items were in proportion to their abundance in vegetative types dominated by grasses. Two notable exceptions occurred. First, there was substantial production of bahia grass, fescue, and low hop clover seeds in June and July but little utilization by poults. Perhaps these food items were only marginally available because of the height differential between

seedheads and young birds early in the season, or possibly the young poults preferred soft mast and insects during this particular stage of development.

Secondly, carpet grass seed yields were low, but the seeds constituted a major source of food for poults. The southern periphery of the open pine type and the edges of two unimproved pastures were the only locations where carpet grass was abundant and recorded sightings during August and September indicated that broods preferred these areas. Perhaps this is indicative of poults showing a preference for a particular species.

CONCLUSIONS

Food habits data presented in this paper illustrate the wide variation that exists in the summer diet of eastern wild turkey poults. Poult foods, as determined by dropping analysis, closely approximated those food items produced in grassy, permanent openings. Greater amounts of food were produced in grassy, permanent openings than in the forested vegetative types.

An interspersion of grassy clearings with associated ecotone is needed to enhance brood production of the eastern wild turkey. Species composition within the grassy clearings may be as important as the extent and dispersion of the clearings.

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BEHAVIOR OF HUMAN-IMPRINTED AND HEN-REARED WILD TURKEY POULTS

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Abstract: Behavior patterns are described for human-imprinted and hen-reared wild turkey poults (*Meleagris gallopavo silvestris*) from hatching until 4 months of age. Poults fed primarily on insects during the first 5 weeks of life. By the 11th week, plants accounted for about half the diet. The behavior of poults indicated the dependability of human-imprinted turkeys for controlled experimentation.

Key words: *Meleagris gallopavo silvestris*, poult foods, turkey flock activity

This paper describes the general behavior patterns and the sequence in which they develop in turkey poults during the first 4 months of life. We include observations on the hatching process and brood activity. This information may help others to recognize and understand the various behavior patterns and the conditions under which they normally occur.

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Knowledge of poult behavior is considered basic to efficient management of turkey habitat and populations (Lindzey and Wanless 1973). Most observations of wild birds are incomplete or distorted because of the brevity of the observation or the effects of the observer on the events (Bailey 1967). Because wild birds are wary of humans, there has been little controlled experimentation. We believe it is practically impossible to learn the detailed behavior patterns of poults by observing wild birds, and that imprinting poults to humans is the best alternative.

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Imprinting is the learning process through which a young animal forms a social attachment with a parent. In precocial birds, the process occurs rapidly at a specific time and only once (Lorenz 1937). Through imprinting, the experimenter can become the parent object of a group of turkey poults (Hess 1973). Once the bond has been established, turkeys react to the experimenter as if he were one of their own species. The imprinting bond lasts for the duration of the turkey's life, and has been shown to be irreversible for domestic turkeys and Japanese quail (*Conturnix c. japonica)* (Schein 1963, Kimmel and Schein 1971). Human-imprinted poults follow the experimenter as if he were a hen, and field observations can be made without wing-clipping or restraining the birds.

Most behavior patterns that we discuss follow the terminology of Hale and Schein (1962) and Bailey (1967). We contrived additional terms out of necessity during the study.

METHODS

Three groups of turkey poults were studied. The first group hatched from artificially incubated wild eggs and game farm eggs and was imprinted to humans. The second group hatched from eggs laid and incubated by hens that were previously imprinted by humans. The third group hatched from artificially incubated game-farm eggs and was not imprinted.

Human-Imprinted Poults

Human-imprinted poults included 25 wild poults from eggs obtained in West Virginia and 74 poults from game-farm eggs. All birds were hatched in a forced-air incubator during the spring of 1972, 1973, or 1974. Before poults were dry, we removed them from the incubator and began to imprint them by spending 10 to 16 hours a day with them for the first 72 hours after hatching (Healy and Goetz 1974).

After imprinting, the poults were used for comparing various brood habitat conditions at Coopers Rock State Forest near Morgantown, West Virginia. The birds received daily care, and general records were kept of their behavior in the pens and in the field. Each group was observed in the field for about 5 hours per day for an average of 3 days per week from June through September. We spent 201 days making field observations over the three summers. We also spent 234 hours timing the feeding rates of individual birds.

Hen-Reared Poults

Hen-reared poults included 12 broods raised by hens that had been imprinted to humans in 1972 or 1973. In 1973, we maintained seven hens and two gobblers in a 0.65-hectare (ha) wooded enclosure. These birds produced five broods. In 1974, six hens and two gobblers in the enclosure produced four broods. Six hens and three gobblers produced three broods in a separate 0.81-ha wooded enclosure. Even as adults, the imprinted hens allowed us to observe them and their broods at close range.

Non-Imprinted Poults

Non-imprinted poults consisted of 50 game-farm poults hatched in June 1972, and removed from the incubator when they were about 24 hours old. Except for their isolation from social contact with humans for the first 72 hours after hatching, the non-imprinted poults were fed and caged in the same way as human-imprinted poults.

RESULTS

Behavior of Human-Imprinted Poults

Artificial incubation required about 28 days. Poults took from 4 to 21 hours to hatch out of the egg, but 12 to 48 hours were required to hatch all the eggs in a group.

Peep- and purr-calls were given by poults as soon as they hatched. The peep-call consists of three or four notes ascending in pitch and volume, and it is given by poults under stress. This call could be elicited from pipping birds by handling the egg. The purr-call was a soft purring sound, given by newly hatched poults as soon as they were picked up and held. The purr-call was the most common vocalization given by poults of any age. It could be heard at any time, but the highest frequency occurred during feeding and at the start of brooding and dusting sessions. The purr-call signaled location and contentment.

Poults rested most of the first 6 hours after hatching. During this time they started standing, preening themselves, and pecking. By 6 hours of age, most poults could take a few steps, but they were incapable of sustained walking.

Between 6 and 12 hours after hatching, poults began to eat and drink mash and water. They could stand for several minutes at a time and began exhibiting the *stretching* pattern: extending the neck forward and stretch-the leg and wing on one side to the rear. They also began responding positively to handling by humans. Poults would approach a stationary, calling observer and attempt to follow if the observer moved. They gave the purr-call when brooded by us, and peeped when left alone.

Between 12 and 24 hours after hatching, poults became fully coordinated and began a cycle of activity consisting of 20 to 30 minutes of brooding followed by 5 to 10 minutes of locomotion. Activity periods began when poults awoke and left the brooding area (usually a heating pad that one of us was sitting on). Usually, birds started activity by stretching and then running for several feet while flapping their wings, a behavior called the *run-flap.* During an activity period, birds fed, drank, and preened.

Between 20 and 24 hours after hatching, the *grab-run* behavior was first observed. Feeding birds that encountered a food object too large to swallow would grab it and run from the flock. Other birds often responded by pursuing and attempting to grab the object. This behavior persisted throughout the summer.

Table 1 summarizes the first 24 hours of activity.

Table 1. Behavior development of human-imprinted wild turkey poults the first 24 hours after hatching.

Age (hours)	Activity or event
0 = hatch	Peep- and purr-call. Poults sleep when held.
17	Pecking and preening.
5	Standing.
6	Poults take first steps.
7	Stretching.
8	Poults dry.
10-14	Walking and running. Poults run and flap wings. Eating and drinking. Poults orient to and approach people, purr when held, and peep if left alone.
15-23	Coordination of all activity increases rapidly. Following response strengthens. Grab-run behavior seen in feeding.
24	Poults follow strongly (run to keep up), purr when held, and peep if left alone.

On the second day after hatching, poults became integrated into cohesive flocks that showed regular cycles of feeding and brooding, and they followed us as a unit.

By 48 hours of age, poults were capable of following us in the field. Because hatching required about 24 hours, we usually did not begin field work with a brood until 50 to 60 hours after the first bird had hatched. Birds that had taken longer to pip usually showed an accelerated behavioral development after hatching. In this way, the flock behavior became synchronized on the third day after the start of hatching, despite a 24-hour spread in the ages of the birds.

On the third day, several new behavior patterns appeared. While feeding, the flock assumed formation called the *feeding line*. Poults moved side by side in a loose arc-shaped line, pecking at food items as they advanced. This formation persisted into adult life. Poults as young as 2 days were observed performing adult-like scratching in mash that we supplied. However, scratching was rare in the field, and it did not become a standard feeding activity until September.

Putt-calls and sunning behavior were also observed on the first day in the field. The putt-call consists of single, sharp notes, often connected in a series. The call is given in response to fear-producing stimuli such as a snake or hawk. Sunning birds reclined on one side and extended the upward wing and leg to expose a large surface area to direct sunlight.

During the first week, we observed strutting, the female sexual crouch, and the lateral-threat display typical of adults. These behaviors were classified as play because they did not lead to fighting or sexual activity.

Often, the same individual alternately performed male and female sexual patterns in rapid succession, usually when the flock was at rest. Play was usually initiated by one bird strutting to a resting poult, and others soon joined in the strutting. Strutting, threatening, and crouching would then be done in rapid succession. This sequence of behavior patterns was often followed by hopping and short bursts of running, and was then repeated. The strutting included production of the low-pitched pulmonic puff.

By the end of the first week, poults could leap over a 9-inch barrier, and their running and flapping looked more like flying. True flight occurred on the eighth day and thereafter it became an important behavior for escape and for following us in the field.

On about the 10th day, dusting became a flock activity. Up to this point, dusting was an individual rather than a group behavior. From the 10th day on, the flock generally spent l/2 hour or more each day dusting if the weather permitted.

The next major development occurred during the fourth and fifth week when birds began eating plant foods in quantity. For the first 5 weeks, poults primarily ate insects. During late June, small seeds became available and poults grew large enough to eat them. By the end of the fifth week, poults were fully feathered, and few sought brooding after that age. Seeds of the panic grasses *(Panicum* spp.) became important, and from the 11th week on, plants usually formed half or more of the diet (Table 2).

During the eighth week, we observed the first true fighting. The lateral threat was accompanied by a short, staccato trill that we referred to as a *rattle.* Fighting usually began with mutual threatening and progressed to striking with the wings and kicking. Eventually one bird would grab the other's beak or snood, and the birds would entwine their necks and push against each other with their breasts. Fights usually ended by one bird gaining the advantage and getting a beak hold on the skin at the back of the opponent's neck. With this hold, the winning bird would force the other's head toward the ground until the loser was able to twist free. Fights were usually brief and never resulted in serious injury. Males fought more frequently than females, and fighting behavior continued through the summer and into the fall.

The first gobbling was heard during the 11th week. Both males and females gobbled during periods of excitement. Gobbling was most frequently elicited by loud noises or when two groups of poults were calling to each other.

By the 12th week, wattles showed clearly on males, and a beard could be felt beneath the feathers. Males and females could be distinguished by the breast feathers. From this point on, birds generally behaved in accordance with their genetic sex roles.

By the 14th week poults no longer flushed or hid at the sight of a hawk, but stood and watched soaring hawks while giving a soft, high-pitched whine. Birds moved into cover only if the hawk appeared suddenly or approached rapidly.

Table 2. Percentage of insects in diet, number of observed pecks, and food items eaten by human-imprinted poults, May 26-September 15, 1974.

Age (weeks)	Insects eaten	Pecks	Food items	
			Major	Minor
1	50	44	Leaf hoppers, flies, oak flower parts.	Spittle bugs, ants.
2	96	666	Leaf hoppers, flies, moths	--
3	93	1,813	Leaf hoppers, flies, plant bugs.	Wood sorrel flowers
4	80	1,000	Leaf hoppers, flies, plant bugs.	Grass and vetch leaves.
5	82	1,043	Leaf hoppers, plant bugs, grasshoppers.	Panic grass seeds, dock flower buds.
6	67	817	Leaf hoppers, spittle bugs.	Panic grass seeds.
7	62	2,201	Leaf hoppers, plant bugs, flies.	Panic grass seeds, wood sorrel flowers, raspberries.
8	57	4,139	Leaf hoppers, flies, panic grass seeds.	Wood sorrel flowers.
9	54	1,582	Leaf hoppers, flies, panic grass seeds.	Raspberries, sedge seeds.
10	78	2,720	Leaf hoppers, panic grass seeds.	Grasshoppers, blackberries.
11	39	1,844	Leaf hoppers, panic grass seeds.	Violet seeds.
12	43	1,720	Panic grass seeds, sorrel flowers, sedge seeds.	Caterpillars, Japanese beatles, moths.
13	56	1,646	Leaf hoppers, sorrel flowers, panic grass seeds.	Autumn olive berries.
14	33	1,961	Panic grass seeds, autumn olive berries, wood sorrel.	Caterpillars, grasshoppers.
15	22	2,434	Autumn olive berries, ragweed, dock, panic grass seeds.	Black cherries.
16	21	1,744	Weed seeds, autumn olive berries, sorrel, panic grass seeds.	Viburnum fruits, solomon's seal, grapes.
17	16	2,087	Acorns, autumn olive, grass blades, caterpillars.	Viburnum fruits.

Table 3. Behavior development of human-imprinted wild turkey poults during their first 4 months of life, May 24-September 30, 1974.

Age	Behavior or Event
Days	
1	See Table 1.
2	Regular cycles of activity and brooding; scratching.
3	Poults respond to any human. First field observations: Poults form feeding lines, hunt insects. Putt-calls. Sunning.
4	First occurrence of strutting, crouching, and threatening patterns.
5-7	Running and wing-flapping gradually approaches flight.
8	First true flight.
10	Dusting becomes a flock activity. All birds respond to putt- and trill-calls made by the experimenter.
14	Birds have become skilled fliers.
Weeks	
3	Flock encircled and putted at snake, 5-10 minutes.
5	Poults fully feathered, they seldom require brooding.
6	Poults begin stripping grass seed; plant parts become important in diet.
8	Fighting begins.
11	First gobbling.
12	Wattles clearly visible on males, and beards can be felt beneath the feathers. Most males and females can be distinguished by the breast feathers.
14	Poults no longer flush or hide at the sight of a hawk; they freeze and watch like adults.
16	Poults begin eating acorns.
17	Shift to fall feeding habits; poults show preference for forested areas, and mast predominates in the diet.
18	Typical fall feeding behavior.

The first acorns were eaten during the 16th week (second week of September), and this started a major change in feeding behavior, which continued during the 17th week. Feeding rates became equal in field and forested areas. Birds began to feed for long periods in the woods, and scratching became a regular feeding behavior. Acorns, viburnum fruits, solomon's seal fruits, grapes, and caterpillars became important food items (Table 2). Insects, particularly grasshoppers, were still eaten in fields; but insect availability was limited by cool wet weather. By the end of the 18th week, the shift to adult feeding habits was complete.

Table 3 summarizes behavioral development during the first 4 months.

Behavior of Hen-Reared Poults

Detailed records were kept of the behavior of the hen-reared poults until they were 3 weeks old. At this age, the poults began to avoid humans; however, they could usually be approached within 9 meters (m) because the avoidance response was counterbalanced by a strong attraction to the hen, which did not flee. When we were present, the poults stood erect and watched us or concealed themselves in dense vegetation near the hen. Little of their behavior except avoidance could be observed at close range after 3 weeks of age. We made the rest of our observations by using binoculars or by hiding from the birds. The behavior patterns that we observed, both before and after 3 weeks of age, corresponded to those of the human-imprinted birds (Table 4).

Table 4. Behavior development of hen-reared wild turkey poults during the first 3 weeks of life.

Age (days)	Activity
1	Poults heard and seen under hen sitting on the nest.
2	Hen leaves nest and poults follow. Walking, running, run-flap behavior, purr-call, pecking, feeding, preening, sunning, stretching. Poults respond to hen's hiss-call. They respond to hen's putting and trilling by hiding in the vegetation or under the hen.
3	Feeding lines, catching insects, putt-calls, grab-run behavior. Some poults dust when hen dusts.
5	Scratching.
6	Drinking
7	Poults attempt flying
9	Flying.
10	Dusting becomes a flock activity.
14	Flying into trees.
19	Strutting and threatening postures.
20	Roosting in trees.

Incubation varied from 27 to 31 days and averaged 28.6 days for eight nests. Eight of 10 hens left the nest one day after we first heard poults at the nest, and the remaining two hens left on the second day. We did not determine the time that pipping began; but by comparison with our poults, hen-reared poults appeared to be about 48 hours old when the hen left the nest.

Broods were highly organized when they left the nest, and poults were capable of following under most circumstances. Poults that fell behind gave the peeping call. Hens responded by stopping, giving kelking calls, and sometimes by returning to the poult. All poults responded immediately to the hen's trilling call by hiding in the vegetation or running under the hen.

Hens directed the attention of poults to food items by giving a hissing call and pecking insects to the ground. Poults responded by rushing to the hen's head and taking the insect. The hens provided insects that usually were larger than those the poults caught for themselves and those that were out of reach of the poults. Hen-reared poults fed mostly on small flies and leaf hoppers - the same type of insects eaten by human-imprinted poults. Although we could not reproduce the hissing call, we could easily direct imprinted poults to food by touching it with our fingers. The first grab-run behavior was seen when hens dropped insects for the poults.

Play behavior was rarely seen in hen-reared poults. Feeding and brooding were the predominant activities. Strutting and threat behaviors were not seen until the 19th day and were recorded only a few times during the study.

Non-Imprinted Poults

Non-imprinted poults avoided visual or physical contact with humans. They ran or flew if we entered their cages and frequently injured themselves by running into the sides of the cage. When we were in the cages, we were unable to observe any behavior except avoidance.

Beginning on the 10th day, individual non-imprinted poults were introduced to human-imprinted flocks and taken into the field. The non-imprinted poults did not avoid the other poults, but they did not follow the flock. They did not feed normally. Some ate nothing at all, and others ate very little. They usually crouched silently in the vegetation.

DISCUSSION AND CONCLUSIONS

Both wild and game-farm poults exhibited the same behavior when they were imprinted to humans and raised under similar conditions. This does not indicate that there are no behavioral differences between the two groups, but it shows the importance of early experience. We believe that social imprinting, with the hen or a suitable substitute, is essential for the development of normal behavior.

Our efforts to use poults reared in groups, but not imprinted by a parent, were disappointing. Non-imprinted poults avoided people; and under field conditions, they did not show the same behavior patterns that the human-imprinted or hen-reared poults did. Handling or moving them to new environments produced injuries. Mortality rates were high, and little useful information could be obtained.

The age at which we first observed a behavior pattern does not necessarily indicate the earliest age at which poults were capable of performing the behavior. We may have missed the first occurrence of some behavior patterns, and poults might have shown the pattern earlier under different conditions.

We found that poults less than 12 weeks old rarely filled their crops. Cherry, blackberry, and autumn olive seeds generally appeared in the droppings about 2 hours after being eaten. It was not until late August that poults routinely filled their crops and retained food in them after feeding.

The nesting, hatching, and early brood activity of human-imprinted and hen-reared poults were very similar to those described by Williams *et al.* (1973) for the Florida wild turkey (*M. g. osceola*). Foods of human-imprinted poults were similar to those described for wild poults (Dalke et al. 1942, Hamrick and Davis 1971).

The phenomenon of imprinting provides a useful tool for studying the habitat needs of turkeys. The experimenter can simulate the natural imprinting processes and produce a strong and permanent social bond that does not alter basic behavior, but redirects social responses to a new parent object. This frees the experimenter from many constraints and allows him to combine field and laboratory techniques. Even minor habitat changes can be evaluated by direct comparison of poult behavior in different situations.

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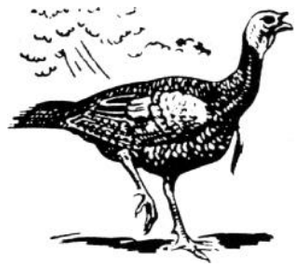

EFFECT OF GRAZING MANAGEMENT PRACTICES ON WILD TURKEY HABITAT

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Abstract: Grazing management systems designed to improve forage for livestock also improved the nesting and feeding conditions for Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) at the Sonora Research Station.

Key words: *Meleagris gallopavo intermedia,* nesting cover, food plants, rotation grazing

On the Edwards Plateau of Texas, heavy continuous grazing by cattle, sheep, and goats has caused a severe decline in forage density and vigor, and has reduced the range carrying capacity for livestock and various wildlife species (Merrill 1959). Also, the reduced forage production has lowered livestock gains and left wildlife in poor condition and subject to heavy death losses in times of drought and severe cold. The adverse effect: of overgrazing on wild turkey have been pointed out by Blakey (1943)[1] and Callendar (1947).

This paper relates grazing management and brush control practices to improvement of wild turkey habitat, and points out some interrelations between domestic livestock, the wild turkey, and other game birds and animals.

STUDY AREA

The Sonora Research Station, comprising 1402 hectares (ha), is located in the central portion of the Edwards Plateau of Texas midway between the towns of Sonora and Rocksprings. Soils are derived from limestone and are predominantly Tarrant stony clay. The terrain is made up of low, stony hills with slopes of 3 to 15 percent and flat divides and valleys with slopes of less than 3 percent. Grasses are predominantly curly mesquite *(Hilaria belangeri*), grama *(Bouteloua* spp.), bluestem *(Andropogon* spp.) and panicums *(Panicum* spp.). The browse overstory is primarily live oak *(Quercus virginiana),* and shin oak (*Q. pungens vaseyana*), and cedar *(Juniperus ashei).* The less abundant brush species include elbowbush (*Forestiera pubescens)*, hackberry (*Celtis laevigata*) and sumac *(Rhus* spp.). The average rainfall of the area is 58 centimeters (cm), varying from 13 cm to 107 cm annually.

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[1]Blakey, Harold L. 1943. Status and management of Rio Grande wild turkey on the Edwards Plateau of Texas. Progress Report. Economic Wildlife Investigations, Division of Wildlife Research, U. S. Dept. of Interior.

The study area, established in 1948 on land that had been severely overused by cattle, sheep, and goats, was divided into pastures 32 ha in size except for two livestock enclosures used as check plots. A livestock management study was set up to test continuous and deferred rotation grazing systems. Grazing treatments in use from 1948 to 1969 were as follows:

1. Continuous grazing at 3 stocking rates (16.2, 8.1, and 5.4 ha per animal unit) using 5 kinds or combinations of livestock at each rate (cattle alone: sheep alone; goats alone; a combination of 50 percent cattle, 25 percent sheep, and 25 percent goats; and a combination of 50 percent cattle and 50 percent goats).

2. Deferred rotation grazing on a 4-pasture system with stocking at 8.1 ha per animal unit using 50 percent cattle, 25 percent sheep, and 25 percent goats.

METHODS

All methods of data collection were designed for a livestock grazing management study. Information about wild turkeys was not collected under an experimental design. The number and class of turkeys seen on the pastures and the number of nests observed represented chance findings during the course of pasture research with vegetation and domestic livestock.

RESULTS

Response of Wild Turkey Habitat to Grazing Management

The first observation of wild turkey response to a changing range condition was on a pasture completely rested from deer and livestock. During the first 2 years of the study this pasture developed a good grass cover composed at first primarily of curly mesquite but later progressing to stands of taller grasses such as cane bluestem (*Bothriochloa barbinodis*), sideoats grama (*Bouteloua curtipendula*) and Texas cupgrass *(Eriochloa sericea).*

During the first 4 years, the 4-pasture deferred rotation system and all pastures lightly grazed developed an excellent stand of vegetation that provided adequate nesting cover as well as food plants for wild turkeys. The veqetative cover was composed of curly mesquite grass, sideoats grama, cane bluestem, vine mesquite (*Panicum obtusum*), plains bristleqrass (*Setaria machrostachva*), tall dropseed (*Sporobolus asper*), sedge *(Carex* spp.) Texas snoutbean (*Rhynchosia texana)*, velvet bundleflower (*Desmanthus velutinus*), orange zexmenia (*Zexmenia hispida*), prickly ash *(Xanthoxylum* spp.), skunkbush sumac (*Rhus aromatica*), littleleaf sumac (*R. microphylla)* , elbowbush, hackberry, oak, juniper, and other less abundant species. Wild turkey nests were observed on all pastures carrying such cover.

The moderately grazed pastures developed fair grass stands but provided less desirable nesting cover than the 4-pasture rotation system and the lightly grazed units.

The heavily grazed pastures, regardless of livestock combination, developed poor grass stands entirely inadequate for nesting cover. They produced little seed, berries, or other food for wild turkeys.

Occurrence of Wild Turkey Nests

Wild turkey nests were found only in pastures where a good grass cover developed. Nests were first found in the completely rested deer-livestock enclosure which was free from all grazing. This unit was enclosed with a 2.1 meter (m) net and barbed wire fence to prevent deer movement. During the second year of the study, turkey hens were observed flying into and out of the pasture. Four nests were found within the 11.3-ha, 800-m long exclosure, and 4 turkey hens with their broods were observed there. After the 5th year of the study neither turkey hens nor their nests were observed in the exclosure. Failure of hens to return to this site for nesting is attributed to the development of good nesting cover in other grazing units, especially the 4-pasture system and the lightly grazed pastures which were located nearer to desirable roosting sites than was the ungrazed exclosure. Also, predators such as fox, raccoon, and javelina were frequently seen in the area. The possible concentration of predators in isolated areas of grass cover was pointed out by Blakey (1943) who stated that grass along roadsides and at the edges of fields provided the primary nesting requirements for turkeys but also attracted predators. Frequently nests were completely destroyed in such areas.

As desirable grass cover developed on other areas, both nests and turkeys were observed. During the course of the study, 10 nests per 100 ha were recorded on the 4-pasture system, 6 nests per 100 ha were recorded on the lightly grazed pastures carrying goats alone and cattle, sheep, and goats, and 3 nests per 100 ha were observed on the pasture lightly grazed with cattle alone (Table 1).

Although turkeys were observed in the moderately grazed pastures with fair grass cover, no nests were ever found there and neither turkeys nor nests were found in the heavily grazed pastures with poor grass cover.

Table 1. The number of wild turkey nests on several grazing systems.

Grazing management system	Nests per 100 ha
Light continuous grazing with goats	6
Light continuous grazing with cattle, sheep and goats	6
Light continuous grazing with cattle alone	3
Four-pasture deferred rotation	10
Complete rest	35

During the years 1947-48, before the start of the range management study, no turkeys or nests were observed on the research station, although it is believed that some were present. At the present time, turkeys are commonly seen on pastures with better vegetative cover and observations indicate a population of approximately one turkey to 16 ha. Since all observations are on a chance basis, this is probably a conservative estimate. It is significant that turkey nests and turkeys with poults were seen only in pastures such as the 4-pasture deferred rotation system or light grazing where the vegetative cover was adequate for nesting and production of turkey food.

Blakey (1943) estimated a population density of one bird to 40 to 50 ha on rangeland being grazed at 90 to 100 animal units per 2.59 square kilometers (km^2) on the Edwards Plateau. He also stated that one bird to 32 ha was common on undeveloped range with a high natural carrying capacity, and that one bird to 11 ha was the highest population ever developed and sustained on intensively improved pastures in the Southwest.

In 1969, under revision of the range research program, virtually all pastures at the Sonora Research Station were placed in some type of rotation grazing system. The most promising is a 7-pasture rotation system with one livestock herd. Each pasture is grazed for 21 days and rested for 126 days while each of the other pastures is grazed in turn. No wild turkey nests have been observed, but more turkey hens with their broods have been seen in these intensive rotation pastures than in any of the others. A short grazing period of six to nine weeks each year with rest for the remainder of the year provides excellent feed and cover for turkeys, although the heavy concentration of livestock during the grazing periods greatly increases probability of nest destruction by trampling.

Turkey Location and Movement

At the Sonora Research Station, turkeys remain on or near nesting areas from March to August or September. From early October through December no turkeys with young capable of flying have been observed in pastures that did not have large trees with limbs as much as 4 to 6 m above ground and suitable for roosting. Most areas on the station have woody vegetation varying in height from 2 to 5 m, which is seldom used by turkeys for roosting. Trees with limbs from 4 to 6 m above ground are found primarily in the larger draws. These trees are usually 7 to 12 m in height and provide the preferred roosting sites.

It appears that a vegetative cover adequate for nesting is a basic requirement for wild turkeys in early spring but that as soon as poults are capable of traveling or flying they require an adequate roosting area. Apparently the roosting requirement dominates over the nesting requirement as soon as the poults are capable of flight. After December, most turkeys leave the research station unless some unusual factor intervenes. A lack of adequate roosting sites on the station may be a major cause for early migration.

In the spring of 1959, a 24-ha area was root plowed and reseeded to native grasses and sorghum almum (*Sorghum almum*). This area was rested throughout the grazing season and produced a heavy stand of sorghum almum with a high seed yield, accompanied by a good stand of native grasses. The root plowing was done on a pasture adjacent to one where good roosting trees were located. Turkey remained on the two areas throughout most of the winter. During the ensuing years when rainfall was adequate to produce seed crops of sorghum almum or native grasses such as sideoats grama or vine mesquite, the wild turkeys remained on the two pastures late into the winter. When little seed was produced due to low rainfall, the birds left earlier.

It would therefore appear that mechanical brush control with reseeding and management to produce good stands of desirable seed plants should increase turkey populations and improve welfare of turkeys, providing the brush removal does not destroy necessary cover and roosting trees.

On the Sonora Research Station, turkeys have been observed crossing open areas of approximately one km or more with no apparent fear. This indicates that protective brush cover for travel is less critical to turkeys than to either deer or small species of game birds such as bobwhite quail. Netwire fences present serious obstacles to turkey movement and turkeys have been seen moving up and down fences for as much as half a day without flying over unless disturbed. Thus, fences enclosing small pastures on the Sonora Station may discourage turkey habitation.

In conclusion, grazing management systems can be designed to improve forage plants for livestock and to provide adequate cover plants for wild turkeys. It is therefore reasonable to suppose that conditions favorable to game and to domestic animals can be compatible, providing for satisfactory performance of both.

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TRAVEL CORRIDOR TECHNIQUE OF WILD TURKEY MANAGEMENT

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Abstract: Travel corridors provided the eastern wild turkey (*Meleagris gallopavo silvestris*) easy access to suitable habitats at Union Camp Corporation's Palmetto Bluff Plantation in southeastern South Carolina. Even-aged short rotation pine management was practiced on 65 percent of the forest, and produced 414,769 cubic meters (m^3) of pine and 62,525 m^3 of hardwood. Turkey management was practiced on 35 percent of the forest land, and a sizeable turkey population maintained.

Key words: Short rotation, even-aged timber management, *Meleagris gallopavo silvestris*

Palmetto Bluff Plantation is located on a peninsula between the New and May Rivers in Beaufort County, South Carolina. This part of Union Camp's Combahee Forest contains 7,287 hectares (ha) of typical Carolina low country: 1,277 ha marsh; 4,075 ha pine land; 890 ha hardwood land; 746 ha swamp; 223 ha in reserve for lodge, roads, and village area; and 77 ha in game plantings.

The soils are of the St. Lukes series, mainly Charleston, Edisto, Stono and Ona loamy fine sands. They range from droughty to imperfectly drained.

Since the late forties the plantation has been used primarily by Union Camp Corporation for customer entertainment. Little timber was harvested. In 1955, the forest land was divided into working circles of 1,246 ha. These were subdivided into 30 compartments of approximately 405 ha. This was the beginning of Union Camp's program of even-aged pine management which included the bedding and row planting of pines following harvest and land clearing. Compartment #10 is an example of one of the 17 compartments of the Varn Harking Circle on Palmetto Bluff (Fig. 1).

In 1957 when the first compartment on Palmetto Bluff was scheduled for harvest, it appeared that the wild turkey population would be reduced to a few remnant flocks if the short rotation even-age management program was continued. Therefore, before a wildlife management plan was established and to meet a cutting deadline, the decision was made to retain five large oak trees per 0.41 ha in the pine land. In the absence of large oak trees, 45.7 centimeters (cm) dbh, eight smaller oak trees per 0.41 ha were left when present. Because of clearcutting, harrowing, burning, site preparation, and planting, half of the oak trees were lost.

When asked for a management plan for Palmetto Bluff, the writer's major question was, "How do we grow and harvest pulpwood and still have ample turkey for the guests to harvest?" Since young pine plantations have an understory too thick for turkey use for at least 10 years it was obvious that at least one-third of the pine land would be too thick for turkeys if the plan of clearcutting and planting was followed.

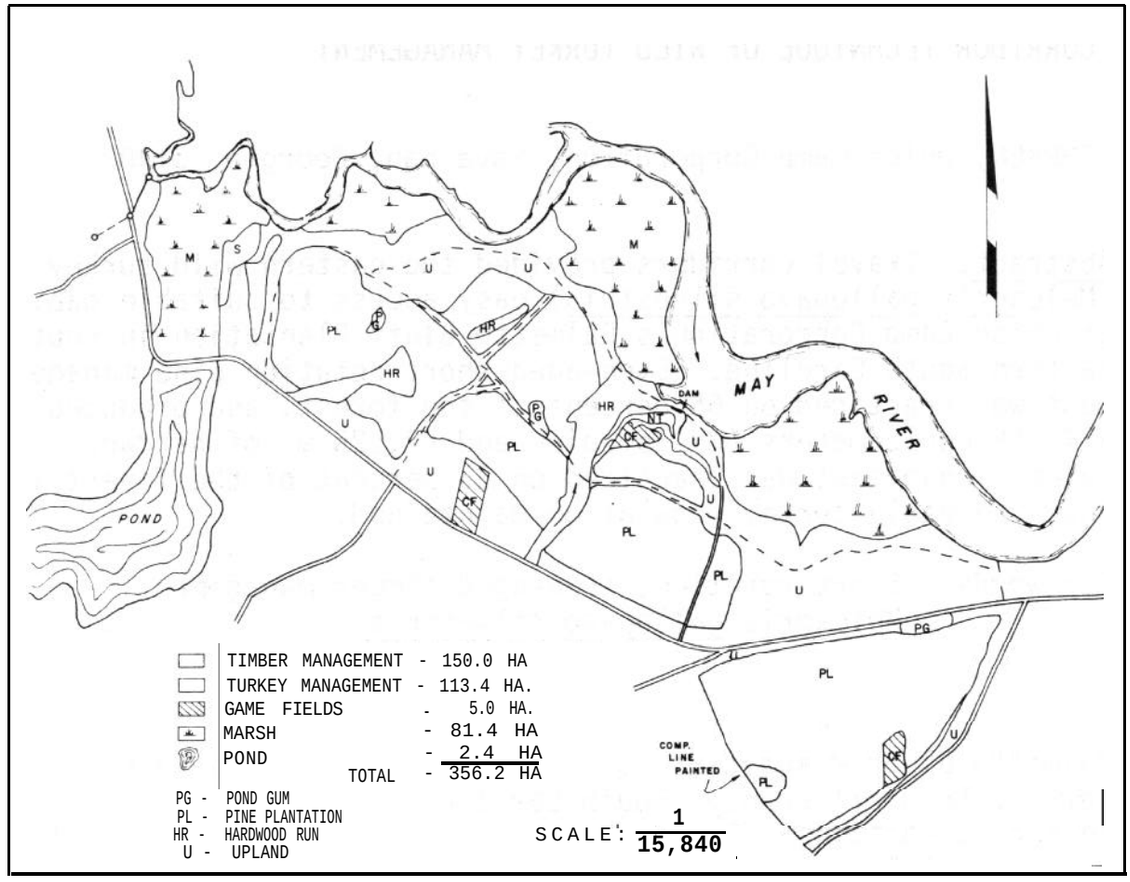

Figure 1. Compartment #10 of the Varn Working Circle on Palmetto Bluff Plantation.

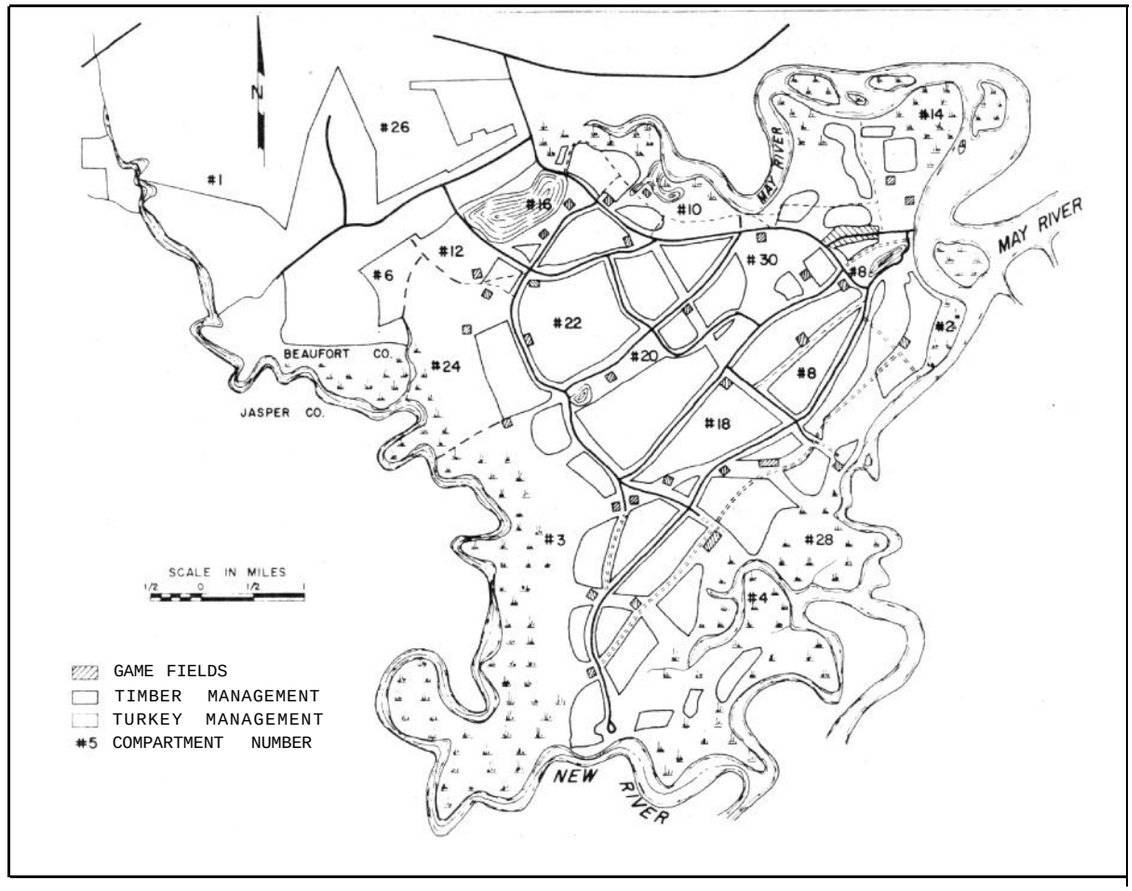

Figure 2. Palmetto Bluff Plantation of Union Camp Corporation, Beaufort County, South Carolina.

shoulders, 26 ha of grass and grain fields, and 34 ha of corn. The unfenced fields and road shoulders were planted one-half to Pensacola bahia grass (*Paspalum notatum*) and one-half to oats (*Avena sativa*) and rye *(Secale cereale).* An example of how these fields were connected to the swamps and hardwood areas by travel corridors is shown in Fig. 2.

To date 13 of the 17 compartments on the Palmetto Bluff Plantation have been harvested for a total of 414,769 m^3 of pine and 62,525 m^3 of hardwood. The forest inventory includes 428,717 m^3 of pine, 145,396 m^3 of hardwood, and 4,456 m^3 of cypress.

A turkey population of 230 to 410 birds has been maintained. During the last four years the population has remained at 410 birds. These figures were obtained from observations of the turkey flocks and gobblers made by the six full-time game management employees (Table 1).

As part of the customer entertainment program at Palmetto Bluff, an average of 150 pen-reared l-1/2 year-old gobblers are released annually before the gun. Our return has averaged 50 percent over the fifteen-year period. The released birds are wing-tattoed so that accurate records of pen-reared and wild birds bagged can be maintained without spoiling the esthetics of the harvest with a banded bird. The number of wild turkeys harvested and the released birds brought to bag are shown in Table 2.

Table 1. The number of wild turkey flocks and total birds at the 7,287 ha Palmetto Bluff Plantation, 1959-73.

Year	Flocks	Juveniles and Hens	Adult Gobblers	Total
1959	12	180	48	228
1960	12	228	30	258
1961	15	150	40	190
1962	15	150	40	190
1963	15	150	40	190
1964	15	150	50	200
1965	20	160	100	260
1966	21	168	125	294
1967	20	200	100	300
1968	20	240	110	350
1969	20	280	125	405
1970	20	300	110	410
1971	20	300	110	410
1972	20	300	110	410
1973	20	300	110	410

An overall workable plan involving clearcutting was highly desirable because Union Camp's Woodlands Division was geared to even-aged management. Also, the local forest supervisor was required to predict and schedule the harvest one year in advance, and he had to know where, when, and how much of a harvest was scheduled in each compartment. There was no literature available to indicate reasonable compromise between short rotation timber management and turkey management other than a paper by Don Strode (1956).

The problems and possible solutions were discussed with Dr. H. S. Mosby, Mr. H. L. Holbrook, and Mr. C. H. Shaffer, and Union Camp Forest Managers Mr. W. R. Nelson, the Late Mr. S. B. Kinnee, Jr., Mr. J. W. Gnann, and with the late Mr. P. E. Buckles, Game Manager of Palmetto Bluff. These discussions were the basis for the coordinated timber-turkey management plan, which was devised to use about 35 percent of the forest land for game and 65 percent for timber management. It was anticipated that this would produce 75 percent of the maximum timber and 75 percent of the maximum turkey population.

Due to the wild turkey's need for open understory, large travel areas and overlapping ranges, the plan included 100-meter-wide travel corridors of mature timber and a prescribed burning schedule of one to three years in all the upland pine areas. In order to be esthetically pleasing, some of the travel corridors were located along the primary company roads. On the first compartments, travel corridors were 60 m wide on each side of the road. This width was ample for turkeys but picturesquely it left something to be desired. We eventually concluded that the 100 m corridors on both sides of the primary roads, 60 m strips along the bluffs, and 100 m strips connecting the game fields with other forest corridors and hardwood areas, were more effective and visually pleasurable.

The management plan was based upon the theory that wild turkeys can prosper on less total range if the corridor allows the turkeys to travel over a much larger area. As it turned out, the 60- to 100-m wide corridors enabled turkeys to move in quality habitat from game field to river bluff, to marsh edge, to swamps, to drains, to hardwood bottoms. The very young pine plantations did not restrict any flock of turkeys from walking to any suitable habitat on the entire Palmetto Bluff Plantation.

To date 38 percent of the pine land has been cut over, and the estimated turkey population is one bird per 18 ha. The only restriction for the cut-over land is that all oak trees over 45.7 cm dbh must be retained.

On the travel corridors plus additional areas managed primarily for turkeys, the major considerations are that timber be harvested economically when scheduled and that the needs of turkeys are met. On the first compartment, pines were thinned heavily to release as many hardwoods as possible for the benefit of turkeys. However, the undergrowth that remained was too thick for turkeys, and there was not enough pine needles for fuel to prescribe burn. On subsequent compartments sufficient pines were retained to provide enough fuel to burn on a one- to three-year cycle.

The management plan for Palmetto Bluff included 77 ha of food plantings for deer and turkeys. Due to the high deer population (on Palmetto Bluff) the fields growing corn *(Zea mays),* peas (*Vigna sinensis*), and soybeans *(Soja max)* had to be fenced. This plan included 15 ha of grass and grain road

Table 2. Harvest record for wild and pen-reared turkeys at Palmetto Bluff, 1955-73.

Year	Man-days Hunted	Total Bag	Wild Turkeys	Pen-reared Gobblers
1955	-	76	-	-
1956	-	82	-	-
1957	-	51	-	-
1958	-	50	-	-
1959	384	63	12	51
1960	387	73	25	48
1961	396	90	35	55
1962	325	125	18	107[1]
1963	367	153	30	123
1964	361	84	0	84
1965	384	128	44	84
1966	450	98	15	83
1967	288	80	13	67
1968	302	122	15	107
1969	340	104	18[2]	86
1970	140	56	17	39
1971	134	52	8	44
1972	152	61	8	53
1973	401	65	3	62

[1]Included 36

[2]Included two bearded hens.

In summary, Union Camp Corporation has developed a plan of coordinating timber and turkey management. Foresters not only practice their accustomed even-aged short rotation pine management, but they also practice good wild turkey management by including travel corridors. The turkey population has increased from 276 birds in 1959 to 410 birds in 1973. Furthermore, an average of 50 percent of the pen-reared l-1/2 year-old gobblers that were released prior to and during the hunting season have been harvested.

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FEATURED SPECIES, CONCEPT - ITS APPLICATION TO WILD TURKEY MANAGEMENT ON SOUTHERN NATIONAL FORESTS

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Abstract: Under the featured species concept, the habitat requirements and mobility of a wildlife species guides coordination of timber and wildlife habitat management. Forest management options available through even-aged silviculture are used to manipulate and control habitat and to produce and manage timber. The system has been in use 4 years, and has resulted in a positive approach to wild turkey *(Meleagris gallopavo silvestris)* management on over 1.62 million hectares (ha) of National Forests, Military Reservations, State Forests, and AEC lands. The system is adaptable for other game, non-game, and endangered or threatened species.

Key words: Even-aged management, habitat management, *Meleagris gallopavo silvestris*

THE CONCEPT

The featured species concept is a method of coordinating timber and wildlife habitat management based upon habitat requirements and mobility of a selected wildlife species. The decision to feature a wildlife species applies to designated units of land of suitable size and forest types. The even-aged management options such as stand size and distribution, rotations, and prescribed burning are used to manipulate and control habitat and to produce and manage timber (Holbrook 1974).

The need for selecting a featured species results because habitat requirements for different species are often unique. Gray squirrels *(Sciurus carolinensis)* require mature hardwoods with dens and reliable mast crops. Ruffed grouse (*Bonasa umbellus*) thrive in young age classes of timber. Wild turkeys need mature timber for winter range and new regenerations for nesting and brood range. Red-cockaded woodpeckers (*Dendrocopos borealis*) seek mature pines. All these conditions cannot be met on the same land, at the same time. Therefore, there is a need for establishing management direction by naming the featured species.

The featured species concept is adaptable to other wildlife species whether threatened or endangered, game, or non-game provided their habitat requirements are understood. This concept was developed with combined timber and wildlife inputs so that management needs of both resources are accomplished simultaneously through direct, nonconflicting guidelines. The concept does not imply "dominant use" or "single species" management. "Dominant use" means that the land will be devoted to a primary resource and

other resource values are incidental. The concept does not result in "single species" management because it is applied under even-aged silviculture to achieve sustained yields of both wildlife and high quality sawtimber. This assures a variety of habitat niches ranging from site preparation to seedlings and saplings, to pole timber, to immature sawtimber and finally to mature sawtimber stands within a forest. Variety in wildlife is a product of these habitat niches. Management to benefit the featured species does not preclude use by other species and is often beneficial to them. Featured species are not selected for special zones, administrative sites, or wilderness.

So far, management guidelines under this concept have been developed for five endangered or threatened species, three non-game species (including songbirds as a group), and fourteen game species including the real king of upland birds -- wild turkeys.

HOW THE CONCEPT WORKS WHEN APPLIED TO WILD TURKEYS

The first step is to determine the habitat needs and mobility. In the southeast, good eastern wild turkey habitat contains mature stands of mixed hardwoods, groups of conifers, relatively open understories, scattered clearings, well-distributed water, and reasonable freedom from disturbance. Home range is usually about one square mile.

The turkey's diet consists primarily of grass and weed seeds in the late summer and early fall, mast and forage in late fall, winter and early spring, and forage and insects in spring and summer. Acorns, dogwood berries, clover, and pine seed are the foremost winter foods. Openings are essential for brood range and summer food.

Logging and timber cultural treatments are the most lasting and effective means of manipulating habitat conditions to meet these recognized needs, so the next step is to adapt the timber management options: rotations, stand size and distribution, regeneration and conversion, site preparation, seeding and planting, intermediate treatments, prescribed burning, and maintenance of key areas. Through these adaptations we retain or develop mast capability, keep conifer stands moderately productive for food and cover, keep understories open from pole timber stages through sawtimber, mold stand composition, and disperse regeneration areas for nesting and brood range. At the same time, we distribute the adverse impacts such as rank sapling and brush growth which occurs when young stands are from 5 to 20 years old.

Given the preceding combination of habitat conditions within the home range plus reasonable protection and with native wild birds as a source, we can produce turkeys.

Direct habitat improvements are used to meet habitat needs that can't be met through timber management.

USE OF THE SYSTEM IN SOUTHERN FORESTS

The procedure for selecting the featured species includes four major areas of consideration.

1. Habitat capability - the capacity of the land to produce food and cover.

2. Compatibility with other resources - recognition of conflicts.

3. Public interests and needs - local preference or custom, socio-economic values, and aesthetics.

4. Cooperator and public involvement - cooperative planning under the Memorandum of Understanding and through public participation.

The Forest Service bases the selection decision on inputs to the above items from the state Game and Fish Commissions, interdisciplinary teams, and the public through Unit Planning and the associated Environmental Statements. Once the species selection is made, it provides a mutual basis for cooperative planning and work between the Commissions and the National Forests.

CISC (Continuous Inventory of Stand Condition) is the basic inventory of forest types and stand conditions for southern National Forests. The coordination guidelines for distribution, size, and number of regeneration cuts are applied to this inventory through a ten-year stand selection system. The perspective is forestwide rather than by compartment.

Implementation training in use of this concept was first done on the forests in 1971 by the forest wildlife and timber staffs and a regional office team from the range, timber and wildlife staff unit. New professionals are trained at Regional Compartment Prescription Schools. The Forests conduct the training for technicians and foremen.

The system also guides both the priority setting for direct habitat improvements and adjustments to the road systems.

In summary, the featured species decision is a line (Forest Service) decision that commits resources and land management effort.

OUTCOMES

The Southern National Forests (4.9 million ha) adopted the featured species system in 1971. They now feature wild turkeys on 1.6 million ha. Other forested lands where wild turkeys are featured include:

Naval and Marine Bases	14,000 ha
Air Force Bases	38,000 ha
State Game and Fish lands	30,000 ha

The Southeastern Area of State and Private Forestry and the Southern Region developed a popular publication for small landowners that applies the same principles for 5 major game species including turkeys (Byrd and Holbrook 1974).

We feel that the system works for the southern National Forests. It is a positive approach to timber and wildlife habitat management coordination rather than mitigation. It was developed cooperatively with the Game and Fish Commissions, the U. S. Fish and Wildlife Service, Forest Service Research, Southeastern Area State and Private Forestry, several Cooperative Wildlife Units, and many knowledgeable individuals.

Once the direction is set by naming a featured species, whether it is for wild turkeys, other game or non-game species, or endangered or threatened species, and the habitat requirements and mobility are spelled out -- we're on our way to coordinated timber and wildlife management.

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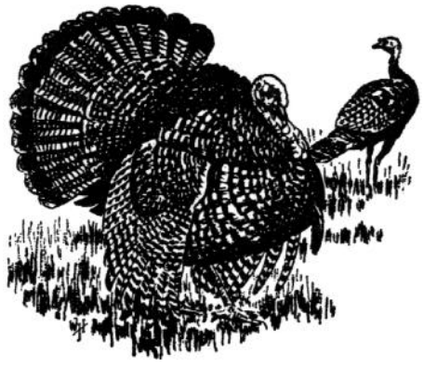

HABITAT USE AND SEASONAL MOVEMENTS OF WILD TURKEYS IN THE SOUTHEAST

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Abstract: Habitat use and seasonal movement data were obtained from 105 eastern wild turkeys (*Meleagris gallopavo silvestris*) instrumented with radio transmitters and from other non-instrumented birds at five study areas. Turkeys preferred a diversity of habitat types in their ranges and often made seasonal movements to meet their needs. Hens moved farther in the spring than gobblers because of their special needs for nesting and brood rearing habitat. Implications for management are discussed.

Key words: *Meleagris gallopavo silvestris*, radio telemetry, nesting, brood rearing.

Managers of wild turkey populations must consider turkey habitat preferences because the amount and arrangement of habitat types may influence turkey movements and population levels.

This paper describes the habitat use and seasonal movement of wild turkeys from four study areas in Alabama and one in western Kentucky. It is a contribution of the Alabama Cooperative Wildlife Research Unit, Auburn University Agricultural Experiment Station, Game and Fish Division of the Alabama Department of Conservation and Natural Resources, the U. S. Fish and Wildlife Service, and the Wildlife Management Institute.

We are indebted to Ben Stimpson and Elwood Overstreet of Choctaw Bluff Hunting Club for their assistance and cooperation. At Stimpson Sanctuary, Gene Widder and Fred Pringle rendered valuable assistance. Operators of Sorrel1 Ranch, J. C. Money and Joe Burt, facilitated our research. Kimmey Maddox, Joe McGlincy, Dave Nelson, Frank Dukes, and Bill Blackburn are student assistants deserving special recognition. We thank Charles Kelley, Director of the Game and Fish Division of the Alabama Department of Conservation and Natural Resources, for use of State aircraft and other support. We also acknowledge the active support of Ray Nall of the Tennessee Valley Authority. Part of the research was financed by TVA and the Federal Aviation Administration.

STUDY AREAS

Three of the Alabama study areas are in the Coastal Plain: Choctaw Bluff Hunting Club, Fred T. Stimpson Sanctuary, and Sorrel1 Ranch (Saco). The Saugahatchee Research Area (SRA) is in the Alabama Piedmont and the Kentucky study area is at Land-Between-The-Lakes (LBL). Sizes of study areas, major habitat types and estimated turkey populations are shown in Table 1.

Habitats of three study areas have been described in more detail elsewhere: Stimpson Sanctuary (Johnson 1970), SRA (Gardner et al. 1973), and LBL (Wright 1975).

The Choctaw Bluff study area is part of a 9,315 hectare (ha) hunting club in southwestern Alabama, approximately one-half is mature river-bottom hardwood. The remainder is primarily pine upland and associated creek bottom hardwood. The study area contains 32 openings, 27 are less than four ha in size and two are larger than 20 ha, the largest is 61 ha.

The Saco study area is representative of a much larger area of intermingled pine, permanent pasture, and smaller areas of hardwoods in east central Alabama. It has 68 openings, 45 are less than four ha in size and five are larger than 20 ha. The largest opening (a very long pasture with an irregular edge) totals 393 ha.

Table 1. Size, habitat composition, and estimated wild turkey populations on one Kentucky and four Alabama study areas.

Study Areas	Size[1] (ha)	Percent of Major Habitat Types in Total Area				Estimated Number of Turkeys per km^2
		Pine	Pine-Hardwood	Hardwood	Openings[2]	
Saco	3,396	61	9	6	24	>12.4
Sanctuary	2,105	30	50	15	5	>12.4
C. Bluff	3,553	42	2	49	7	12.4
SRA	3,676	5	73	12	10	4.8
LBL	20,078	5[3]	0	80	15	1.1

[1]Study areas at Saco, Choctaw Bluff, and LBL are only portions of the areas under similar land management.

[2]Includes pastures, old fields, cutover areas, cultivated fields, and wildlife food plots.

[3]Pine and cedar.

Pine makes up the largest percentage of habitat type at Saco and is the second largest habitat type on the two other Alabama Coastal Plain study areas. Most of the pines on these three study areas are of sawlog size. At Choctaw Bluff and Stimpson Sanctuary, most of the pine is on a three-four year burning cycle. At Saco, most of the pine type is grazed by cattle and it is unburned. These pine types are open and in many places the understory consists of herbaceous plants with scattered shrubs and small trees.

METHODS AND PROCEDURES

One hundred and five instrumented turkeys (85 hens and 20 gobblers) provided data (nine or more locations) for estimating seasonal ranges and movements at the five study areas in 1972, 1973, and 1974. Numerous observations of additional patagium-tagged and untagged turkeys provided data on use of habitats and for population estimation. Records of gobbler harvest for 1960-74 were obtained from Choctaw Bluff and for 1974 from Saco.

Population estimates at SRA were based on direct counts of a stabilized population where about 80 percent of the population was patagially tagged (Gardner et al. 1973). The estimate for LBL was from marked-unmarked ratios during summer 1973 and spring 1974 (Wright 1975). At Choctaw Bluff the estimate was from counts of separate flocks of turkeys at 11 bait sites from 1,645 ha during January-February 1974. Many more turkeys per kilometer (km) were seen at Saco and Stimpson Sanctuary in summer 1974 than at Choctaw Bluff. The 1974 spring kill per unit area was much higher at Saco than Choctaw Bluff while hunting procedures and pressure were similar.

All instrumented turkeys were captured with alpha chloralose or tribromoethanol by the method of Williams et al. (1973B), or with rocket projected nets. Captured turkeys were banded and patagially marked essentially as described by Knowlton et al. (1964). Each turkey was released near its original capture site. Radio equipment operated in the 164 MHz range or the 151 MHz range. Transmitters were mounted as described by Williams et al. (1969) and were used to obtain locations by triangulation (Cochran and Lord 1963). The equipment also aided in obtaining sightings of turkeys. Outermost locations were joined to circumscribe the minimum range (Ellis and Lewis 1967) on study areas or adjoining lands. Aircraft were used on numerous occasions to establish contact with turkeys.

Thirty-two turkey nests of instrumented turkeys were located and eight others were accidentally found. Summer brood ranges were estimated from radio and visual observation of broods of 10 instrumented hens and from visual observations of habitat use by many additional poults.

RESULTS AND DISCUSSION

Maximum Movements and Spring-Summer Ranges

Range shifts from winter or early spring to summer are described for 77 instrumented hens and 16 instrumented gobblers from four study areas and adjoining lands. Gobblers moved shorter maximum distances from their winter

Table 2. Distance traveled by turkeys from winter-spring capture sites to most distant point in spring-summer range at four study areas, 1973-74[1].

Study Areas	Maximum Distance (km)	Average Maximum Distance (km)	Number of Turkeys	Percent of Turkeys Moving a Maximum of		
				3.2 km or Less	3.4-4.8 km	More Than 5.0 km
			Hens			
C. Bluff	10.1	4.2	43	37	33	30
Sanctuary	11.1	4.2	9	56	11	33
Saco	4.8	2.9	20	50	50	0
LBL	3.4	3.2	5	80	20	0
			Gobblers			
C. Bluff	6.4	2.8	11	82	9	9
LBL	4.8	2.5	5	80	20	0

[1]Choctaw Bluff, Saco, and LBL data are for 1973 and 1974. Stimpson Sanctuary data are only for 1974.

ranges than hens (Table 2). At Choctaw Bluff and Stimpson Sanctuary average maximum movements of hens from capture sites were much longer than those at Saco and LBL. These longer movements appeared to be related to an inadequate amount of open habitat types. Openings were important because 86 percent of the spring-summer ranges of 72 instrumented hens from Alabama study areas contained openings and all hen ranges at LBL had openings. At both Choctaw Bluff and Stimpson Sanctuary, 44 percent of the hens emigrated beyond the boundaries of the areas under management during the spring to adjoining lands that had more openings. The hens that emigrated selected ranges containing a higher percentage of openings than hens that remained on the study areas (Table 3). There was no evidence that juvenile hens dispersed longer distances than adults because the age composition of emigrants was the same as that of non-emigrants.

The total percentage (24) of openings was greatest at Saco and interspersion of openings was better. Therefore, hens would have to travel shorter distances there to include openings in their ranges. Average range sizes for hens were much smaller at Saco and LBL than at Choctaw Bluff and Stimpson Sanctuary (Table 4) and the reason for this may be because these areas had a higher total percentage of better distributed openings.

Large openings shaped to give maximum edge effect were very attractive to hens. Nineteen instrumented hens moved several km north from their winter capture sites at Choctaw Bluff to a 55.5 ha field, 2.2 km long and 0.2 km wide.

Table 3. Percent of major habitat types in spring-summer ranges of hen turkeys that egressed and those that remained on two study areas.

Study Areas	Number & Percent of Hens	Average Maximum Movement (km)	Percent of Major Habitat Types in Spring-Summer Ranges			
			Pine	Pine-Hardwood	Hardwood	Openings
			Egressed			
C. Bluff	19 (44)	5.2	73.9	0.0	13.3	12.3
Sanctuary	4 (44)	6.8	40.9	16.0	18.2	21.8
			Non-Egressed			
C. Bluff	24 (56)	3.5	56.5	2.5	31.9	5.3
Sanctuary	5 (56)	2.0	61.3	19.1	13.3	6.2

Table 4. Major habitat types and minimum size of spring-summer ranges occupied by 77 turkey hens and 16 gobblers at four study areas.

Study Areas	Tracking Period (days)	Range Size (ha)	Percent of Major Habitat Types in Ranges			
			Pine	Pine-Hardwood	Hardwood	Openings
			Hens			
C. Bluff	104	644	64.2	1.4	23.7	8.4
Sanctuary	103	474	52.5	17.7	15.4	13.1
Saco	89	318	71.0	13.2	3.8	12.0
LBL	76	264	0.0	0.0	87.5	12.5
			Gobblers			
C. Bluff	124	476	87.6	0.0	11.9	0.5
LBL	83	221	0.0	0.0	92.6	7.4

This field, which they used heavily during spring and summer, was made up of corn patches, over-grazed pasture, and an annually burned old field. Another field at Choctaw Bluff (60.7 ha) with an irregular edge, and composed of corn, oats, and annually burned old field was used by 13 instrumented hens during spring and summer.

Seventy-nine percent of all the Alabama hens selected spring-summer ranges that contained three or four of the major cover types (pine, pine-hardwood, hardwood, and openings) and only four percent of the hens selected ranges with only one major cover type (pines). This habitat selection illustrates the importance of maintaining diversity in turkey habitat.

Nesting Habitat Selection

Turkey nests were located as follows: Saco 16, Choctaw Bluff 11, Stimpson Sanctuary 5, LBL 4, SRA 4. Of these 40 nests, 23 were in openings (20 were in old fields or cutover openings of mixed herbaceous vegetation, brush, and pine reproduction and three were at abandoned house sites). Of the 17 nests not in openings, 11 were in upland hardwood or pine-hardwood, three were in pine and three were in bottomland hardwood. Four of these nests were within 15 m of an opening and three were within 37 m of an opening. In summary, 75 percent of the nests were either in openings or near the edges of openings. Six of the nests not near openings were close to roads or trails (from 0.6 m from a game trail to 46 m from a logging road). Inasmuch as over half of all the nests were in old field successional stages or their equivalent (cutover areas or abandoned house sites) these types were preferred for nesting.

The nesting habitats selected by turkeys reported here were similar to those reported by Hillestad (1973) at SRA. In Florida Williams et al. (1973A) reported hens nesting in an ecotone between grassy pasture-like areas and denser scrub.

Brood Range Use

Many types of openings were used by hens with broods. Permanent pasture or mowed grasses seemed to be favored types but various grains and legumes, old fields and chufa fields were used by the hens and poults. The percent of 643 monthly sightings in pastures for individuals of three instrumented broods at SRA was as follows: August, 71; September, 60; October, 48; November, 17; December, 0; January, 25. At Choctaw Bluff, 45 percent of 92 summer poult sightings were in openings. At LBL during April, May, and June, 84 percent of the sightings in 1973 and 97 percent in 1974 were made in open fields. During July-August of 1972-74, the percent of sightings in open fields was 64, 86, and 83 respectively. In September 1972 the percent was 92.

The average range size for hens with broods at Saco was 111 ha whereas the average size of total spring-summer ranges for all hens was 318 ha. The range of one brood at Stimpson Sanctuary was about half the size of the average spring-summer range of hens. At both areas brood ranges contained higher percentages of openings (17.5 and 24.0) and lower percentages of pine (31.0 and 54.0) than spring-summer ranges of all hens.

An earlier telemetry study of hens and poults at SRA (Hillestad and Speake 1971) showed that movements were small, linear, and strongly influenced by feeding areas of permanent pastures. Previous food habit studies by Hamrick and Davis (1972) at Choctaw Bluff and nearby areas and by Kirk (1973) at Stimpson Sanctuary showed that grass seedheads and insects were the most

important foods for turkey poults. These food items were much more abundant in grassy openings than in the forest.

Our data showing the importance of openings to turkeys supports the findings of other recent telemetry studies (Ellis and Lewis 1967, Hillestad and Speake 1971). Williams et al. (1975) found that turkeys in south Florida did not use certain grassy openings between late winter and early summer but remained in cypress woods where there was ample sunlight penetration through the overstory for good growth of grasses and forbs. He suggests that summer turkey foods may be more abundant in cypress woods than in dense woods with sparse understory vegetation such as occurred over most of the range of the eastern wild turkey. This may be the reason for the difference in use of openings.

Fall and Winter Habitat Use

At SRA a shift to winter habitat occurred by the end of November. The average distances that turkeys moved to establish winter ranges was 2.2 km for eight hens and 1.9 km for four young gobblers. Average fall-winter range size was 430 ha for eight hens and 247 ha for four young gobblers. These turkeys had fall-winter ranges that included more than 10 percent of each major habitat type. Young turkeys steadily decreased their use of pastures between August and December and increased their use of forest. Individuals of the three instrumented broods were seen 31 percent of the time in forest types during August-October and 76 percent of the time in November-January. This shift in habitat use corresponds closely with the findings of Barwick and Speake (1973) with instrumented mature gobblers at SRA.

Turkey harvest data from Choctaw Bluff showed a strong relationship between habitat types and hunter success. In the three hunting territories where hunting was best there was a substantially higher proportion of hardwood and openings than in three territories where hunting was poor (Table 5).

Table 5. Turkey yields for a 15-year period (1960-74) and major habitat types at the three best and three poorest hunting territories at Choctaw Bluff Hunting Club.

Territories	Total Size (ha)	Number of Turkeys Killed	Percent of Major Habitat Types			
			Pine	Pine-Hardwood	Hardwood	Openings
Three Best						
Fall	309	37	49.0	3.5	42.9	4.6
Spring	323	117	67.6	6.8	23.9	1.7
Three Poorest						
Fall	636	0	90.5	2.6	4.8	0.1
Spring	512	17	91.7	3.7	2.1	0.0

CONCLUSIONS AND RECOMMENDATIONS

Turkeys tolerate a wide range of habitat conditions and patterns of land use but the majority of them will select seasonal ranges that have a diversity of habitat types. Spring and summer habitat should include 12 to 25 percent of well dispersed openings. In order to reduce the distance of spring dispersal of hens seeking open country to nest and raise poults, these openings should be well dispersed or located near the center of a management area. Cattle-timber operations such as Saco with well distributed permanent pastures and timber managed on a long rotation provide a favorable land use pattern for wild turkey management. Turkeys are very tolerant of cattle grazing which, like burning, keeps the forest open. Large forested tracts are likewise satisfactory but often contain less than 10 percent openings. Artificial openings should be created at frequent intervals to produce grasses, forbs, and insects. Nesting habitat can be provided by timber cutting and maintenance of mixed herbaceous vegetation and scattered brush as in old fields.

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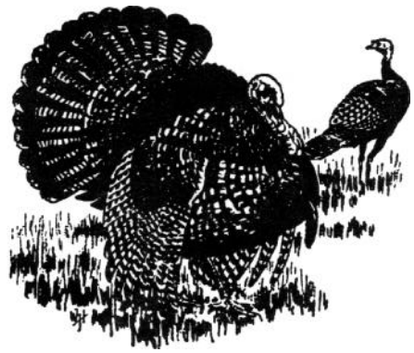

WILD TURKEY POPULATION CHARACTERISTICS IN NORTHERN PENNSYLVANIA

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Abstract: Wild turkeys (*Meleagris gallopavo silvestris*) were historically absent in northcentral Pennsylvania. Extensive clearcutting in the late 1800's changed the forest from a coniferous to a hardwood type. Fifty years later the region became a major turkey producing area. Wild turkey populations have averaged 0.83 birds per square kilometer (km^2) during the winter and 1.6 birds/km^2 during the fall. Hens were more prevalent during high population years and toms during declining periods at Armenia Mountain. Toms were harvested at a higher rate than hens during the fall season. An average kill of 0.46 birds/km^2 has occurred during the fall and 0.08 toms during the spring.

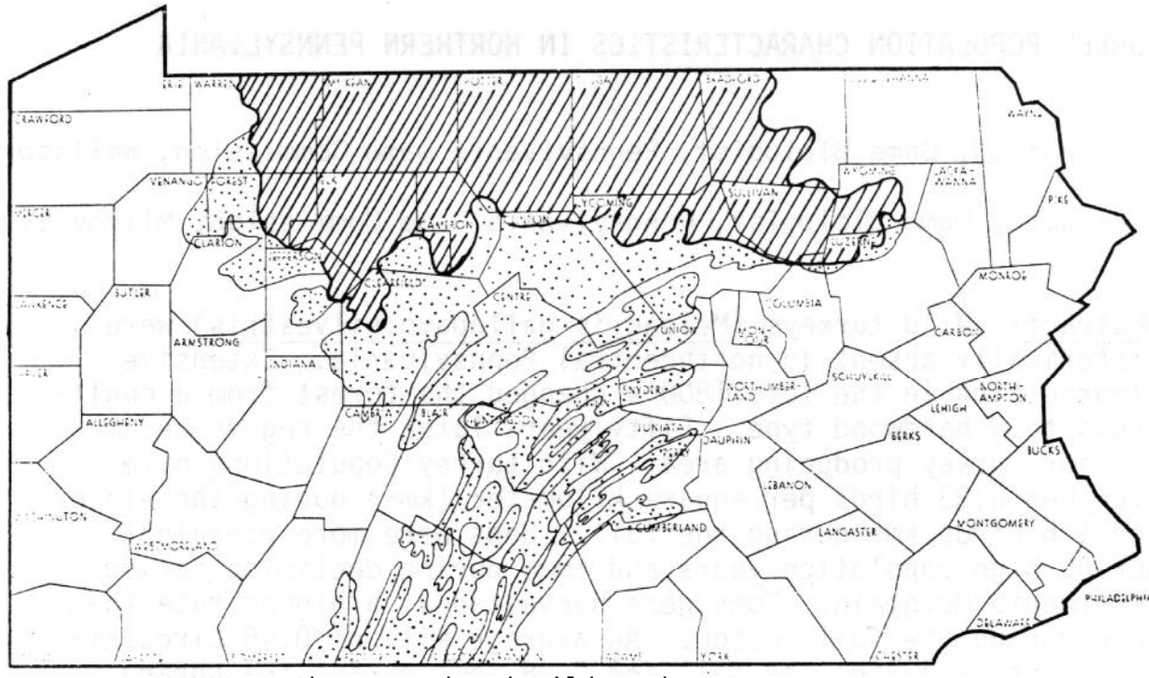
Key words: *Meleagris gallopavo silvestris,* population densities, sex and age ratios, harvest rates

The eastern wild turkey was absent in northcentral Pennsylvania prior to 1940 (Wunz and Hayden 1973). It was believed that the vast climax forest of hemlock-white pine (*Tsuga canadensis* (L.) Carr, *Pinus strobus* L.) formed an ecological barrier to turkeys. Massive clearcutting during the late 1800's and subsequent fires caused an ecological change from a predominately coniferous forest to hardwoods.

Wild turkeys began spreading into the maturing northern hardwood range from the south along a fairly solid front through McKean and Potter Counties in the late 1940's. Populations apparently peaked about 1955 (Wunz 1973, Eaton 1964). Flocks began invading new range northward, eastward, and westward in the northern hardwood type to the Allegheny River in northwestern Pennsylvania and into southern Tioga County in the eastern part of the state by the mid 1950's (Wunz and Hayden 1967). Expansion of turkey range continued in Tioga and western Bradford Counties until the early 1960's.

The northern hardwood forest comprises 50 percent of the primary turkey range in Pennsylvania and produces 50 percent of the total harvest. The region is 77 percent forested and only one county exceeds 19 people/km^2 Two counties, presently, have a slowly decreasing human population. Wood and dairy products are major industries in the region. People's attitude toward wildlife, particularly the wild turkey, is excellent. Perhaps this philosophy is due to the fact that this bird was not found in the region prior to the 1940's. Good law enforcement has also been important in developing and maintaining this good attitude.

Turkey populations in the northern hardwood type are found throughout the heavy forested and rolling hill dairy farm range where woodlots may occupy as little as 20 percent of the land area.



Northern Hardwood Wild Turkey Range.
Oak Forest - Wild Turkey Range.

Figure 1. Primary wild turkey range in Pennsylvania.

The contiguous northern hardwood forest inhabited by wild turkeys encompasses about 16,000 km^2 (Fig. 1). There is a great potential for turkey management in this region because much of the land is publicly owned. Since 1961, turkey habitat preferences and population characteristics have been studied intensively to provide basic information for management.

We thank the research personnel who assisted in trapping operations, brood surveys, and walked many miles on snowshoes during winter censuses, particularly, Lincoln Lang, Steve Liscinsky, and Horn Kriz. Forest Ranger Curt Walcott, Mrs. Walcott, and hunting camp owners provided many of the initial observations of turkeys feeding on bait lines and frequently assisted in trapping and banding. For critical review of the manuscript we are indebted to Dale E. Sheffer and Harvey A. Roberts, Pennsylvania Game Commission.

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GEOLOGY AND CLIMATE

The northern hardwood forest is part of the Allegheny Plateau that has become deeply eroded by streams. Major stream drainages are the Allegheny and Susquehanna Rivers. Two-thirds of the range is glaciated and soils are strongly acid and poorly drained (Lull 1968). The unglaciated section is comprised of well-drained, strongly acid soils. Springs and seeps are abundant. Elevations range from mountain tops of 762 meters (m) to valley bottoms of 328 m.

The climate in the northern hardwood range is the coldest in Pennsylvania. The average minimum temperature in January is minus 8.8°C and the average maximum is 1.1°C (Lull 1968). An annual snowfall of 81-203 centimeters (cm) provides an average 80-100 days of snowcover in excess of 2.54 cm. A snowcover of up to 86 cm is common during severe winters and may persist from late November to late March. Severe winters occur approximately one out of five years. The summers are cool with an average maximum temperature of 27.7°C in July and an average minimum-temperature of 13°C. Average annual rainfall is 102 cm.

FOREST TYPE

The northern hardwood forest is classified as a maple-beech-birch type (*Acer saccharum* Marsh-F*agus grandifolia* Ehrn.-*Betula lutea* Michx.) (Ferguson 1968). It includes the black cherry type (*Prunus serotina* Ehrh.). Associated species are white ash (*Fraxinus americana* L.), red oak *(Quercus borealis* Michx.), red maple (*Acer rubrum* L.),hemlock, and hop-hornbeam *(Ostrya virginiana* (Mill.) K. Koch). Big tooth aspen *(Populus* grandidentata Michx.), white birch *(Betula papyrifera* Marsh) and quaking aspen (*Populus tremuloides*-Michx.) are common on severely burnedI sites. Bluebeech (*Carpinus caroliniana* Walt) and quaking aspen are common along valley bottoms.

Terrain varies from steep mountains with narrow valleys that are 90-95 percent forested to rolling hills where less than 50 percent of the land area is wooded. Dairy farming is an important industry in the rolling hills region and turkey range is confined to the steep wooded terrain and woodlots. In recent years, dairy farming has declined and pastures are now reverting to hawthorn *(Crataegus* spp.), blackberry *(Rubus* spp.), and quaking aspen.

STUDY AREAS

Armenia Mountain in Tioga County was selected in 1961 as an area to study the population characteristics and habitat preferences of wild turkeys. Studies were conducted from 1962 through 1974. The study area is 81.3 km^2 in size and is a combination of steep mountain habitat and abandoned farms. It is 75 percent forested and 25 percent in reverting field types.

Population data from Potato Creek in McKean County were included to substantiate turkey densities from an area typical of the heavily forested habitat. The Potato Creek area is 95 percent forest and five percent food plots and Savannah openings.

METHODS

Winter track counts were conducted at Armenia Mountain and Potato Creek since 1962. A snowcover in excess of 25 cm over a 10-day span was necessary for a census. Ideal conditions included two days free of snowfall prior to census taking. A deep snowcover usually forced turkeys from the ridgetops to valley bottoms where they fed in spring seeps and along the lower slopes. Track counts were taken in late winter after the birds had concentrated along the-valley bottoms. Snowmobiles were used to check ridgetops

for possible stray birds and to transport personnel to the heads of drainages. Populations as determined by track counts represent a minimum density.

The sex composition of turkeys was determined by direct observation and track size. A tom track in Pennsylvania is approximately 135 millimeters (mm) in length and 120 mm wide compared to a hen track of 115 mm in length and 100 mm wide.

Extensive baiting was used to determine reproductive success and population trends on the Armenia Mountain study area since 1966. A 72 km dirt road was baited for two weeks during mid-September with equal portions of wheat and oats. At marked locations about one km apart along the road, a liter of grain was scattered over a five m^2 area. The line was rebaited every two to three days depending upon feeding activity of songbirds, deer, and rodents. The concentrated grain area was replenished daily after a turkey flock began feeding on the bait line.

Hunting camp owners and foresters driving through the study area helped record the number of turkeys feeding at bait sites. Tracks, droppings, and molted feathers were frequently checked around baited areas to determine whether the flocks were broods or several adults.

Hunter bag checks were conducted on Armenia Mountain from 1961-74. In conjunction with bag checks, a windshield distribution of mailable wingtip-breast feather envelopes was made from 1962-74. Cover letters concerning the progress of hunting season surveys were periodically included with the envelopes to increase hunter interest and participation.

During spring gobbler seasons, a windshield distribution of hunter survey postal cards was conducted. Hunters reported on an individual daily basis, including kill location, hours hunted, gobblers heard, turkeys seen.

Wild turkey broods were cannon-net trapped on Armenia Mountain during the late summer from 1963-72. An attempt was made to capture at least 35 percent of the baited population each year. Birds were sexed and aged by physical and feather characteristics (Mosby 1963). Captured turkeys were marked with aluminum leg bands and wing tags and released at the trap site.

RESULTS

Winter Populations

The highest population density determined by winter track counts was 1.43 birds/km^2 on the Armenia Mountain study area in 1967-68 and 1.93 birds/km^2 at Potato Creek in 1968-69 (Table 1). A low population of 0.29 birds/km^2 was recorded on Armenia Mountain during the severe winter of 1969-70 when snow in excess of 80 cm blanketed the ground for several weeks. A low population of 0.17 birds/km^2 occurred during a mild winter at Potato Creek in 1964-65.

The average wild turkey density at Armenia Mountain of 0.83 birds/km^2 is considered representative of a well harvested, thriving population in the northern hardwood type. This density projected to the northern hardwood range indicates a wintering population of 13,000 turkeys. However, since large

Table 1. Number of wild turkeys per km^2 during the winter in Pennsylvania's northern hardwood forest type.

Year	Armenia Mountain	Potato Creek
1961-62	0.87	—
1962-63	0.77	0.34
1963-64	0.81	0.37
1964-65	—	0.17
1965-66	1.00	0.27
1966-67	0.89	0.30
1967-68	1.43	0.31
1968-69	0.85	1.93
1969-70	0.29	0.62
1970-71	0.39	
1971-72	0.70	0.56
1972-73	1.12	0.37
1973-74	0.76	
Average	0.83	0.52

remote forested tracts are usually under-harvested during the fall season, it is likely that the winter population of turkeys would reach 16-20,000 in this region.

Summer Populations

The known baited population of turkeys at Armenia Mountain during the late summer varied from 1.08 to 2.44 birds/km^2 (Table 2). The density at Potato Creek was 3.9 birds/km^2 in 1971 and 1.5 in 1972. Based upon these summer baiting observations, the fall density of turkeys in northern hardwood range is rarely more than 3.9 birds/km^2 in a good reproductive year. Thus, the 16,000 km^2 northern hardwood range probably supports a fall population of 39,000 to 61,000 turkeys or an average 50,000 birds in good reproductive years.

Fall Harvest

Bag checks: The wild turkey in Pennsylvania's northern hardwood range has been subjected to an any sex 3-6 week season since 1954. Hunter bag check, were conducted at Armenia Mountain from 1961-74. The recorded kill in 1966 and 1974 at Armenia Mountain was 0.5 birds/km^2, but it is believed that the actual harvest was closer to 1.0 birds/km^2 in 1966 and 1.4 in 1974. A low kill of 0.22 birds/km^2 was recorded in 1970 following a severe winter when the population was reduced.

Table 2. Wild turkey populations on two northern hardwood study areas baited in late summer.

Year	Armenia Mountain		Potato Creek
	Number	Number/km^2	Number/km^2
1966	198	2.44	-
1967	150	1.86	-
1968	117	1.43	-
1969	88	1.08	
1970	101	1.23	-
1971	88	1.08	3.87
1972	139	1.72	1.47
1973	114	1.39	-
1974	161	1.97	-
Average	128	1.6	

Table 3. Sex ratios for wild turkeys during winter, summer, and fall at Armenia Mountain study area.

Year	Winter	Summer	Fall
	Toms:Hens	Toms:Hens	Toms:Hens
1962-63	47:100	43:100	250:100
1963-64	44:100	115:100	280:100
1964-65	39:100	26:100	72:100
1965-66	56:100	71:100	55:100
1966-67	89:100	67:100	180:100
1967-68	68:100	90:100	114:100
1968-69	108:100	131:100	128:100
1969-70	166:100	86:100	187:100
1970-71	105:100	78:100	100:100
1971-72	76:100	57:100	85:100
1972-73	---	75:100	---
1973-74	29:100	57:100	33:100

Beginning in the fall of 1973, turkey hunters were required by law to report a harvested turkey. Two counties (Potter and Tioga) in the northern hardwood forest reported an average kill of 0.46 birds/km^2. When these harvest data and those from Armenia Mountain were projected to the entire northern hardwood range a harvest of 7-11,000 turkeys was indicated for the 1973 fall season.

Band returns: A total of 502 turkeys were tagged on Armenia Mountain from 1963-72 and 25 percent of the bands were voluntarily returned by hunters. The harvest rate from Armenia Mountain is thought to be higher than adjacent range because the study tract is very accessible to hunters. A harvest rate of 25 percent projected to the estimated fall population of 39,000 to 61,000 turkeys indicated a possible legal harvest of 9,750 to 15,250 birds from the northern hardwood range each fall.

Band returns during the fall hunting season from Armenia Mountain indicated that toms were more susceptable to the gun than hens. There were 426 turkeys banded as juveniles and 27.6 percent of the toms were harvested the first fall compared to 12.4 percent of the hens. When the banded juvenile birds were 2 l/2 years of age, 35.2 percent of the toms had been shot compared to 17 percent of the hens. The oldest banded turkeys shot on Armenia Mountain were a 5 l/2 year old hen and a 4 l/2 year old tom (Hayden and Wunz 1970).

Spring Gobbler Season

A six day spring gobbler season was inaugrated in May 1968 and has gradually been expanded to three weeks. Hunter survey cards placed on cars on Armenia Mountain indicated an average harvest of 0.08 toms/km^2. Game Protector reports from 14 counties in the northern hardwood region indicated an estimated 1,165 toms were harvested in the 1974 season or 0.07 toms/km^2. An average harvest rate of 0.07 to 0.08 toms/km^2 indicated approximately 1,165 to 1,300 toms were harvested in the northern hardwood range.

Sex Ratios

Winter sex ratios: Winter sex ratios of turkeys at Armenia Mountain varied with the population trend except for 1967-68. The sex ratio ranged from 39 to 89 toms per 100 hens between 1962 and 1967 (Table 3) and the winter population was average (Table 1). The fall population during this period was high. In the winter of 1967-68, the sex ratio was 68 toms per 100 hens and the population was the highest recorded. This high wintering population was followed by poor reproduction. A sex ratio of 105 to 166 toms was found during the next three winters (Table 3). The fall populations during these years was low.

Winter track counts during February 1972 disclosed 76 toms per 100 hens and the population density was slightly below average (Table 1). Good reproduction occurred during the summer of 1972 despite adverse weather during the peak of hatch. The sex ratio during the winter of 1974 was 29 toms per 100 hens and the summer population was 161, the second highest turkey population during the study on Armenia Mountain. A wintering population of 0.83 birds/km^2 with a sex ratio favoring hens has provided the highest summer populations.

Summer trapped juveniles: The sex ratio of 481 poults captured and tagged during the late summer from 1963 to 1972 averaged 65 toms per 100 hens. Only twice from 1963 to 1974 did the number of captured juvenile toms exceed hens (Table 3). The highest sex ratio of 131 captured juvenile toms per 100 hens was reached in 1969 when the summer population on Armenia Mountain reached its lowest point (Table 2). Summer trapping since 1971 has yielded more juvenile hens than toms and the population has been increasing.

Fall harvest sex ratio: More hens than toms were harvested during high or increasing population years of 1965, 1966, and 1974 at Armenia Mountain even though toms are generally harvested at a higher rate than hens (Table 3). During the period of declining and low populations from 1968-71, the tom harvest exceeded the harvest of hens.

DISCUSSION

Wild turkey populations in Pennsylvania's northern hardwood range vary from area to area during the same year. When Armenia Mountain supported a low summer population in 1971, Potato Creek, 160 km to the west, showed a high population. Wintering densities have been high in one study area and low in the other during the same year.

Summer densities are not necessarily dependent upon the wintering population. Reproduction may be excellent from a low wintering population and extremely poor with a high number of breeders. For example, a high winter density of 1.43 birds/km^2 on Armenia Mountain in 1968 was followed by poor reproduction. The 1968 summer population was comprised primarily of adults. In contrast, a low winter population of 0.31 birds/km^2 at Potato Creek in the same year resulted in phenomenal reproduction (Wunz and Hayden 1975). An average winter density of 0.50 birds/km^2 at Potato Creek in 1973 produced the highest summer population on record.

The only population decrease that occurred simultaneously on Armenia Mountain and Potato Creek was during the severe winter of 1969-70. Wild turkeys cannot be stockpiled in the northern hardwood range because of mortality during a severe winter. Winter mortality is expected one out of three years, but the turkey population is capable of bouncing back in one or two years without any reduction in the length of the hunting season. The winter population on Armenia Mountain was suppressed due to severe winter weather in 1970 and 1971. In 1972, the wintering population returned to near normal levels.

Holbrook (1973) suggests a density of 3.9 birds/km^2 during the fall as a basic goal on National Forests in the south. It appears that this goal is only met periodically in the northern hardwood range. Baited summer densities that represent approximately 75 percent of the population have ranged from 1.08 to 3.87 birds/km^2.

The role of sex ratios in a wild turkey population is complex and is not clearly understood at this time. Factors such as adverse weather during the reproductive cycle, the ratio of hens to toms in broods, and high or low success of sportsmen during the hunting season influence sex ratios from year to year. However, there appears to be some relationship between populations and sex ratios. Hens on the average are produced at a higher rate

than toms in Pennsylvania's northern hardwood range, especially during high population years. Sex ratios based on track counts, summer trapping and fall bag checks all showed a high number of hens in the population in good reproductive years.

Interestingly, the major population decline on Armenia Mountain began after a high winter population with a sex ratio favoring hens. Reproduction from this high population was very poor. The population did not show signs of recovering for three years. The problem was compounded by the fact that winter mortality occurred during two of the three years of low populations.

Sex ratios determined by fall bag checks are often not representative of the population. Toms during the fall hunting season are more susceptible to the gun than hens and usually inflate the sex ratio of the harvest. The number of hens killed exceeded the number of toms only during high reproductive years.

Although the maximum turkey harvest in the northern hardwood type is not known, the fall harvest has reached 35 percent of the population periodically at Armenia Mountain without ill effects. Banding studies indicated that at least 25 percent of the fall population can be safely removed by hunting each fall without causing a decrease the next fall.

CONCLUSIONS

In northern Pennsylvania, conversion of the climax forest of hemlock-white pine to northern hardwoods in the late 1800's created a desirable habitat for wild turkeys in the 1940's. Wild turkey populations fluctuate annually with the wintering densities approximately one half that of the summer. Hens are produced at a higher rate than toms, especially in good reproductive years. At least 25 percent of the fall population can be removed by hunting without any ill effects. Toms are more susceptible to the gun than hens during a fall hunting season.

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ECOLOGY OF MERRIAM'S WILD TURKEY ON THE FORT APACHE INDIAN RESERVATION

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Abstract: The ecology of Merriam's wild turkey *(Meleagris gallopavo merriami)* was studied on the Fort Apache Indian Reservation in Arizona during 1964-73. Removal of 65 percent of the mature ponderosa pine had little effect on the turkey population. Intensive cutting in roosting sites and range improvement practices caused partial or complete abandonment.

Daily movements were within a 2.0 kilometer (km) radius of the roosting site, but seasonal migration was as far as 29 km. Meadows were used quite heavily as feeding areas, but turkeys seldom ranged farther than 45 meters (m) from escape cover. Grasses and forbs were important foods, especially in the spring and fall. Ponderosa and pinyon pine seed, and acorns were eaten seasonally. Juniper berries were utilized in the absence of other mast crops.

Turkeys used small earthen stock tanks during dry periods. Winter and spring precipitation was important for poult survival. The correlation coefficient between precipitation (January through June) and the hen:poult ratio (25 August-30 September) was 0.828.

Key words: *Meleagris gallopavo merriami*, food habits, movements, reproduction, habitat, management

The purpose of this study was to define more precisely the habitat and habits of Merriam's wild turkey on that portion of the Fort Apache Indian Reservation in east central Arizona which contained a relatively large turkey population and where human disturbance was minimal. The study area contained three main overstory communities, ponderosa pine, pine-juniper-oak, and pinyon-juniper. From September 1964 to September 1973 studies were made of seasonal food habits, roosting and water requirements, winter and summer home ranges, mortality factors, and annual productivity. The effect of pinyon-juniper eradication and logging on turkey populations was evaluated the last 3 years. Suggestions for turkey management are based on these investigations.

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STUDY AREA

The study area (Fig. 1) was an irregular plot of about 5,000 hectares (ha) located in the western portion of the White Mountain Apache Indian Reservation in southern Navajo and northern Gila Counties, Arizona. The area is referred to as the Grasshopper study area after the name of a summer cow camp, located in the northern portion. Elevations range from 1,500 to 2,100 m. The gradually descending plateau is bounded on the west by a broad, grassy plain, on the south by the precipitous Salt River Canyon, and on the east by a series of juniper covered ridges and grassy meadows. The heavily vegetated rolling hills are cut by steep canyons. A broad intermittent stream channel, associated with a long narrow meadow, traverses the area from north to south. A network of unimproved roads permitted vehicular travel over most of the area during dry periods.

The northern portion of the area was logged and part of the southern end was subjected to a pinyon-juniper eradication program in 1969. Cattle grazed the area during the summer.

Overstory vegetation on the lower elevations is a complex of pinyon pine (*Pinus edulis* Engelm.), one-seeded juniper (*Juniperus monosperma* (Englem.) Sarg.), alligator juniper (*J. deppeana* Steud),Utah Juniper (*J. osteosperma* (Torr.) Little), and scattered stands of ponderosa pine (*Pinus-ponderosa* Lawson) located mostly on north exposures. Dense stands of manzanita *(Arctostaphylos* spp.) and associated shrubs are present on some of the southern slopes. The overstory gradually changes to ponderosa pine on the higher elevations, mostly with an understory of pinyon-juniper and oaks (*Quercus gambelii* Nutt., *Q. emoryi* Torr., and *Q. grisea* Liebm.). Much of the timbered area is interspersed with small openings that are dominated by grass and forbs. Composition in these openings changes little with elevational changes. The most abundant grass species is blue grama *(Bouteloua gracilis* (H.B.K.) Lag.). Less important species, in order of abundance, include six weeks love grass (*Eragrostis lutescens* Scribn.), western wheat grass *Agropyron smithii* Rydb.), red three awn (*Aristada longiseta* Steud.), stony hills muhly (*Muhlenbergia cuspidata*), and tickle grass (*M. sinuosa* Swallen). The more abundant forbs are spurges *(Euphorbia* spp.), followed by spreading fleabane (*Erigeron divergens* Torr. & Gray), plantain *(Plantago* spp.), loco *(Astragulas* spp.), goldenweed (*Aplopappus gracilis* (Nutt.) Gray), filaree (*Erodium cicutarium* (L.) L'Her.), western yarrow (*Achillea lanulosa* Nutt.), western ragweed (*Ambrosia psilostachya* DC), and common dandelion *(Taraxacum officinale* Weber).

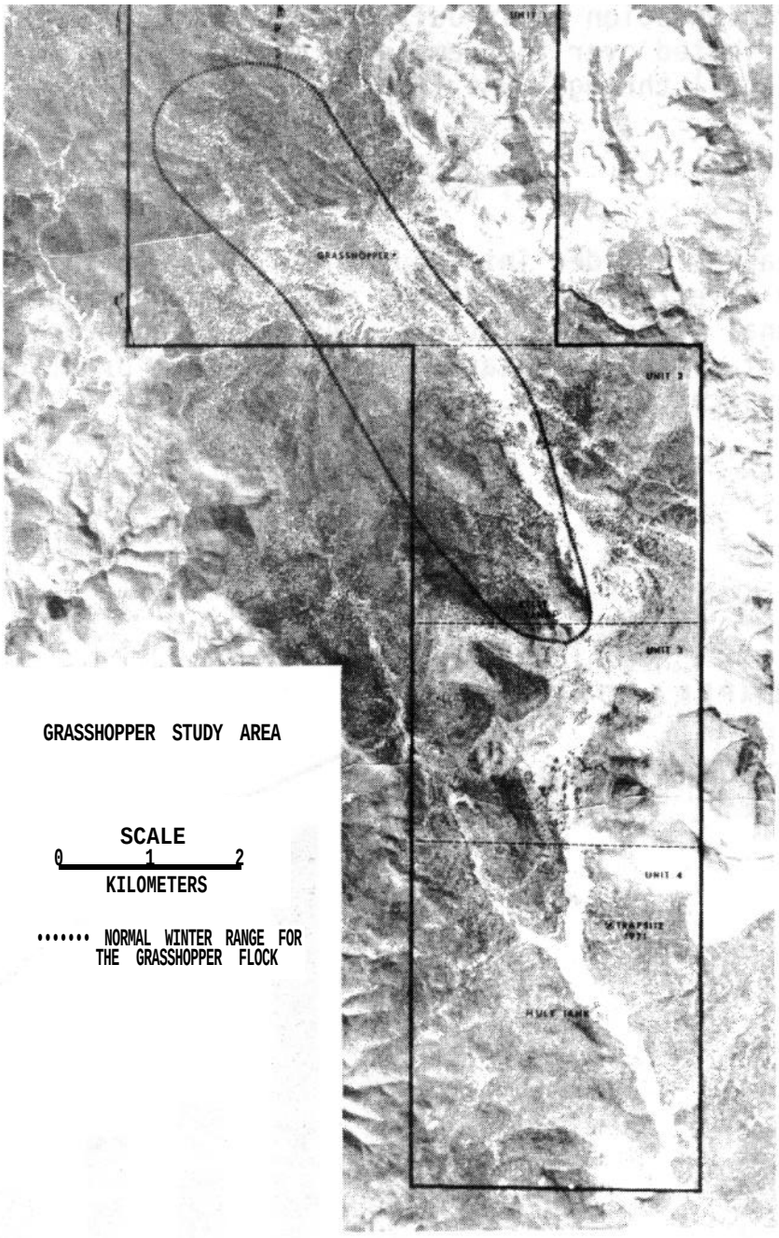

Figure 1. The Grasshopper study area on the Fort Apache Indian Reservation.

The mean annual temperature at Cibeque, about 16 km east of the study area, is 12.0°C (U. S. Department of Commerce 1972). Peak summer temperatures occasionally exceed 37.8°C, and winter lows rarely drop below -15°C.

The annual precipitation for Cibeque averages 48.8 cm. During the study period it ranged from 67.9 cm in 1965 to 27.2 cm in 1970. Normally, about one-half of the precipitation falls July through October. The other half is fairly evenly distributed over the remaining months except for a seasonal drought period in April through June (Fig. 2).

UNIT DESCRIPTION

The study area was divided into four units (Fig. 1) in an attempt to determine possible effects of habitat and of timber and range management practices on seasonal turkey populations. As nearly as practical, the units represented areas of similar vegetation and management practices separated by recognizable physical features.

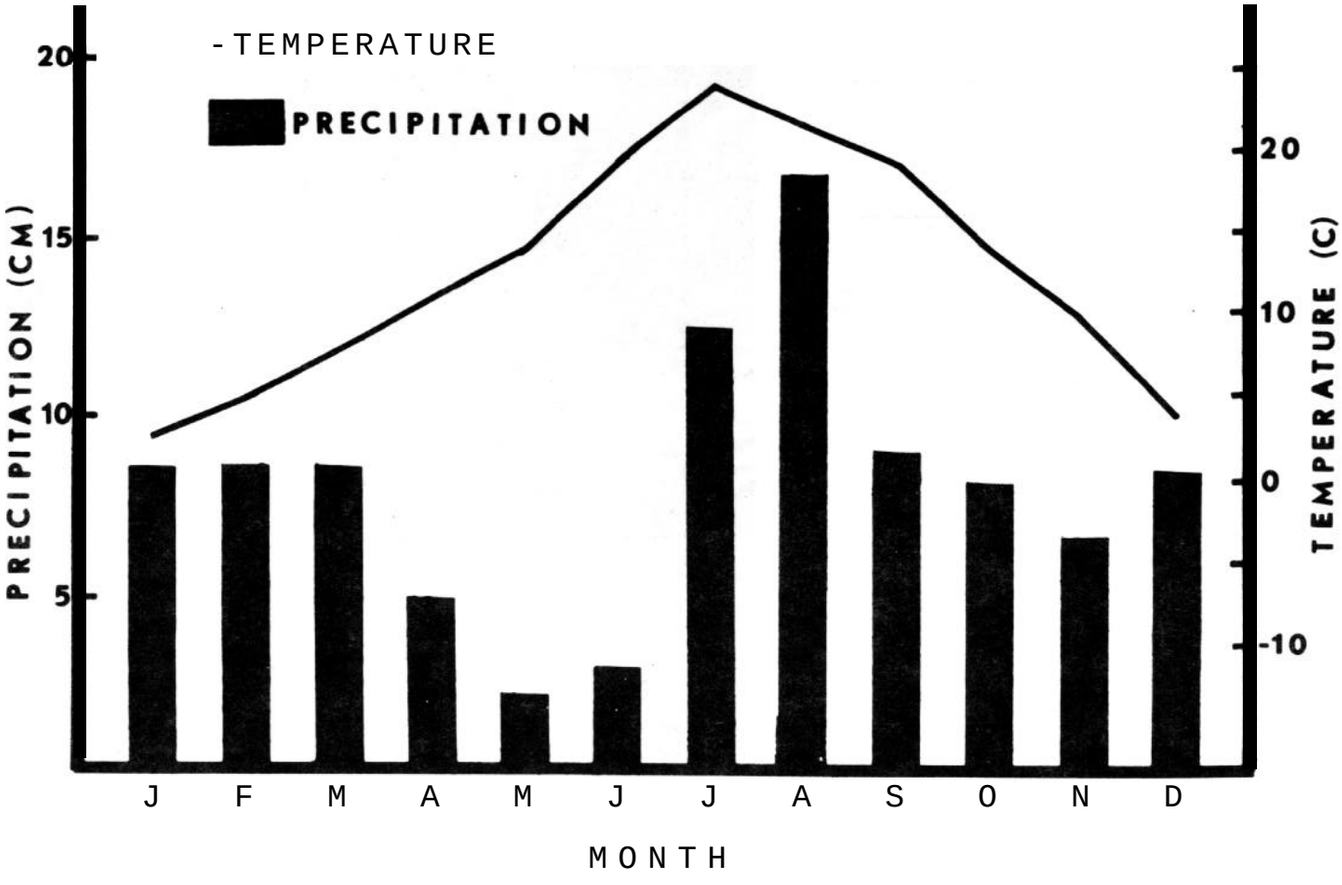

Figure 2. Average monthly temperature and precipitation for Cibeque, Arizona.

Unit 1

This unit had an area of 19 square kilometers (km^2) and a total of 11.2 km of survey roads. Vegetation is typical of the upper transition zone. Pure ponderosa pine stands are present, but most ponderosa is mixed with pinyon, juniper, and oak. A timber harvest, started in fall 1969 and completed in fall 1970, removed about 65 percent of the mature ponderosa pine plus the suppressed trees. The harvest, which extended about 20 km north of the study area, covered all of the unit except part of the northeast corner that had been subjected to pinyon-juniper control before the study began. Access to the northeast corner was poor and none of the survey route was located in the treated area. Removal of timber along the survey route improved visibility considerably.

Units 2 and 3

These units consist of 18.4 km^2 of mostly pinyon-juniper with a meadow extending through the center of the unit with small stands of ponderosa pine. Most ponderosa pine is located at the northern edge of the unit where light cutting occurred in the winter 1969-70. The 8.8 km of survey road ran through the meadow and visibility was not changed because of timber harvest. Some pinyon-juniper had been removed from Unit 3 before initiation of our study but these units had little disturbances during the study.

Unit 4

This unit contains 12.6 km^2 of pinyon-juniper with a meadow extending through the center of the unit where the 4.8 km of survey road was located. Few ponderosa pine are present and mostly on northern exposures. From the fall of 1969 through the fall of 1970, the eastern side of the unit was subjected to a range improvement program covering about 800 ha. All trees and shrubs were removed by chaining and burning except the small groups of ponderosa pine.

METHODS

Turkeys were observed seasonally from an automobile along established routes through the study area. Data were recorded denoting number, sex, and age of turkeys seen for the specific location, vegetation type, distance from cover, behavior, weather conditions, and time and duration of observation.

Sexes and ages of turkeys were determined by morphological characteristics described by Leopold (1943) and Knoder (1959). Areas of intensive use were located by tracks, scratching and "dusting" spots, and accumulations of droppings.

A cannon net trap described by Dill and Thornsberry (1950) was used to capture 109 turkeys during the winter periods, 1966-71. The most successful trap sites were those prebaited with a mixture of cracked corn and oats in areas of heavy and consistent turkey use. The trapped birds were marked by various methods ranging from plastic streamers attached to a leather harness tied around the wings to numbered tags attached through the patagium (Knowlton

et al. 1964). The most efficient tags were orange patagium tags 7.6 x 12.7 cm in size with black numbers and in several instances, the numbers were still clearly visible 3 years after marking.

To supplement movement information from sightings of color-marked birds, we equipped 13 turkeys with 164-MHZ radio transmitters that were sealed in clear, heat-shrinkable tubing and attached to the back by tanned deer hide strings tied around the wings (Patton et al. 1973).

The aspect, slope, and distance from water and open meadow were recorded for each roost site. The height, dbh, and distance from the ground to the first branch of each roost tree was measured (Boeker and Scott 1969). Similar measurements were taken of roost trees after a timber harvest.

Turkey observations and counts were taken before and after timber harvest and juniper control treatments. Changes for various periods were compared by the student t-test with $P \leq 0.05$ as the criterion of significance.

A time-lapse camera, described by Patton et al. (1972), was used to record turkeys at a waterhole from 5 May to 2 June and from 4 to 22 November 1970. The camera was set to expose a single frame at 5-minute intervals beginning at sunrise and ending at sunset. Turkeys were counted by viewing the processed film through a binocular microscope.

Food habits were determined by examining 36 turkey crops and 866 fresh droppings collected during the four climatic seasons. Material from each crop was separated by species, the percent composition by volume was determined, and samples were ovendried and weighed as described by Martin (1963). Quantitative contents of droppings in increments of 5 percent were made by ocular estimates through a binocular microscope.

A gobbler call count route was established and run each spring during years 1966-73. Our route was similar to those described by Donahoe and Martinson (1963) in Ohio except that it included 12 listening stops spaced at 1.6-km intervals. The survey began 0.5 hours before sunrise and normally was completed in 1.5 hours. The total number of gobbles heard and the number of individual calls from each gobbler at each stop were recorded (Scott and Boeker 1972). Counts were timed to cover at least one of the two gobbling peaks that normally occur at the onset of breeding and again at the beginning of incubation (Bailey and Rinell 1967).

In addition to recording all known acts of predation on turkeys, an attempt was made to gain information on nest predation. Twenty artificial turkey nests, using five chicken eggs, were established on 14 May 1968. These nests were checked for predation 16 and 42 days after establishment.

RESULTS

Seasonal Movements

A good population of turkeys was on the study area year-round. However, some birds moved off the area during spring dispersal and others that wintered to the south of the study area moved on to the area during the summer.

On 26 and 27 January, 1971, 37 hens from a flock of 115 hens were trapped and marked with numbered patagium tags. Subsequent observations of this group of birds provided the best information on movements. These birds were trapped at the north edge of Unit 4 which was south of the winter range used in previous years, however, low mast production, except for juniper berries, may have caused the birds to move in search of food. By 10 February the marked birds had moved 8 km north and were rejoined with unmarked birds on the normal winter range, where they remained until the spring dispersal. Seven yearling gobblers, marked on 12 February 1971 at the same trap site as the 37 hens, remained together but separate from the hens and were observed on several occasions 3 km north of the trapsite until 27 July 1971. None of these gobblers were observed again until April 1973, when one was seen with a group of hens 3 km north of the trapsite.

Thirty-four of the 37 hens marked in January 1971 were individually recognized by their tags after release. Most birds were observed during February-April 1971 while they were still on their winter range. Generally, movement from the wintering area began between 5 and 10 April and by 20 April most of the turkeys were on their summer range. Most of the spring dispersal was toward higher elevations, however, one marked bird was observed in summer south of the trapsite at a lower elevation than the winter range. Reports of two marked turkeys 29 km north of the study area were received from Arizona Game and Fish personnel. These observations were made at the same general location on the Apache-Sitgreaves National Forest on 22 April 1966 and 24 April 1969.

Jonas (1966) suggested that about 50 percent of the Merriam's turkey population in the Long Pines area of Montana disappeared each year, whether hunted or not. If the mortality and emigration rate is similar for this study area, nearly all of the surviving birds in 1972 and 1973 returned to the same wintering grounds: 18 of the 37 hens tagged in 1971 were individually recognized in the vicinity of Grasshopper between November 1971 and early April 1972, and 7 were identified during the same period in 1972-73. The actual number of tagged birds on the study area, however, was probably higher than the number individually recognized. Several times, observers saw orange tagged birds without being able to read the numbers, usually because the birds were moving in dense cover. Barrett Edgar, Arizona Game and Fish Department (personal communications), observed at least six marked birds in one flock near Grasshopper on 1 March 1974.

Home Range and Daily Movements

Although 13 turkeys were equipped with transmitters, only one transmitter on an adult hen worked sufficiently well to gather data on daily movements. The hen was trapped on 27 January 1971 at the south end of the study area. By 12 February she had moved 8 km north with a large flock of turkeys that remained in the general vicinity of Grasshopper until spring dispersal. This hen was located by radio on several occasions during February-April, each time within 2.0 km of the roost site. She was monitored daily 8 to 12 March and moved in all directions from the roost area. The last ground contact with this bird on the study area was 6 April. On 30 April she was located by aircraft 17.0 km northwest of Grasshopper and was subsequently located visually and by radio from the ground on several occasions until 19 May, always within 1.5 km of the 30 April location.

Although these radio-tracking data suggest that turkeys' daily movements probably do not exceed 2 km in any direction from the roost, the home range for a group of turkeys during any season consists of a much larger area. For example, Spicer (1959) found that birds, starting at one roost, may move about for 5 days before returning to it and beginning a similar trip. Turkeys on the Grasshopper area regularly visited a series of fall, winter, and spring roost sites except when disturbances or food shortages altered their travel patterns. During the winter of 1967-68, when mast crops failed almost completely, one large group of turkeys alternately used two roost areas 3.2 km apart.

Flocking Behavior

The largest flocks were observed during winter. Birds per flock averaged 67 in December and 37 in January (Fig. 3). Most of the turkeys observed in December and all in January were in segregated flocks of juvenile toms, adult toms, or both juvenile and adult hens. On several occasions mixed sex and age classes of turkeys were observed roosting in the same area, but they separated into segregated flocks when they left the roost.

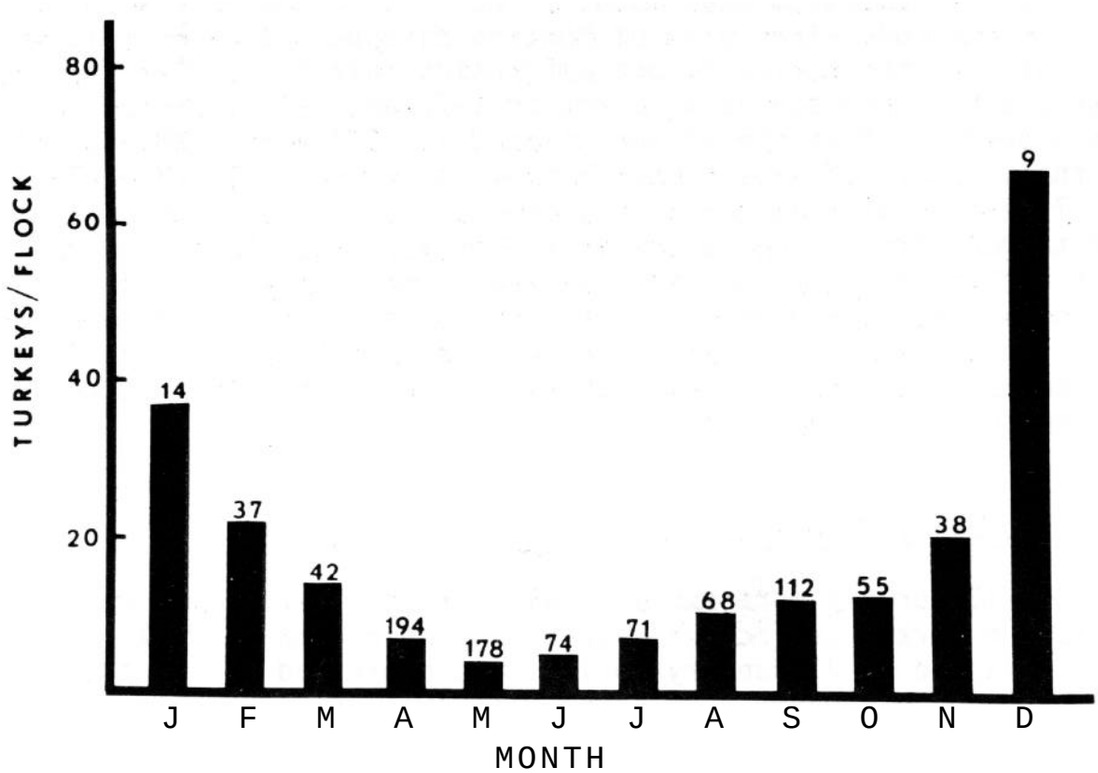

Figure 3. Mean turkey flock size by month on the Grasshopper study area, 1965-73. Figures above bars represent number of flocks observed.

Some turkeys began to form breeding groups by late March, and 17 percent of the March flocks contained both hens and toms. Breeding activity peaked in April, when 64 percent of the flocks contained both sexes. The average breeding group was 2.2 toms and 7.5 hens. During the May incubation period, lone hens were frequently observed. This resulted in the lowest mean flock size of any month (4.3 birds).

By late May, turkeys had again begun to segregate and only 38 percent of the May flocks and 3 percent of the June flocks consisted of both hens and toms. Yearling toms were observed frequently with adult toms after the breeding season.

In June, poults were usually accompanied by only one hen, but by July many of the hens with broods had joined with others, and the average number of hens in a group of poults was 2.7 for both July and August. During the fall months, turkeys continued to join together and flock size gradually increased until December when the average flock size was 67 (12 to 117 per flock).

Reproduction

Turkey brood surveys were conducted each year to determine trends in poult production and survival. Young poults used wooded areas with very small openings during the first few weeks after hatching, therefore early broods were difficult to locate and only 20 broods were observed in June. The mean number of poults per hen for June was 5.0. The low was 2.2 in 1966 and the high was 9.0 in 1969. These spring brood sizes were smaller than those reported for the Merriam's race in Colorado (Hoffman 1962), New Mexico (Spicer 1959), and South Dakota (Peterson and Richardson 1973), but were comparable to those reported for Arizona (Arizona Game and Fish 1968, 1971, 1973).

Hens with broods had an average of 3.46 poults between 25 August and 30 September thus, about 30 percent of the poults were lost between June and September. Mosby (1967) found an average loss of 20-25 percent for eastern turkeys between June and September.

Spring precipitation may be a critical factor in poult survival in the Southwest where April, May, and June are normally very dry. Fall brood sizes were closely associated with the winter-spring precipitation pattern. Total precipitation for January through June was highly correlated ($r = 0.828$) with brood size during 25 August to 30 September. The greatest departure from this pattern occurred in 1972. Only 6.12 cm of moisture was recorded from January through June, but all of it fell in May and June. During the last week of August 3.1 poults per hen were recorded. Four or more poults per hen were recorded during three different years, when the January-June precipitation was more than 20 cm. The lowest brood size (1.8) occurred in 1971 when January to June precipitation was only 5.26 cm. One of the highest late summer brood counts (4.3) occurred in 1969 following an 18-cm snowfall on 7 May when some hens had begun incubating. The resulting moisture from that snow stimulated good vegetative ground cover, which young poults probably depend on for both insect food and protective cover.

Table 1. Percent of turkeys sighted seasonally in plant communities, 1965-73.

Plant Communities	Winter	Spring	Summer	Fall	Total
Meadow 0-45 m from cover	16.0	49.4	65.7	53.5	45.8
Meadow 45+ m from cover	1.0	3.8	6.9	4.0	3.7
Ponderosa pine	19.2	12.6	5.4	12.1	12.8
Oak	2.0	tr.	1.0	tr.	0.7
Pinyon-juniper	7.5	6.7	8.0	6.8	7.1
Mixed trees and shrubs	54.3	27.5	13.0	23.6	29.9
Total birds	1,929	2,746	1,402	2,603	8,680

Habitat Used

The vegetative types used seasonally by turkeys are shown in Table 1. Turkeys spent much of the mid-day in heavy cover where they were difficult to observe, thus about 80 percent of the sightings were made during mornings and evenings. Sixty-two percent of the sightings concerned feeding birds, and seasonal use by vegetative type may be related to the pattern of food availability.

Meadows

Open meadows constituted only 18 percent of the study area, but nearly 50 percent of the turkeys were sighted in this habitat. Of these birds 93 percent were within 45 m from escape cover. Turkeys more than 45 m from escape cover were usually moving rapidly across the openings. Meadows were used highest in summer when poults fed extensively on grass seeds and insects.

Tree and Shrub Communities

Since only small parts of the study area can be separated into pure stands of any trees or shrubs, most turkeys were seen in a mixture of tree and shrub species. Tree and shrub communities served as escape cover and provided sites for loafing, nesting, brood rearing, and roosting. Consequently, turkey spent more time in this type than in open meadows, which were used mainly for feeding and courtship. During winter, when much of the diet was mast (acorns, juniper berries, and pine seed), most observations were made in the tree and shrub communities.

Roost Areas

All of the 18 roosting sites located on the study area were in the ponderosa pine type. These preferences for ponderosa pine as roosting sites

agrees with studies by Jonas (1966) in southern Montana and Hoffman (1968) in Colorado.

All roosts were within 45 m of open meadows that were 0.2 ha or larger in size. Turkeys almost invariably sailed from the roost trees to the openings in the morning. Hoffman (1968) also noted that roosting sites were located at the edge or near a natural opening or open ridge.

In this study 13 of the 18 roosting sites faced east or northeast. The remaining roosts were on ridge tops or in trees that grew on western exposures but extended above the ridge top. This suggests that turkeys may select sites that provide the earliest morning light.

Sixteen of the 18 roost sites were within 0.8 km, and generally within 0.4 km of permanent water. The two other roosts were about 1.6 km from water. One was used only in winter and the other in late summer and early fall during the rainy season.

The number of roost trees used by turkeys ranged from 1 to 37 and averaged 15 per site. Understory vegetation was sparse except in a few instances where juniper seedlings formed dense thickets. The largest number of turkeys observed in a single roost tree was 15. The highest number recorded at a site was 117. Turkeys preferred the upper half of trees and no obvious differences between the sexes were detected in the choice of roost trees.

Mature or over-mature, flat-topped trees with open canopies and large horizontal branches were preferred as roost trees. Their occurrence may be instrumental in roost site selection and form the nucleus of the site (Boeker and Scott 1969).

Five roosting sites that had been inventoried before a timber-harvest were reinventoried after harvest. One 0.5-ha area, consisting of 37 roost trees and with a basal area of 26.4 m^2/ha had been used consistently during winter and spring (Fig. 4). After cutting it was reduced to eight intermediate class

Figure 4. Turkey roost site on Grasshopper study area. Before cutting (left the tree basal area was 26.4 m^2/ha and the site was used consistently as a winter roost. After cutting to a tree basal area of 10.6 m^2/ha (right) the site was not used again as a roost.

trees (51 to 71 cm dbh) with a basal area of 10.6 m^2/ha and was abandoned. Turkeys also abandoned another roost where the tree basal area was reduced to 16.8m^2/ha but they returned after 3 years. Turkeys continued to use four other cut-over areas where basal areas were not reduced below 20.7 m^2/ha. In these areas the mean diameter of roosting trees dropped from 62.7 to 57.4 cm dbh, mean tree height from 23.6 to 22.0 m, and use of intermediate class trees increased from 36 percent to 98 percent. In general, tree reduction within a roost site to 20.7 m^2/ha basal area seemed to have little effect on roosting behavior, but reduction to 16.8 m^2/ha basal area caused the turkeys to either move to other areas or to become erratic in their roosting behavior. In Colorado, Hoffman (1973) found that removal of about half of the old-growth unevenaged ponderosa pine did not deter turkeys from using established roost sites.

Burning in and around one of the major winter and spring roosts during slash clean-up in January 1970 caused temporary abandonment but turkeys resumed use the following December. Two small stands of ponderosa pine trees used as yearlong roost sites in a pinyon-juniper community were abandoned when they were isolated from travel lanes by a juniper control program.

Responses to Timber Harvest in Unit 1

Turkeys moved from the timber harvest area during the cutting and 0.02 and 0.14 turkeys/km were recorded in the summer and fall of 1970 when cutting occurred. This compared to summer counts of 0.27 turkeys/km before harvest and 0.76 after, and fall counts of 0.86 before and 2.74 after harvest (Fig. 5). None of these changes were significant at the 5 percent level and much of the increase was probably because of improved visibility.

This unit accounted for 31 percent of the spring, summer, and fall observations before the timber harvest and 38 percent after (Table 2). The undisturbed units (2 and 3) increased from 39 percent to 49 percent during the same periods. The timber harvest apparently had little effect on turkey populations although they abandoned heavily cutover roost areas or became erratic in roosting behavior.

Responses to Pinyon-Juniper Control in Unit 4

During the 4 years before treatment 30 percent of all turkey observations made were made in Unit 4, but only 13 percent of the observations were made there during the 4 years after treatment. The pretreatment surveys indicated a higher number of birds/km in the pinyon-juniper area than on the rest of the study area for each of the three seasons, whereas posttreatment surveys showed a lower number (Fig. 5). The summer and fall declines were significant for turkeys/km and percent of total birds. The spring decline from 0.69 turkeys/km pretreatment to 0.48 posttreatment was not significant although the percent of turkeys observed in the unit (29 to 20) was significantly lower. The most severe decline was noted during summer when turkey observations dropped from 0.4l/km for pretreatment to 0.08 for posttreatment. Many of the turkeys probably moved into the undisturbed areas where large increases in turkey populations were noted after treatment.

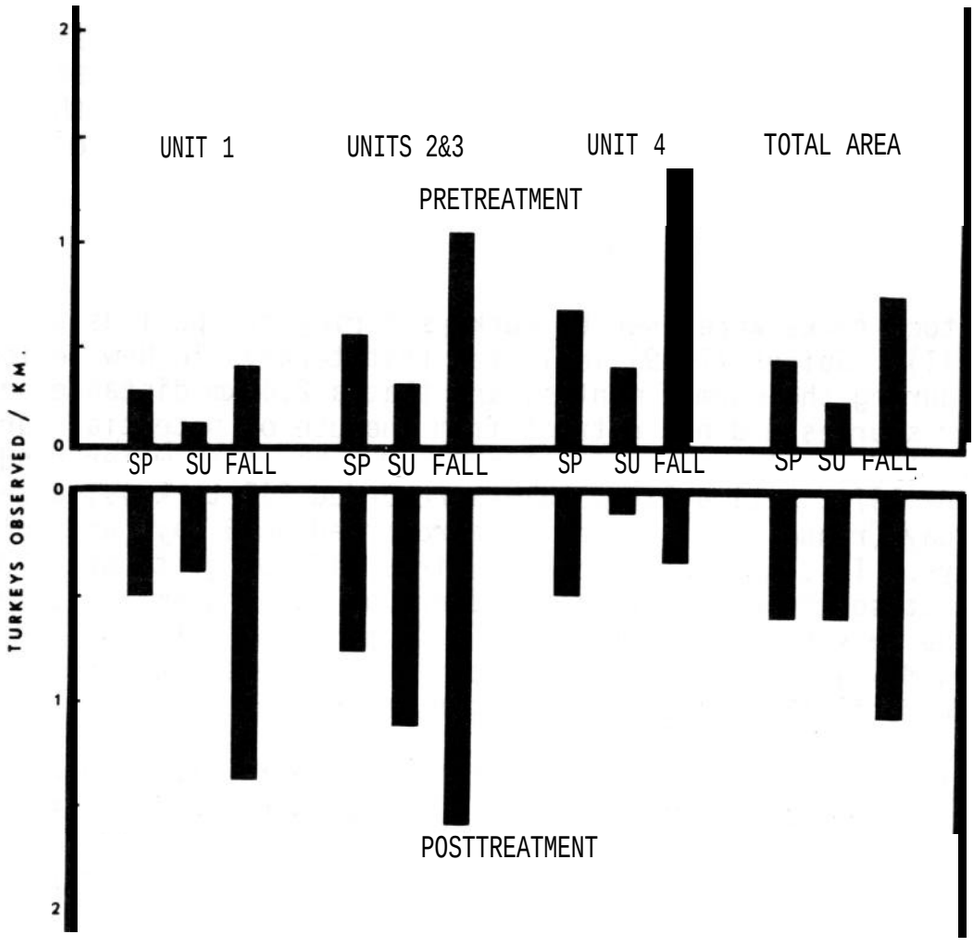

Figure 5. Comparison of turkeys observed/km before and after cutting of ponderosa pine and clearing of pinyon-juniper.

Table 2. Distribution of turkeys before and after a timber harvest in Unit 1, no disturbance in Units 2 and 3, and pinyon-juniper control in Unit 4.

Season	Number of Turkeys Seen		Percent of Total Turkeys Seen					
			Unit 1		Units 2 & 3		Unit 4	
	Before	After	Before	After	Before	After	Before	After
Spring	1410	1185	27	43	44	37	29	20
Summer	790	467	22	27	46	70	32	3
Fall	1728	739	37	36	32	54	31	10
Total	3928	2391	31	38	39	49	30	13

The west side of Unit 4 was undisturbed and vegetation was similar to the treated area except there were very few ponderosa pine trees present to provide roost sites. Two intensively used yearlong roost sites on the east side were isolated at least 300 m from cover by the treatment and were abandoned.

Water

Several stock tanks were used by turkeys during dry periods of the year (spring and fall). Spicer (1959) indicated that turkeys in New Mexico required free water during the warmer months, and that a 2.4 km distance between permanent water sources did not detract from the use of potential turkey range. Turkeys frequently used Kelly Tank, a O.2-ha stock water pond. Between 5 May and 2 June 1970, a time-lapse camera recorded 249 turkeys, a mean of 9.2 birds per day (range 0-33). None were recorded on 3 days and only one on three other days. This suggests that the birds did not go to water daily, since the nearest source of alternative water was about 3 km away. Most turkeys visited the tank between sunrise and 9:00 a.m. and between 2:00 p.m. and sunset. During May 1971, Kelly Tank was dry and turkeys abandoned the range around the tank until the summer rains began in July.

Turkeys also made frequent use of waterholes in the fall when the diet changed to grass seeds and mast. Between 4 and 22 November 1970 the time-lapse camera at Kelly Tank operated for 6 days and recorded 199 turkeys, a mean of 33 per day (range 0-100). In contrast to the spring pattern, most visits occurred between 9:00 a.m. and 4:00 p.m.

Food Habits

The food habits of turkeys on the Grasshopper study area have been reported by Scott and Boeker (1973) and are summarized here. Grasses and forbs were the most important year-round food items in the diet. Dandelion *(Taraxacum* spp.) was used heavily throughout the year, particularly in spring. Grasses were used most heavily in fall after several species of loveqrasses, muhleys (*Muhlenbergia* spp.), bromes *(Bromus* spp.), and gramas *(Boutelous* spp.) had matured. Grass seeds were the most important during years of low mast production.

Acorns and pine seeds were used heavily during fall and winter when they were available (Fig. 6). Seed production of both pines and oaks are irregular and cannot be relied on as an annual food source.

Fruits of manzanita and skunkbush (*Rhus trilobata*) were readily eaten during the summer. Juniper was the most consistent mast-producer on the study area. Its fruits accounted for about 40 percent of the turkey diet in 1970 when other foods were limited because of drought conditions and failure of other mast crops.

A wide variety of animal foods were taken, especially during the summer when they were a very important food source for poults. Grasshoppers (family *Arcrididae)* made up the highest volume of animal food.

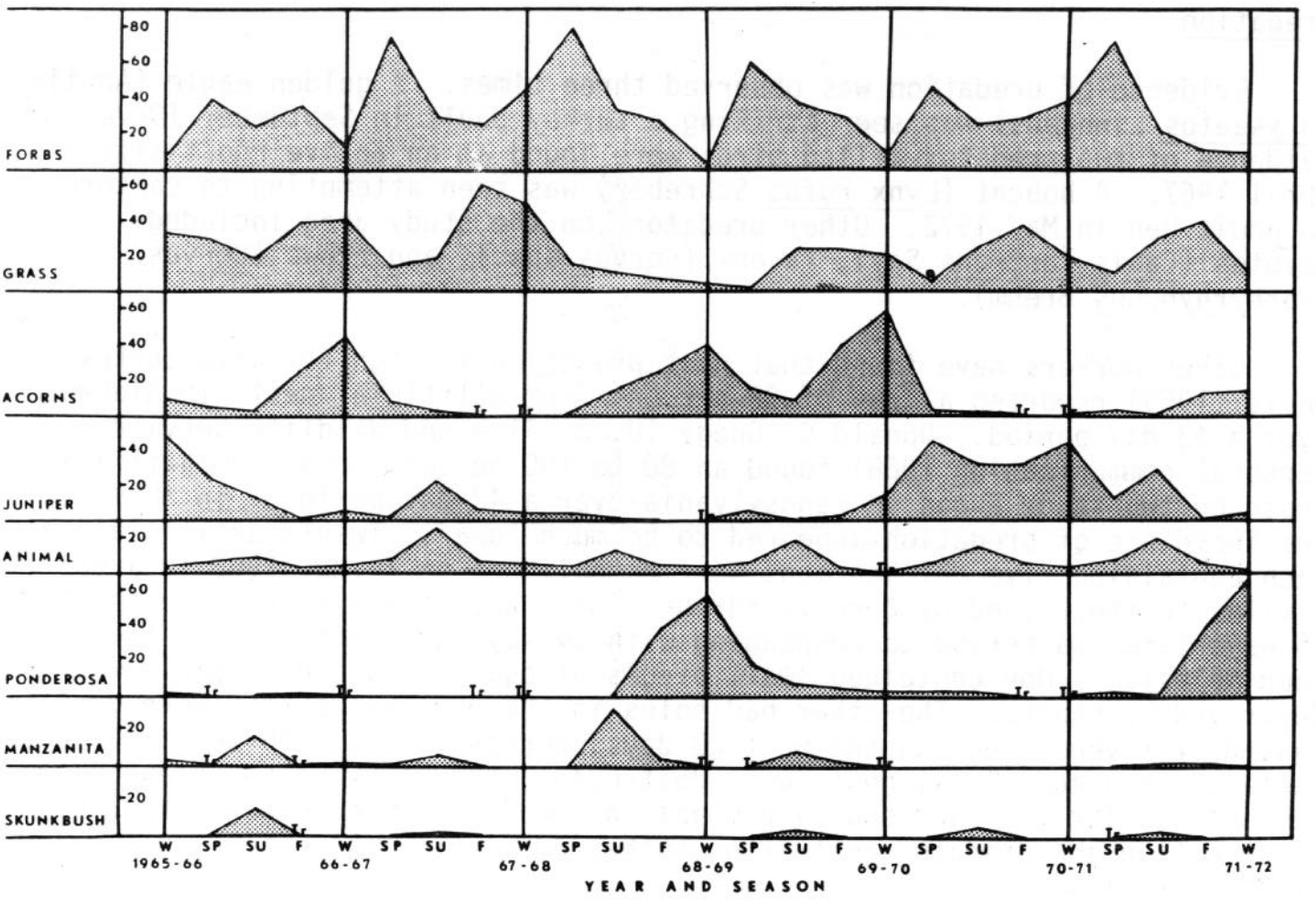

Figure 6. Seasonal use of major food items by turkeys on Grasshopper study area (Figures at left indicate percent volume).

Gobbler Call Counts

Males gobbled in response to several kinds of noises but most frequently to the "yelping" of hens. The number of calls per gobbler was related to the sex ratio ($r = 0.855$), suggesting that gobbling surveys could be used as a population index (Scott and Boeker 1972). Highest gobbling activity was from roosts and began about 30 minutes before sunrise, and then gradually decreased. During the peak of the breeding season sporadic calls were heard throughout the day, but most had ceased by 2 hours after sunrise.

Davis (1971) reported that weather affected gobbling activity in Alabama, but only high winds appeared to deter gobbling in our study. Successive surveys run with similar climatic conditions had daily variations that could not be associated with weather.

Gobbling activity peaked around 21 to 24 April. The number of calls per listening point decreased from late April through 15 May, but the number of calls per gobbler during a 4-minute listening period remained fairly constant from 19 April through 15 May.

Predation

Evidence of predation was observed three times. A golden eagle *(Aquila chrysaetos* Linnaeus) was seen striking a turkey poult in September 1967. Evidence of two predator-killed birds were found at an active roost site in April 1967. A bobcat (*Lynx rufus* Schreber) was seen attempting to capture an adult hen in May 1972. Other predators on the study area included coyotes (*Canis lantrans* Say), ravens *(Corvus* spp.), and crows *(Corvus brachyrhynchos* Brehm).

Other workers have found that nest predation is high for wild turkeys. Davis (1959) reported a loss of 85 percent from artificial nests in Alabama over a 43-day period. Donald C. Gnegy (U. S. Fish and Wildlife Service, personal communication 1968) found an 80 to 100 percent loss from artificial nests on two study areas in Pennsylvania over a 42-day period. In this study the incidence of predation appeared to be much lower. Twenty artificial nests each containing five chicken eggs were established on 14 May 1968 in areas similar to those used by turkeys for nesting. When these nests were checked 16 days later (a period corresponding with turkey egg laying), only two had been molested. One contained small pieces of egg shells and probably was destroyed by skunks. The other had holes in the egg shells that were probably caused by ravens. During the next 28 days, corresponding with the incubation period, seven additional nests were destroyed. Skunks or raccoons appeared responsible for two, and snakes probably accounted for the other five. Effects of predation and predator control on turkey populations have been summarized by Markley (1967).

MANAGEMENT IMPLICATIONS

Merriam's turkey readily eat a wide variety of food items. Perhaps the prime ingredient of optimum turkey habitat is diversity of mast-producing overstory trees, shrubs, and forb and grass communities. A complete failure of food would rarely occur in these conditions, and cover requirements would be met in all seasons. Meadows play an important part in turkey habitat as feeding areas but they need not be large, since turkeys seldom venture more than 45 m from cover.

Use of stock watering tanks by turkeys during dry seasons suggests that the maintenance of a consistent free water supply would enhance populations, particularly in the drier portions of this turkey's range.

Adequate roosting sites are highly important. Turkeys consistently chose mature and over-mature ponderosa pine trees. The roosting cover provided by these pines, which frequently occur on north-facing slopes, may be essential if turkeys are to utilize the pinyon-juniper type. When planning a timber harvest, forest managers should leave clumps of mature ponderosa pine, particularly those where turkeys already roost. Reduction to 16 m /ha of tree basal area in a roosting site may cause turkeys to change sites or move. Isolation of potential roost sites from other cover, as in juniper eradication programs, may also be detrimental to turkeys.

Turkeys abandoned the pinyon-juniper site while eradication work was in progress. Although turkeys returned to the area once the logging and tree eradication ceased, turkeys would undoubtedly be adversely affected by continued human activities of this sort.

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UTILIZATION OF MAN-MADE ROOSTS BY TURKEY IN WEST TEXAS

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Abstract: The Rio Grande turkey (*Meleagris gallopavo intermedia)* has extended its range into 1.4 million hectares (ha) of semi-arid scrub mesquite prairie in West Texas. A well established and increasing population exists where the southern edge of the High Plains meets the Edwards Plateau and Trans-Pecos. Population fluctuations are proportional to range conditions and rainfall patterns. Natural roost sites are absent, but man-made structures such as utility lines and poles, oil storage tanks, and windmill towers provide adequate substitutes.

Key words: *Meleagris gallopavo intermedia*, habitat requirements, power lines, predation, rainfall

The information presented in this paper is a result of field observations and interviews with landowners, sportsmen, and power company officials. Data were collected through the survey and inventory activities of the Permian Basin Regulatory Project which was established in 1966 and at present includes 36 counties in the lower Panhandle of West Texas.

Since 1958, the Rio Grande turkey has extended its range from the limestone hills of the Edwards Plateau into 1.4 million ha of scrub mesquite prairie on the High Plains. Prior to this time, the turkey population in West Texas was restricted to the Edwards Plateau and major floodplains of the Colorado and the North, Middle, and South Concho Rivers (Fig. 1).

The combination of factors that account for the influx and survival of these turkeys in the relatively treeless expanses of the High Plains are: man-made roosting structures, available food supplies, and adequate seasonal rainfall to maintain food and cover resources within tolerance limits.

Man-made Roosting Structures

During the 1950's, internal combustion engines which powered thousands of oil well pumps in the Permian Basin were replaced by electric motors to reduce maintenance and noise. This conversion resulted in a maze of power transmission lines and poles. Considered a necessary eyesore, these man-made structures created an artificial forest of wooden and metallic "trees" that turkeys readily utilized as roost sites above the reach of natural predators.

Although man-made structures such as windmill towers and oil storage tanks existed prior to the 1950's, it is apparent that the establishment of electrical power to rural West Texas oil fields was the stimulus essential to the

Figure 1. Occupied turkey range, Permian Basin, 1974.

spread of turkey. Thousands of kilometers of lines and poles criss-crossing the zone between occupied, and unoccupied turkey range created inroads to new territory. By chance, a few of these power lines traversed brushy draws and creeks thus creating attractive sites which fulfilled the basic requirements for the survival of wild turkey.

Turkeys utilize a variety of man-made structures varying from 2.5 meter (m) oil storage tanks to gigantic electric line towers 40 m high. Single-pole and double-pole wooden transmission line towers are most frequently utilized as roosts, probably due to greater availability.

To reach the highest transmission towers, most birds will initially fly to lower crossmembers then proceed to the top in short successive flights. More daring birds, including some of the heaviest gobblers, reach the top in a single spiraling flight. Although turkeys exhibit a preference towards

roosting on crossmembers, bare transmission wires adjacent to the towers are used when space is at a premium.

While power lines benefit turkey, turkey do not necessarily benefit power lines. Electric company officials advise that maintenance problems and significant expenses occur when turkey droppings accumulate on insulators, causing flashovers and shorted circuits. Routine washing of insulators reduces the problem, but at an extra cost. In areas where repeated problems have occurred, fiberglass shields have been installed as a preventive measure.

At one electrical company power substation, the maze of poles, crossarms, brackets, wires, and transformers created a special attraction for turkeys. Roosting on these closely spaced elements was extremely hazardous. Several turkeys were electrocuted and services disrupted repeatedly. Attempts to discourage the use of this installation as a roost have been unsuccessful. Shouting, banging on tin sheets, and discharging a shotgun served temporarily in scaring off the turkeys after sundown. A scarecrow, flashing beacon light, and ultrasonic siren proved totally ineffective. A remotely controlled foghorn blown at irregular intervals during the early evening hours has met with some success, but turkey still manage to utilize this site. The turkeys at this site have eventually accepted and ignored any device no matter how unusual when a pattern is displayed in its operation and as long as related injury does not result.

The electrical companies are conducting research to find ways to repel the turkeys from trouble spots, but at the same time allow the turkeys to utilize a majority of the artificial structures. Construction of similar towers, solely for roosting, adjacent to problem areas is one idea under consideration.

Turkeys using these artificial roosts are usually safe from predators - except the illegal hunter. Birds perched on a tall structure in a semi-prairie landscape are silhouetted against the sky and make an easy and visible target.

Availability of Food

In addition to adapting to man-made structures for roosting, the immigrant turkey must utilize foods other than those commonly found on primary turkey range. A food habit study conducted 1970 through 1973 indicated that insects, browse, forbs, and grasses provided the bulk of a turkey's diet. Insects and the fruits of perennial browse and cactus species were preferred, but when these food items were unavailable or in short supply, the turkeys depended heavily upon grasses, grass seeds, and forbs. The seedhead and foliage of resucegrass (*Bromus catharticus)* are utilized heavily when conventional foods are lacking.

On marginal range in Reagan County during the severe winter of 1970-71, rescuegrass, on a percent volume basis, provided 46 percent and foliage of California filaree (*Erodium cicutarium*) 20 percent of the turkeys' diet.

The ability of Rio Grande turkey to heavily utilize grasses and forbs in their diet is considered a major factor in their survival in the marginal

ranges of West Texas. In periods of prolonged drought these buffer food items are not available and drastic decreases in turkey populations result.

Seasonal Rainfall

The hatching success and brood survival of turkeys in West Texas are influenced considerably by seasonal rainfall patterns. For example, during both 1970 and 1971, approximately 15 cm was recorded during the spring and summer and 40 cm for the entire year in the Permian Basin (Fig. 2). Over 5 cm of rainfall occurred in March 1970, the forbs were abundant, and the poult-hen ratio was 5.48:l.0. No precipitation was recorded during March 1971, forbs were sparse, and the poult-hen ratio was 0.10:l.0. Although many variables affect turkey production, the timing and volume of spring rainfall appears to be one of the critical factors.

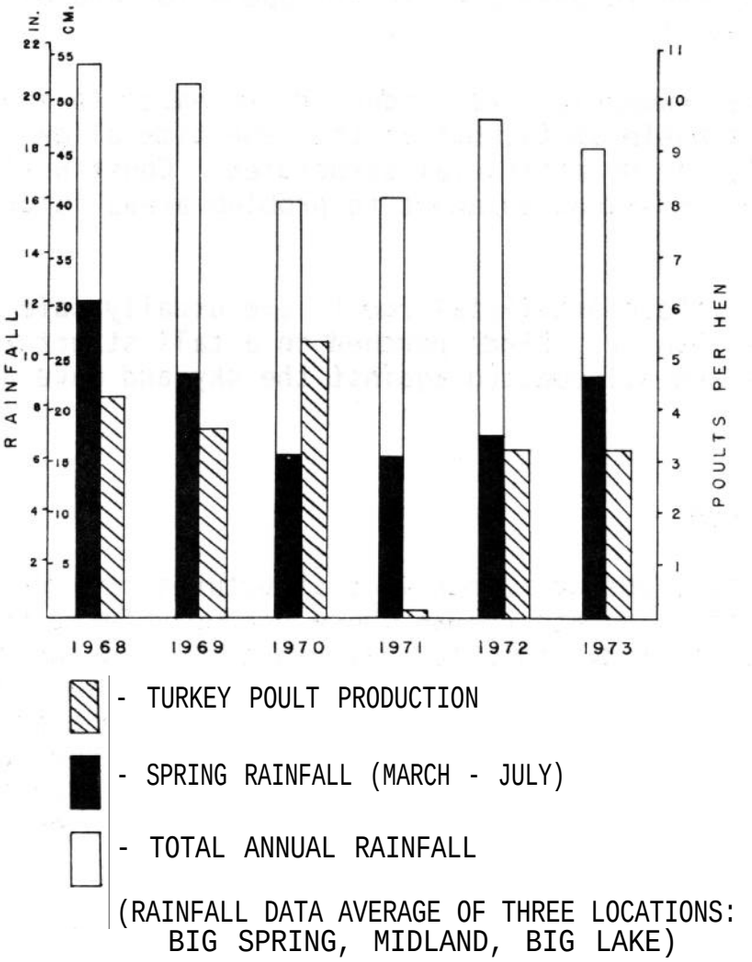

Figure 2. Turkey production vs. rainfall, marginal habitat - Permian Basin.

CONCLUSIONS

Through its utilization of man-made structures as roost sites, the Rio Grande turkey has expanded its range into the treeless expanses of West Texas and proven to be a very tolerant and adaptable bird. Its immigration into West Texas has opened up an additional 1.4 million ha of turkey hunting. In 1969 there were an estimated 15,000 turkeys inhabiting the area. Although overall density of turkeys is light throughout this newly occupied range, the birds concentrate during fall, and the hunter success is increased.

Population fluctuations occur in relation to the rainfall patterns and resultant vegetation characteristic of this semi-arid region. The high turkey populations of 1969 and 1973 indicate the ability of this game bird to rebound from droughty periods and produce a huntable population.

In an era when people are concerned with pollution of the environment it is encouraging to see a large game species benefit from man's "progress".

WINTER ROOST CHARACTERISTICS OF THE RIO GRANDE TURKEY IN SOUTH TEXAS

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Abstract: Winter roosts of Rio Grande turkeys (*Meleagris gallopavo intermedia*) were relatively close to permanent water. Roosts included above average size trees, were within close proximity to brush thickets and clearings, and contained relatively large numbers of trees and surface areas. Artificial roosts included windmills, corrals, camp houses, transmission lines, man-made roosts, and artillery observation towers. Turkeys selected natural over artificial roosts when both were relatively numerous and of the same approximate heights.

Key words: Artificial roosts, mottes, *Meleagris gallopavo intermedia*

This investigation of winter roosting sites in south Texas provides information on the following questions. Why do specific mottes of trees become traditional winter roosts in South Texas? Why are other mottes of trees, that appear adequate for roosting, never used during winter months? What constitutes a winter turkey roost? Such information should enhance turkey management, since winter roosts are considered 'home base' during winter months (Glazener 1967). Likewise, wild turkeys spend approximately one-half of their lives in roost trees. In south Texas, evaluation of turkey winter roosting sites is high on the list of research needs (Kiel 1968).

The author expresses his appreciation to Dr. Ernest D. Ables, University of Idaho, for his guidance and counsel during part of this study. Appreciation is also expressed to Drs. Jimmie D. Dodd and James G. Teer, Texas A&M University, for their assistance in arranging field data. Special thanks are extended to William H. Kiel, Jr., King Ranch, Inc., for his many helpful suggestions in conducting and planning the investigation.

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STUDY AREAS

This investigation was conducted on two divisions of the King Ranch, Inc. in south Texas. Supplementary information was also obtained from Matagorda Island, off the south Texas coast, and from the Laureles Division of the King Ranch in Nueces and Kleberg counties. The average annual precipitation in this region is 67.3 centimeters (cm). The growing season is 314 days. The average first freeze date is 16 December, and the average last freeze is 5 February. The average yearly temperature is 22.4°C. The average January minimum is 8.9°C and the average July maximum is 35.5°C (Anon. 1973).

Santa Gertrudis Division

The 82,354-hectare (ha) Santa Gertrudis study area is located in Kleberg and Jim Wells counties. Vegetation is about 25 percent mesquite *(Prosopis glandulosa* Torr.) brushland, 60 percent grassland, and 15 percent dense brush in various stages of regrowth (Beasom 1970). Mesquite brushland consists of small to moderately large mesquite trees with an understory of granjeno (*Celtis pallida* Torr.) and huisache (*Acacia farnesiana* L.). Hackberry *(Celtis laevigata* Willd.) occurs in scattered clumps, along creeks, open water tanks, and uplands. An aerial turkey census indicated 56 birds per 404.7 ha in 1968 (Beasom 1970). A winter turkey roost contained 200+ roosting birds (1962 Kiel observation).

Encino Division

The 48,372-ha Encino study area is located in Brooks and Kenedy counties. Investigations here were conducted only within live oak (*Quercus virginiana* Mill.) communities that make up approximately 60 percent of the total area (Beasom 1970). The remaining 40 percent consists of open grasslands interspersed with mesquite. The live oak communities are found on upland sandy soils. Aerial turkey census here indicated 51 birds per 404.7 ha in 1968 (Beasom 1970). One roost contained more than 500 turkeys (1962 Kiel observation).

METHODS

Nine winter roosts and nine potential roosts on the Santa Gertrudis area and six winter roosts and eight potential roosts on the Encino area were evaluated for physical characteristics during winter, spring, and summer of 1970-71. A roost was defined as a motte of trees utilized by roosting turkeys during the winter. Major roost trees had heavy accumulations of droppings underneath while minor roosts had light accumulations. A potential winter turkey roost was defined as a motte, containing three or more trees, 4.57 meters (m) or more in height, and composed of the dominant roosting tree species for that study area (hackberry on Santa Gertrudis and live oak on Encino). These mottes were not used by winter roosting turkeys.

Physical criteria used in evaluating the roosts were essentially the same as those used by Boeker and Scott (1969) in Arizona and Hoffman (1968) in Colorado. These included height, dbh, canopy area, and age of roost trees, number of trees per roost site, distance of roost site to permanent water, and distance of roost to nearest clearing. Area of roosts (Crockett 1965) and nearest thicket of brush or trees (0.2 ha or more) to the winter roost or potential roost was also recorded.

RESULTS AND DISCUSSION

Natural and Potential Roosts

All evaluated winter roosts were within 2.26 kilometers (km) of permanent water and most were within 0.50 km (Table 1). This confirms other research which shows that the distance from winter roosts to permanent surface water

Table 1. Distances in meters from winter roosts to permanent water on two divisions of the King Ranch, 1970-71.

Roost No.	Santa Gertrudis	Encino
1	0	1,255
2	0	161
3	457	322
4	1,771	1,932
5	0	1,288
6	1,529	483
7	2,254	--
8	0	--
9	36	--

is important in roost selection by wild turkeys (Crockett 1965, Hoffman 1968, Boeker and Scott 1969). There was no statistically significant difference ($P > 0.05$) between distances to permanent water for actual roosts and potential roosts. These data suggest that turkeys did not occupy roosts just because water was close by. However, there is a possible bias in this assumption, because windmills were used as landmarks in orienting potential roosts for evaluation, and most of the permanent water was located at windmills.

All winter roosts and potential roosts had adjacent clearings. Wild turkeys require a cleared area for ascending and descending the roost but clearings are found almost everywhere, and they do not enter into winter roost selection in south Texas. The shortest vegetative types were usually used most often in ascending and descending the roost. At some winter roosts roads were the selected area.

The brush thickets nearest winter roosts and potential roosts were composed primarily of mesquite and huisache. The distances of brush thickets to roosts and potential roosts were not statistically different ($P > 0.05$) and ranged from 0 to 161 m. Brushy areas near roost sites could influence roost selection in two indirect ways. Thickets could harbor potential turkey predators and provide concealment before attack. This might cause turkeys to disregard roost sites where predator pressure was heavy. Or, thickets could afford concealment and security for winter roosting turkeys as they approach roost sites.

Wild turkeys selected the tallest trees for roosting. On both study areas the average height (1,323 cm) and dbh (62.5 cm) of trees at roost sites was significantly greater ($P < 0.01$) than the average height (925 cm) and dbh (34.2 cm) of trees at potential roosts. This fact was further emphasized during observations in which turkeys were seen flying to evening roosts on 57 separate pccasions. Almost without exception, the majority of birds roosted in the tallest trees. Likewise, greater accumulations of droppings were under tallest trees.

Winter roost trees displayed significantly larger ($P < 0.01$) canopies than did potential roost trees on both study areas. Large canopy cover seemed important in providing gregarious winter roosting turkeys close perch association with the remaining flock. Also, large canopies seemed to provide more horizontal perches than small canopies.

The number of turkeys that would roost in individual trees was highly variable within individual roosts. As many as 12 turkeys were observed in one tree and it was not uncommon to see seven or eight birds roosting in the same tree. Likewise, some roost trees received only periodic use. The number of roost trees was not a good indicator of the number of roosting turkeys. Tree numbers within winter roosts ranged from 8 to 91 on Santa Gertrudis and were significantly greater ($P < 0.05$) than tree numbers within potential roosts. The number of trees within roosts on Encino ranged from 41 to 6,341 and were not significantly different ($P > 0.05$) from tree numbers within potential roosts. The importance of number of trees increased as roosting density increased. It appeared that there could be too few trees but not too many.

Annual growth rings on 26 major roost trees at the Santa Gertrudis area revealed an average age of 39.9 years Twenty-six winter roost trees averaged 34.4 years. Growth rings were not obtained from the Encino area because overmature live oaks would not lend to the use of a forester's increment bore. It was generally noted that the oldest trees displayed the largest growth forms.

All evaluated winter roosts in south Texas were located in a motte of trees. At Santa Gertrudis the mottes ranged in size from 826 to 9,298 m^2 and the area used by roosting turkeys from 7 to 80 percent. At Encino the mottes ranged in size from 2,124 to 52,628 m^2 and the area used from 10 to 58 percent. The less extensive area usage on Encino was attributed to greater motte sizes.

Use of trees within winter roosts at Santa Gertrudis varied from 27 to 88 percent and from 8 to 56 percent at Encino.

Artificial Roosts

At the Santa Gertrudis area turkeys frequently roosted on transmission lines during all months. This area is composed primarily of mesquite-grasslands with relatively few tall trees suitable for roosting. Wild turkeys also were known to roost on camp houses, corrals, and windmills on the Laureles Division of the ranch. This area is composed of mesquite-grasslands and laurel oak (*Q. laurifolia* Michx.)-live oak associations which seldom reach 7 m in height. Wild turkeys were not seen roosting on artificial roosts at the Encino Division, where the area is composed primarily of grasslands and tall live oak trees (sometimes in excess of 15 m). Height and abundance of native trees in relation to artificial roost heights and abundance were the dominant factors in determining whether or not turkeys utilized artificial roosts. It appeared that roosting turkeys preferred natural sites over artificial roosts when both were relatively numerous and the same approximate heights.

The use of artificial turkey roosts was also observed at Matagorda Island off the south Texas coast where pen-raised turkeys had been released during previous years. The island has no trees, thus the Air Force had constructed artificial roosts throughout the government-owned portion of the island. One pattern consisted of four corner posts, approximately 4 m in height, connected along the top with 5.1 by 15.2-cm boards. Additional lumber of this same dimension, along with some 5.1 by 30.5-cm boards, was laid horizontally across the length axis of the top frame to provide perch sites. The second design consisted of an "A" frame with the tallest point approximately 6 m high, directly in the center. Perches consisted of 5.1 by 10.2-cm lumber laid horizontally along the length axis of the top frame. Turkeys on the island readily used the artificial roosts throughout the year along with some artillery observation towers (approximately 25 m tall and transmission lines.

RECOMMENDATIONS

Future timber and brush clearing operations in south Texas should save mottes of trees within close proximity to permanent water. Where there is a shortage or lack of natural roosting sites, artificial roosts should be placed close to permanent water sources.

Clearings with short vegetative types should be encouraged at traditional winter roosts to provide easy access to and from the roost. Artificial roosts should be constructed in an area with some cleared openings present.

Brush thickets near roosts should be retained to provide screening cover for wild turkeys as they move to and from the roost. Artificial roosts should be placed where some screening cover exists as it is doubtful that wild turkey will cross large expanses of cleared land to arrive at a specific roost.

Timber and/or brush clearing operations should protect trees having the greatest height, diameter, and crown canopies.

Mottes with relatively large numbers of trees should be retained in preference to mottes with smaller numbers. Also, some non-roost trees, inside and outside the roost "proper", should be retained.

Future timber and/or brush clearing operations should consider the time required to produce turkey roost trees after they are destroyed. Haphazard brush clearing practices could eliminate groups of trees that are traditional winter roosts, or they could remove groups of trees that one day might provide turkey roosting sites.

The wild turkey appears adaptable in finding suitable roosting sites where natural roosting areas are scarce or absent (Kothmann 1971). Artificial roosts in south Texas included windmills, corrals, camp houses, man-made roosts, transmission lines, and artillery observation towers. They afford wild turkeys a high secure perch, unlimited visibility, and a site free from predators barring some raptors. Perhaps artificial roosts could provide the missing habitat requirement for wild turkeys in regions where natural roosts are absent or relatively scarce.

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BEHAVIORAL FACTORS INFLUENCING VARIABILITY OF ROOST COUNTS FOR RIO GRANDE TURKEYS

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Abstract: Small winter flocks of Rio Grande turkeys *(Meleagris gallopavo intermedia)* used many more satellite roosts than did larger flocks on the Welder Wildlife Refuge in south Texas. Small flocks were more wary and had a wider choice of sites large enough to accommodate their entire group than the larger flocks. Winter flock size decreased, but not in proportion to the population decline. Roost counts were not reliable population estimators from December through February.

Key words: *Meleagris gallopavo intermedia,* census, population density, roost tree availability

Accurate inventories of wildlife species clearly depend on a knowledge of behavior. Season of the year and even time of day influence behavior and thus dictate appropriate census methods (Stokes and Balph 1965). Recent studies (Hirth 1973, Crook 1964) have also demonstrated that habitat strongly influences behavior, even between populations of the same species. The purpose of this paper is to describe how habitat factors combined with a declining population affected the roosting behavior of Rio Grande turkeys and thus influenced roost counts.

Watts (1969) studied the social organization of turkeys at the Welder Wildlife Refuge in south Texas from the fall of 1965 through the summer of 1967. The turkey population then numbered about 700. My study was conducted on the same area from the fall of 1970 through the spring of 1973. During this time the population declined from a high of about 350 turkeys to a low of about 115.

The Welder Wildlife Refuge comprises about 3,150 hectares (ha) near Corpus Christi, Texas. The Aransas River forms the northern boundary of the refuge and provides a band of riparian tree growth. The vegetation then grades into a variety of brush-grassland associations with occasional clumps of of live oak (*Quercus virginiana* Mill.) on upland sites.

I thank Allen W. Stokes and W. Caleb Glazener for their advice and constructive criticism during my study. Helpful editorial comments were provided by Tom Logan and Thomas E. Morse. Robert L. Cook and C. Robert Watts gave valuable insights from their own studies. I am grateful for financial support from the Rob and Bessie Welder Wildlife Foundation, the National Wildlife Federation, and the Ecology Center, Utah State University.

METHODS

Roost counts were made at unequal intervals from December through February, in early morning or late evening. The sex of roosting turkeys was not usually distinguishable because of dim light or distance from the observer. Turkeys could be accurately counted on only one of the two primary roosts (La Vuelta) without the risk of their changing roost sites because of the disturbance. Counts were made at the other primary roost (Hackberry) as the turkeys entered or left the roost area.

A primary (traditional) roost was defined as one which turkeys had used with relative consistency for more than one season. A satellite roost was one which turkeys from a primary roost had used occasionally or for several consecutive nights. Turkeys tended to return to their primary roost after one or more nights at a satellite roost.

Over 85 percent of the population was marked individually with patagial markers (Knowlton et al. 1964). Population estimates were obtained from daily observations of turkeys foraging on the refuge. Sex composition and size of foraging winter flocks were also obtained. Foraging flocks were distinct from winter roost flocks since more than one foraging flock often shared the same roost but ranged separately during the day. Data were not collected in December, 1972 or January, 1973.

RESULTS

Male turkeys wintering on the Welder Wildlife Refuge used two primary roosts. Although there was some interchange of turkeys, the two roosts tended to be used by distinct subpopulations. Interchange between primary roosts usually did not occur until early March at the onset of mating. Males used at least 10 satellite roosts. Both of the primary roosts and all but two of the satellite roosts were used by both males and females during the winter months. Hens usually did not roost with gobblers on smaller satellite roosts, and turkeys from one primary roost did not share satellite roosts with birds from another primary roost.

Satellite roosts ranged from 0.4 to 2.4 kilometers (km) from their respective primary roosts. Distances between satellite roosts varied between 0.2 and 1.8 km. At least three satellite roosts were on private property on the north side of the Arkansas River from the Welder Refuge. Thus, turkeys which foraged on the refuge frequently roosted on land adjacent to it.

Smaller flocks were more sensitive to disturbance than were larger flocks, both on the roost and while foraging. Hens were more likely than males to change roosts when disturbed. Both sexes usually shifted roost sites if poaching or other extreme disturbances occurred, either while the turkeys were on or near the roost. For example, the remains of a bobcat-killed hen were found under a satellite roost on 9 February 1973. A preliminary autopsy suggested that the hen had been wounded by a poacher during the previous evening. The 26 hens using that roost were not seen on the refuge for the remainder of that spring.

Table 1. The number of turkeys using primary roosts during the winter at the Welder Wildlife Refuge.

Year	La Vuelta Roost			Hackberry Roost		
	Average	Range	Standard Deviation	Average	Range	Standard Deviation
1970-71	41.0	15-71	19.3	32.5	26-40	6.0
1971-72	37.0	0-129	32.7	45.9	21-69	14.2
1972-73	5.5	0-11	6.0	37.3	27-61	8.5

The population declined during each year and the sex ratio shifted strongly to favor hens (Fig. 1). However, the size of foraging winter flocks did not change in proportion to the decline (Fig. 2). The numbers of turkeys using primary roosts (Table 1) were extremely variable. Few counts were made at satellite roosts because of the risk that the turkeys would change roost site if disturbed.

DISCUSSION

During my study the roosting patterns of turkeys on the Welder Refuge were so variable that roost counts were not reliable estimators of the winter population. Watts (1969 and personal communications) reported that resident males, on the same area and at very high density, used two permanent roosts and one satellite roost. Hens used only two roosts on their winter range and only one was used by males and females together. During my study adult males and females frequently roosted together on both primary roosts. Males also used at least 10 satellite roosts and females often roosted with males on the larger of these.

I believe that behavioral factors combined with the distribution of roost trees were mainly responsible for the differences in roosting patterns between the two studies on the Welder Refuge. Trees that are suitable roost sites in Rio Grande turkey range usually occur along watercourses (Crockett 1973) or in occasional isolated groves on upland sites. Further, the riparian growth is often not uniformly suitable for roost sites. Roost sites along the river on the Welder Refuge occur in disjunct clumps with varying tree numbers. Thus, some sites will accommodate very large turkey flocks; others will not. Watts and Stokes (1971) reported that members of winter flocks tend to be cohesive and rarely split apart. So at very high density there may be only a few sites that will accommodate the larger flocks.

Watts (1969) observed winter hen flocks of up to 200 during high density, and male winter flocks of up to 28. Figure 2 shows the much lower range in flock sizes I observed. The average flock size decreased, but not in proportion to the annual population decline because flocks of both sexes tended

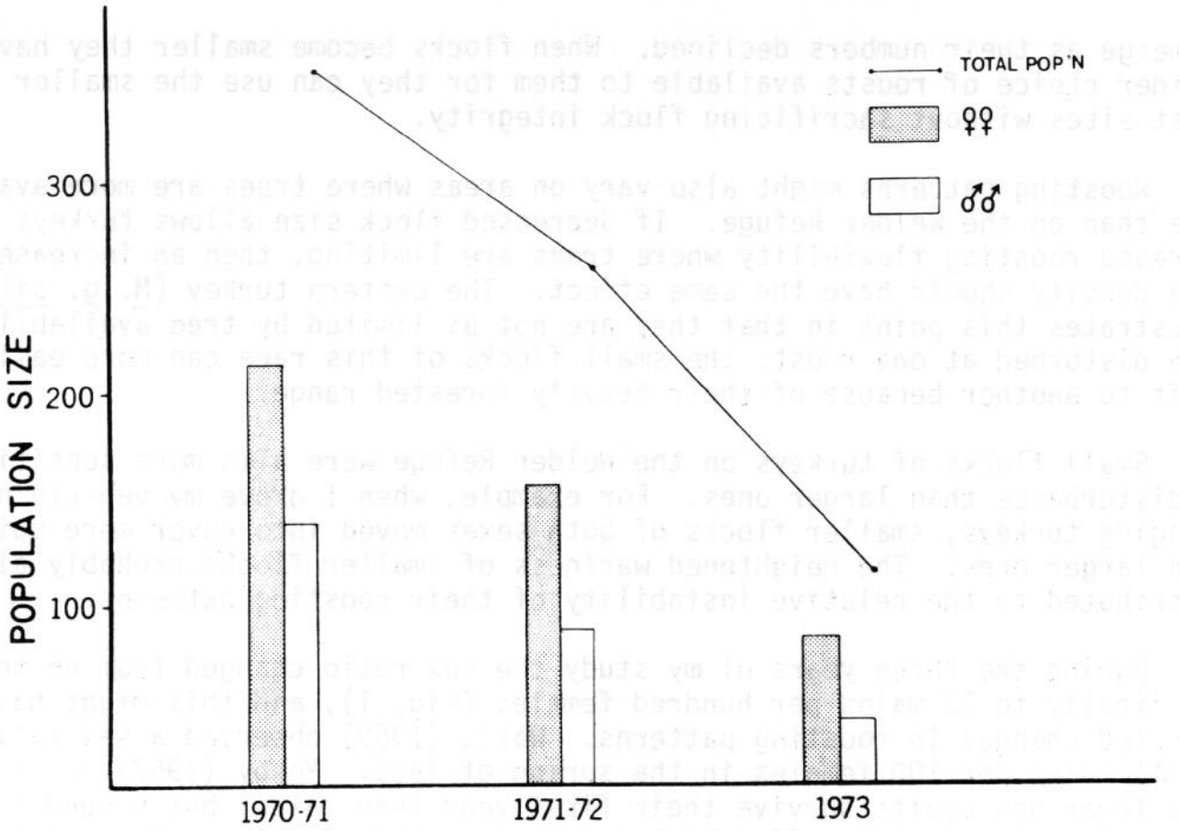

Figure 1. The total population and the numbers of males and females during winter at the Welder Wildlife Refuge.

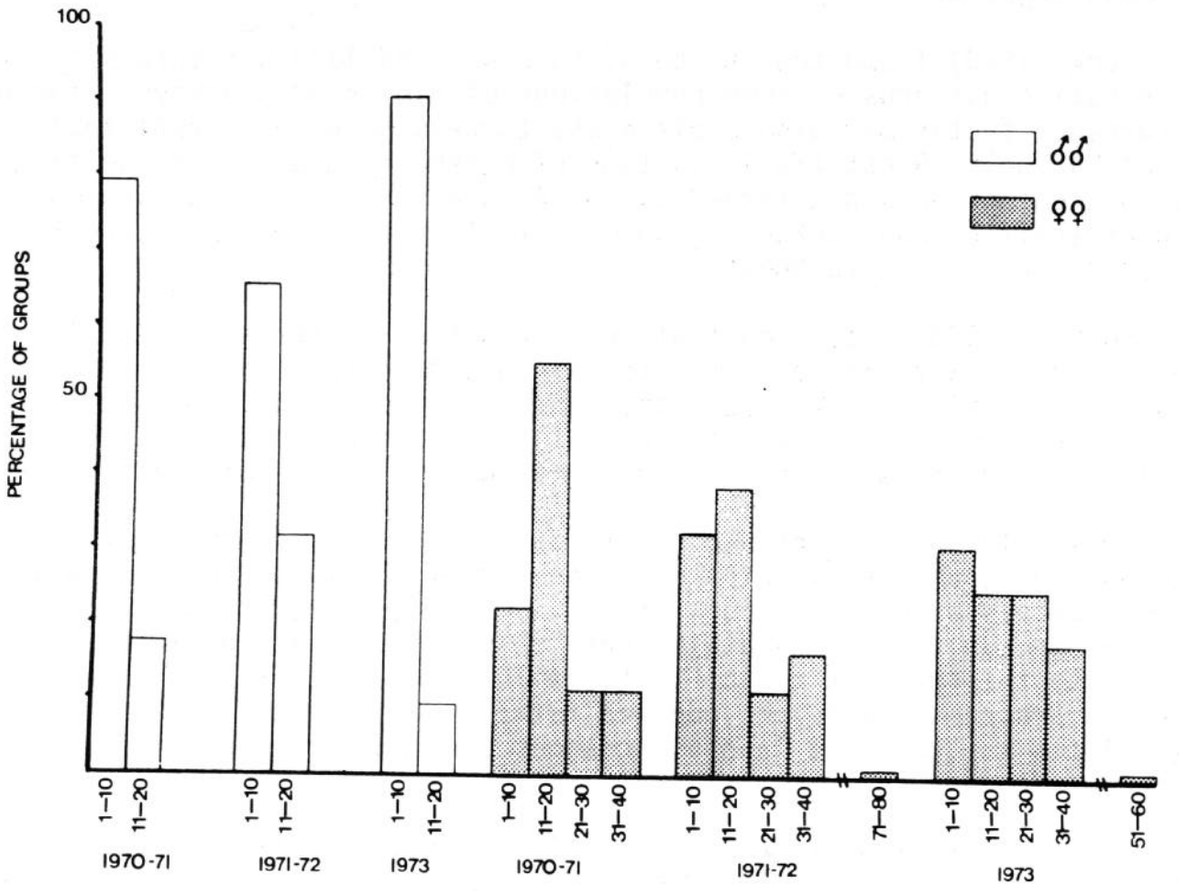

Figure 2. The proportion of flocks in various group sizes during winter at the Welder Wildlife Refuge.

to merge as their numbers declined. When flocks become smaller they have a wider choice of roosts available to them for they can use the smaller roost sites without sacrificing flock integrity.

Roosting patterns might also vary on areas where trees are more available than on the Welder Refuge. If decreased flock size allows turkeys to increase roosting flexibility where trees are limiting, then an increase in tree density should have the same effect. The eastern turkey (*M. g. silvestris)* illustrates this point in that they are not as limited by tree availability. When disturbed at one roost, the small flocks of this race can more easily shift to another because of their heavily forested range.

Small flocks of turkeys on the Welder Refuge were also more sensitive to disturbance than larger ones. For example, when I drove my vehicle near foraging turkeys, smaller flocks of both sexes moved into cover more quickly than larger ones. The heightened wariness of smaller flocks probably also contributed to the relative instability of their roosting patterns.

During the three years of my study the sex ratio changed from 65 to 53 and finally to 33 males per hundred females (Fig. 1), and this might have affected changes in roosting patterns. Watts (1969) observed a sex ratio of 116 males per 100 females in the spring of 1966. Mosby (1967) observed that fewer hen poults survive their first year than males, but beyond the age of one year, males suffer higher mortality than females. The number of poults that survived to the fall did not exceed 0.32 poults per adult hen in any year of my study. Thus, the difference in mortality between hens and gobblers was not compensated for by juvenile recruitment. The increasingly skewed sex ratio coincided with an increasing tendency for males and females to roost together.

Cook (1973) found that human disturbance and land-use intensity affected the roosting patterns of some populations of Rio Grande turkeys. The human disturbance factor may also explain why turkeys were less predictable in their use of La Vuelta Roost (Table 1) than of Hackberry Roost. La Vuelta Roost was located on an island formed by the Aransas River and was much more exposed to boat traffic than Hackberry Roost. Small boat use was also greater in the area near La Vuelta Roost.

Cook's (1973) data show that where roosting patterns are stable, the roost count is a reliable method for Rio Grande turkey inventories. But at least three variables produce unstable roosting patterns where turkey densities are low. These are: human activity and land-use practices, relative availability of roost sites, and heightened sensitivity of small flocks.

We should expect land-use practices to intensify, particularly in the more eastern counties of Texas. In many areas the large ranches, which afforded turkeys with protection, are giving way to smaller "ranchettes". Lindzey and Wanless (1973) state that "changing patterns of land-use probably constitute the greatest threat to the wild turkey...". If future plans for land-use programs are to include realistic provision for Rio Grande turkeys, the effects that current land-use changes have on turkey populations should be monitored.

Roost counts clearly do not provide a reliable estimator where turkeys exhibit unstable roosting patterns. The same factors which produce unstable roosting patterns also suggest unstable or marginal turkey populations and

perhaps justify more intensive census methods than are sufficient in more stable areas.

The heightened mobility of small flocks suggests that adjacent ranches should not be sampled so that duplicate counts of turkeys are minimized where their range may include two or more ranches. Texas landowners often provide winter feed for turkeys (Cook 1973). Counts of turkeys using these feeders might provide better population data than do roost counts since adult and immature sex ratios are recognizable by winter. Poult counts provide immediate knowledge of reproduction during the previous year and reproduction may well be the avenue through which land-use changes inflict the greatest turkey losses.

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EVALUATION OF SPRING TURKEY SEASONS IN MISSOURI

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Abstract: Missouri's first spring wild turkey (*Meleagris gallopavo silvestris)* season was held in 1960. Hunter numbers and harvest increased each year except 1969 and 1974. Hunting success averaged 16 percent. The percent of subadults in the turkey population and length of season accounted for 60 percent of the variability in hunting success. Hunting pressure of 0.6 hunter per square kilometer (km^2) of occupied range had no effect on hunting success. Hunting success rates were highest on opening day, but were similar among dates for the remainder of the season.

Key words: Hunting success, hunting pressure

Wild turkeys would have qualified as a "rare and endangered species" in Missouri 25 years ago. The turkey population reached its lowest level in 1952 when fewer than 2,500 birds were present in 31 Ozark counties (Lewis 1967). The number of gobblers harvested in 1974 was more than double the entire population in 1952. The dramatic turn around in wild turkey populations in Missouri, and throughout most of its ancestral range has been well documented (Mosby 1973) and is one of the gratifying accomplishments of modern game management.

Turkey hunting is gaining in popularity with an ever increasing number of hunters. As hunting pressure increases and turkey populations are more intensively managed, knowledge of the effects of increasing hunter numbers is vitally important to the future welfare of the turkey resource.

This paper presents data on relationships between harvest, hunting success, and hunting pressure in Missouri's spring turkey seasons.

I wish to thank Leroy J. Korschgen, Missouri Department of Conservation, for editorial assistance and Dr. Darrel Eklund, University of Missouri, for statistical advice. This study was financed by Federal Aid to Wildlife Restoration Project 13-R, Missouri Department of Conservation.

METHODS

Since 1960, spring turkey harvest data have been collected at check stations established in each county opened to hunting. A special permit is required to hunt turkey, and this provides a check on the number of turkey hunters. Although farmers residing on a farm are not required to buy a permit, all turkeys must be tagged and checked on the day they are killed. This compulsory checking system provides data on age, weight, longevity, and harvest by county. These data are basic to the overall evaluation of the effects of hunting seasons on the resource.

Each turkey hunter from 1960-69 was requested to return a postcard questionnaire which was attached to the permit. They were asked to report number of days spent hunting, county or counties hunted in, whether successful or not. The rate of return was approximately 50 percent of the permit sales. Successful hunters reported at a higher rate than unsuccessful hunters. Hunting pressure was calculated by multiplying the percent of the total sample hunting in each county times the total number of permits sold. Since forested land encompasses most of the occupied turkey range the hunting pressure/km^2 of occupied range was calculated on the percent of forested land that occurred within a given county. Forest survey data were derived from 1970 Missouri Conservation Needs Inventory (CNI) published under the direction of the Soil Conservation Service.

Hunting success was based on the number of birds harvested by permittees, not on total harvest.

A post-season mail survey was initiated in 1971. Permit booklets included IBM address cards to be filled out by the first permit buyer in each book. Survey cards were coded to allow follow-up mailings to non-respondents and the removal of undelivered cards. Two follow-up mailings were made if needed. This system provided a randomized sample of approximately 15 percent of the permit buyers, and provided information on daily hunting pressure, harvest, and hunting success for the entire season.

Hunting opportunity (length of season) and the percent subadults in the previous year's harvest (population density) were studied because of their measurable impact on hunting success.

RESULTS & DISCUSSION

Harvest

Missouri's spring turkey harvest increased from 94 gobblers in 1960 to 5,739 in 1973 (Table 1). In 1960, hunting was permitted in just 14 counties (Fig. 1). Due to restoration efforts the turkey population and range expanded and 67 counties were open in 1974. Both harvest and number of hunters increased as more counties were included in the area open to hunting.

A small decline in the harvest occurred in 1969, because of a cold late spring and because the permit fee was raised from $5.00 to $7.50 . The resistance to an increased fee was only temporary, and in 1970 both the harvest and number of hunters exceeded the 1968 level.

The greatest yearly increases in harvests were recorded in 1963, 1967, 1970, 1971, and 1972, the years when seasons were lengthened. Other regulations were essentially unchanged, except for legalizing bearded hens in 1970 and in 1973 hunters were permitted to harvest two birds.

The overall harvest in 1973 increased 29 percent, and the second bird in the bag accounted for 14 percent of the increase. The bag limit was reduced to one in 1974 and the harvest dropped 12 percent. The statewide harvest of gobblers/km^2 of occupied range has increased from 0.005 to 0.12

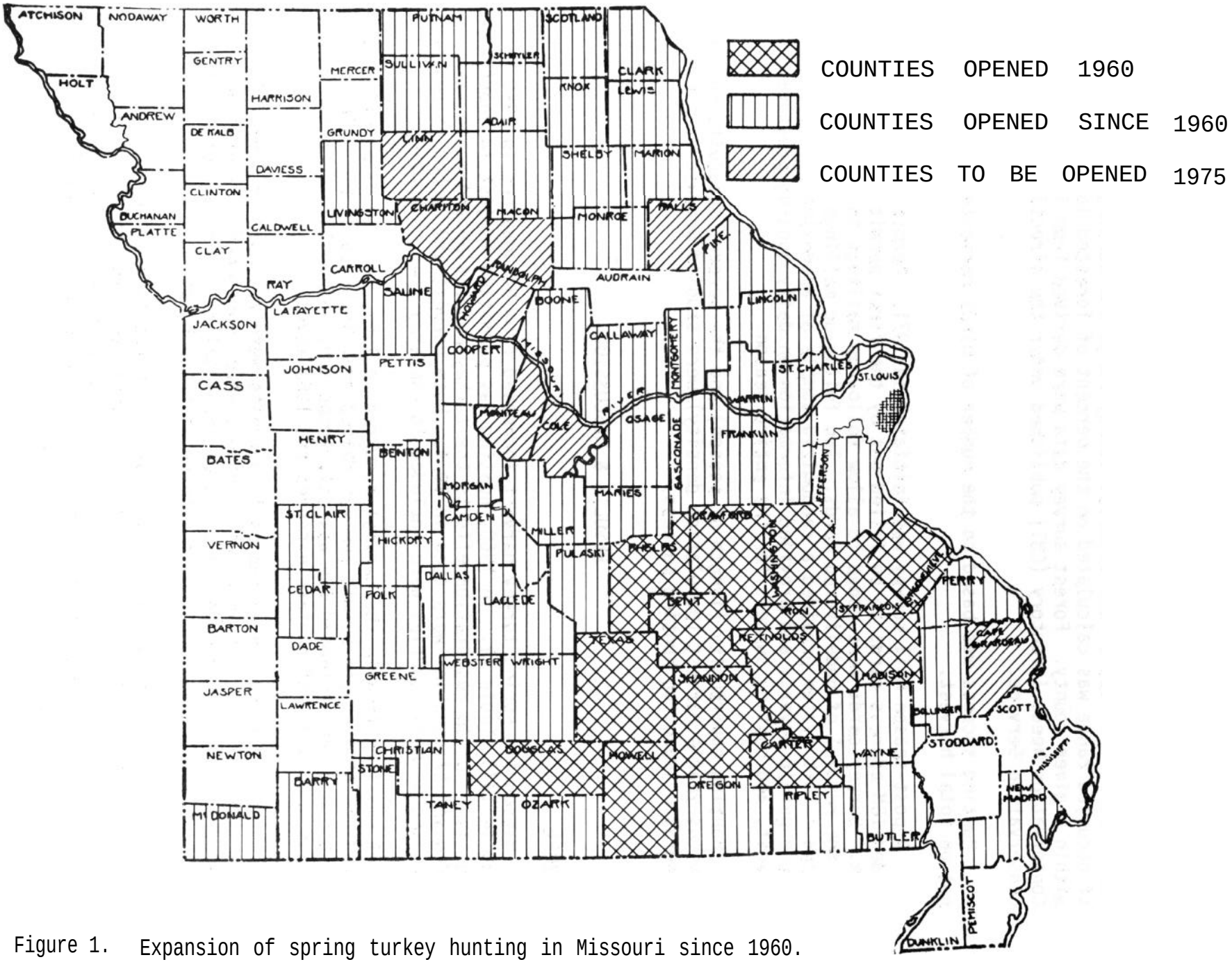

Figure 1. Expansion of spring turkey hunting in Missouri since 1960.

Table 1. Harvest data for spring gobbler seasons in Missouri, 1960-74.

Year	Number of Turkeys Harvested	Number of Permittees	Percent Hunting Success	Percent Subadults	Days in Season	Number of Counties Opened
1960	94	698	12[1]	23	3	14
1961	154	1,001	14	8	3	14
1962	182	1,408	12	28	3	16
1963	357	1,828	18	23	4	19
1964	369	2,961	12	24	4	22
1965	476	2,982	15	17	4	25
1966	572	4,308	13	33	5	29
1967	1,191	6,702	17	22	7	32
1968	1,270	8,078	15	22	5	35
1969[2]	959	7,577	12	23	5	38
1970	1,607	10,069	15	29	7	41
1971	2,864	12,313	22	34	11	45
1972	4,456	20,077	22	47	14	53
1973[3]	5,739	28,245	17	28	13	63
1974	5,286	25,354	19	17	13	67

[1]Based on number of birds killed by permittees.
[2]Permit increase.
[3]Two-bird limit.

since the spring hunts were initiated in 1960. Harvests of 0.6 birds/km^2 occur in some of the more productive range.

Turkey harvest from the Lake Spring Area (Lewis and Kelly 1973) was 0.4 gobbler/km^2 during five hunting seasons, 1965-69, and no noticeable change occurred in the gobbler population. The harvest data from Lake Spring and in some of the more productive range would indicate that the current statewide kill of 0.12 birds/km^2 could be increased significantly.

Hunting Pressure

Increases in hunter numbers have been recorded each year, except 1969 and 1974 (Table 1). The largest yearly increase (63 percent) took place in 1972 when the season was lengthened three days and eight more counties were opened to hunting. The limit was raised from one to two birds in 1973 and the number of hunters increased 47 percent. Ten additional counties were open to hunting that year.

A weekday rather than a weekend was selected for all of Missouri's spring seasons in an attempt to avoid heavy hunting pressure on opening day. This method has been successful because hunting pressure on opening days has been less than on the first Saturday of the season (Table 2). For some

Table 2. The percent of hunters, harvest, and hunting success by day in Missouri.

Day of Season	1971			1972			1973			1974		
	Hunters	Harvest	Success	Hunters	Harvest	Success	Hunters	Harvest	Success	Hunters	Harvest	Success
1st	12.7[1]	19.4	8.6	10.9[2]	19.9	8.6	9.6[3]	17.9	7.3	11.6[4]	20.1	7.4
2nd	13.1	10.3	4.4	11.4	9.7	4.0	9.8	9.9	4.0	11.6	14.1	5.0
3rd	16.3	17.8	6.0	9.4	9.6	4.8	8.0	9.4	4.6	9.5	8.8	3.8
4th	14.4	13.1	5.2	7.5	9.6	6.0	6.9	7.9	4.5	7.4	7.6	4.3
5th	7.3	5.8	4.4	6.9	6.2	4.2	11.5	9.3	3.2	6.7	7.0	4.4
6th	5.9	5.8	5.4	11.7	9.9	4.0	9.3	9.8	4.1	9.7	9.1	3.9
7th	5.4	5.3	5.4	9.9	7.7	3.6	5.0	6.0	4.7	8.6	8.0	3.8
8th	4.8	4.7	5.4	3.8	1.5	1.8	5.7	4.2	2.9	5.2	3.5	2.7
9th	5.2	4.6	4.9	3.8	1.6	2.0	5.3	4.1	3.0	5.0	1.6	1.4
10th	8.2	7.4	5.0	3.8	3.7	4.5	4.9	4.9	4.0	5.5	4.8	3.6
11th	6.9	5.8	4.6	3.7	4.6	5.9	5.3	5.6	4.2	5.4	1.7	1.3
12th	--	--	--	3.6	3.5	4.6	10.3	8.0	3.0	6.5	7.0	4.5
13th	--	--	--	7.3	6.5	4.2	8.3	2.8	1.3	7.6	6.7	3.7
14th	--	--	--	6.2	5.9	4.5	--	--	--			--

[1]Season opened on Thursday.
[2]Season opened on Monday.
[3]Season opened on Tuesday.
[4]Season opened on Monday.

unexplained reason, hunting pressure was higher on the second day of the season than on opening day. Hunting pressure decreased after the second day but increased on the first weekend. A noticeable drop in hunting pressure occurred following the first weekend, with a slight rise on the second weekend.

The hunter density/km^2 of occupied turkey range has increased from 0.04 in 1960 to 0.6 in 1973. Hunter numbers in some of the best turkey range currently exceed 2.2 hunters/km^2 with no apparent adverse effects on hunting success.

Hunting pressure during the spring season is often blamed for poor hunting success and low quality hunting. However, the current level of hunting pressure in Missouri has not depressed hunting success, although it may have affected hunting quality in some localized areas.

Hunting Success

One out of eight hunters (12 percent) was successful in Missouri's first spring turkey season, thereafter hunting success averaged 16 percent, never falling below 12 nor exceeding 22 percent. The variability in hunting success rates throughout the 14-year period was related to weather conditions prior to and during the season, population densities, hunter numbers, season length, and hunter skill.

Hunting success on opening day was higher than for any other day of the season during the past four years (Table 2). There was a significant correlation ($r=0.375$) between hunting pressure and hunting success on opening day, however, this may be due to the unwariness of the birds on opening day. Although hunter success rates were better on opening day, daily success rates during the remainder of the season were similar.

Prediction of hunting success rates for spring gobbler seasons in Missouri was calculated on the basis of percent subadults and season length according to the following formula: Y (success rate) = .10497 + (.0606518 x percent subadults) + (.00542322 x length of season). Calculated values and confidence limits for various season lengths and percent subadults are shown in Table 3.

During the 14-year period, the percent subadults accounted for 39 percent of the variability in hunting success, while the season length contributed 53 percent of the variability. The combination of subadults and season length accounted for 60 percent of the variability in hunting success.

A major objective in Missouri's turkey seasons has been to provide maximum hunting opportunity commensurate with the turkey population's ability to sustain harvest. Harvest estimates can be predicted within reasonable limits when data are available on the anticipated number of hunters, season length, and the percent of subadult turkeys from the previous season's harvest. This information can be used to make adjustments in future regulations to provide maximum hunting opportunity and harvests.

Table 3. Calculated percent hunter success and 95 percent confidence limits for spring gobbler season in Missouri.

Season Length	Percent Subadults in Previous Years Harvest						
(Days)	10	15	20	25	30	40	50
4	13.27	13.57	13.87	14.18	14.48	15.09	15.69
	±4.97	±3.93	±3.45	±2.14	±1.23	±2.74	±4.72
6	14.35	14.66	14.96	15.26	15.57	16.17	16.78
	±4.18	±3.13	±2.32	±1.50	±1.52	±3.18	±5.31
8	15.44	15.74	16.04	16.35	16.65	17.26	17.86
	±3.51	±2.51	±1.74	±1.41	±1.43	±3.84	±6.01
10	16.52	16.82	17.13	17.43	17.73	18.34	18.95
	±3.03	±2.19	±1.74	±1.95	±3.67	±4.64	±6.79
12	17.61	17.91	18.21	18.52	18.82	19.43	20.03
	±3.68	±2.32	±2.23	±2.76	±3.55	±5.50	±7.63
14	18.69	18.99	19.30	19.60	19.90	20.51	21.51
	±3.00	±2.82	±3.07	±3.68	±4.49	±6.41	±8.50
16	19.78	20.08	20.38	20.69	20.99	21.60	22.20
	±3.47	±3.55	±3.97	±4.63	±5.45	±7.34	±9.40
18	20.86	21.16	21.47	21.77	22.07	22.68	23.29
	±4.14	±4.39	±4.91	±5.61	±6.43	±8.30	±10.32

CONCLUSIONS

The popularity of spring turkey seasons in Missouri has been aptly demonstrated by yearly increases in both harvest and number of hunters. Hunting success averaged 16 percent. The highest success was on opening day, but thereafter success rates were similar.

Hunting success was closely related to the length of season, and the percent subadults from the previous year's harvest. Knowledge of hunting success rates based on length of season and percent juveniles can be used to predict the harvest. This information will permit more flexibility in hunting regulations for the future.

Present data indicates that Missouri's turkey population could sustain a higher harvest and accommodate more hunters, however, increased hunting pressure beyond current levels could reduce hunting success rates.

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POPULATION AND HARVEST DATA FOR MERRIAM'S TURKEYS IN NEBRASKA

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Abstract: Wild turkey (*Meleagris gallopavo merriami*) surveys in Nebraska showed little agreement in indicating populations. Fall hunting success can best be predicted by abundance of pine seed and summer hen:poult ratios.

Key words: *Meleagris gallopavo merriami*, poult:hen ratios, hunting success

Accurate census is a major problem in turkey management. Although data have been frequently collected to indicate population levels and harvest, there has been little effort to compare these estimates or indices. The purpose of this paper is to compare various wild turkey surveys in the Pine Ridge of Nebraska and to indicate some reasons for lack of agreement.

Wild-trapped Merriam's turkeys were obtained from the Black Hills of Wyoming and South Dakota and introduced into the Pine Ridge in 1959. This escarpment encompasses about 1,600 square kilometers (km^2) in northwestern Nebraska. It is about 145 km long, east to west, with a maximum width of 32 km. Predominant vegetation consists of open stands of ponderosa pine (*Pinus ponderosa*) with understories primarily of short- and mid-grasses. Hardwoods, which occur mainly along stream courses, include boxelder *(Acer negundo),* cottonwood (*Populus deltoides*), and ash (*Fraxinus pennsylvanica*). Major land use is ranching, with farming in suitable areas. Crops include oats, alfalfa, wheat, corn, barley, and rye (Suetsugu and Menzel 1963).

Annual fall turkey seasons (either sex) have been held since 1962, and spring seasons for toms only since 1964.

This report is a contribution of Federal Aid in Wildlife Restoration Project W-15-R.

METHODS

Data on sex and age ratios, total harvest, hunter success, day of kill, and days hunted for successful permittees were obtained through use of compulsory check stations, except in 1967. A small amount of information was obtained from unsuccessful hunters.

Since 1965, established routes were driven in late June to early August to provide data on hen:poult ratios and relative abundance. In most years, each of six routes was driven three or more times. Random brood observations recorded by Commission and Forest Service personnel and selected landowners provided additional data on production. Information on winter concentrations was obtained from a mail survey of about 60 landowners and by observations of field personnel.

Census data from 1962 to 1973 were compared, primarily by correlation analysis, whenever there appeared to be a reasonable relationship. Data from 1974 are presented herein but were not included in statistical analyses. The following ratios or averages were considered: turkeys observed per route from all routes and from routes paired among years for similar locations and dates, young per hen with brood from all observations (routes plus random) and from routes only, young per hen from routes only, young per adult hen adult from harvest data, hunter success, days hunted, day of kill, and winter turkeys reported per landowner.

RESULTS AND DISCUSSION

The number of turkeys observed on established routes varied from 175 in 1966 to 828 in 1969 (Table 1). The average per route ranged from 16 to 33. These data were not significantly correlated with any other population or harvest indices. Shaw (1973) indicated that results could be improved by eliminating observations which appeared to be repeats of the same birds, but similar adjustments of our Nebraska data did not improve the comparisons with other indices. Shaw also suggested that the number of routes be increased, with few or no repeats. This could not be applied in the Pine Ridge since the surveys covered most of the readily accessible area.

Numbers of young per hen with brood, from route and random observations combined (Table l), were correlated ($r = 0.647$, 10 df, $P < 0.05$) with adult

Table 1. The number of turkeys, by sex and age, observed on established routes, and numbers of hens and young in all brood observations.

Year	No. Routes	Turkeys on Established Routes					All broods[1]	
			Hens				Hens With Young	Young
		Toms	With Young	W/O Young	Young	Total		
1962	--	--	--	--	--	--	36	327
1963	--	--	--	--	--	--	60	524
1964	7	9	22	--	168	199	149	1,184
1965	5	12	23	1	148	184	139	1,038
1966	6	--	27	1	147	175	200	1,479
1967	18	41	45	21	186	293	120	507
1968	24	67	84	30	411	592	187	1,127
1969	26	192	111	47	478	828	279	1,334
1970	21	18	64	14	395	491	178	1,060
1971	18	38	39	12	205	294	100	581
1972	18	9	73	1	475	558	144	995
1973	18	24	37	4	279	344	67	463
1974	18	106	81	27	485	699	95	590

[1]Includes brood routes plus random observations.

Table 2. The number of turkeys, by sex and age composition, in the fall harvest.

Year	Adult		Juvenile		
	Male	Female	Male	Female	Unk. Sex
1962	47	28	126	79	1
1963	44	62	225	154	--
1964	35	56	276	159	--
1965	44	57	198	148	--
1966	35	91	232	163	--
1967	10	25	60	35	--
1968	24	32	89	40	--
1969	50	119	141	111	--
1970	27	61	152	111	1
1971	25	38	176	113	4
1972	40	57	227	114	--
1973	17	56	156	92	--
1974	22	72	199	103	13

hen:juvenile ratios in the fall harvest (Table 2). Thus, these data should provide a reasonable estimate of relative production.

Males comprised 62 percent (range of 56-69) of the juveniles harvested in the fall. This preponderance of males is in contrast to published reports. Jonas (1966) in Montana and Mosby (1967), citing data from Virginia and New York, showed no significant differences in sex ratio. Data from Florida and Pennsylvania showed 57 and 66 percent females in the harvest (Mosby 1967). Another citation by Mosby (1967) showed a significant perponderance of 52 percent males in Virginia.

Many of the Nebraska hunters could not identify the sex of juvenile turkeys. In a sample of 143 males, hunters called 47 percent hens, whereas 14 percent of 78 hens were identified as males. If hunter reports were accepted at face value the relative abundance of the two sex groups would be exactly reversed.

The preponderance of males in the juvenile harvest probably occurred because the hunters select a larger and/or darker bird. It is possible that a better indication of true adult hen:juvenile ratios could be obtained by assuming an equal sex ratio, and multiplying the harvest of young hens by two to compare with numbers of adult hens. Application of this method shows a somewhat better correlation of summer ratios with fall ratios ($r = 0.671$, 10 df, $P < 0.02$) than by using all juveniles in the fall harvest.

Hen:poult ratios from established routes only were not significantly correlated with harvest age ratios ($P < 0.10$).

Fall hunting success was negatively related to the abundance of ponderosa pine seed. In years when pine seed was absent, small grains comprised the majority of turkey crop contents. Pine seed was abundant and was the primary fall food for turkeys in 1964, 1967, 1970, 1973, and 1974. During these 5 years hunter success averaged 42 percent with a range of 40 to 46 percent (Table 3). For 8 years when no pine seed was observed hunter success averaged 55 percent, with a range of 43 to 61 percent.

Reduced success in years of pine seed abundance is probably related to more random and less consistent distribution of turkeys. In years when domestic crops constitute the primary food items, turkeys can generally be found in continued association with grain fields, where they can be more easily seen, relocated, and brought to bag.

The average number of young per hen with brood was not directly correlated with hunting success ($P > 0.10$). However, a multiple regression considering the hen:poult ratios and pine seed presence or absence showed a significant relationship with hunting success ($F = 10.844$, 2/9 df, $P < 0.005$). Predicted hunting success based on this regression averaged three percentage points from actual success.

Table 3. Length of season, turkeys harvested, hunter success, days hunted, and day of kill for the fall hunting season in Nebraska.

Year	Days In Season	Number Harvested	Percent Success	Days Hunted[1]	Day Of Kill[2]
1962	9	281	56	1.45	--
1963	9	555	56	--	2.40
1964[3]	5	590	46	1.51	1.66
1965	9	769	52	1.60	2.84
1966	9	869	58	1.60	2.87
1967	9	621	41	1.73	2.35
1968	9	293	59	1.65	3.12
1969	16	644	43	1.67	3.95
1970	16	511	43	1.60	4.18
1971	16	628	52	1.52	4.56
1972	14	727	61	1.59	3.79
1973	10	477	40	1.51	2.58
1974	14	634	42	1.64	3.70

[1]The average of successful hunters only.
[2]Average day of kill - e.g. 1st day of season = 1, 2nd day - 2, etc.
[3]Two separate 5-day seasons, permit good for only one period of 5 days.

The number of days hunted by successful permittees and the average day of kill were not related to other indices. The average days hunted showed comparatively little variation (range of 1.45 to 1.73), and it is possible that hours hunted would give a better measure of effort.

Winter concentration counts, used alone or adjusted with production indices, were not significantly correlated with other surveys.

Spring hunting success was unrelated to hunter success or total harvest of turkeys the preceding fall. This lack of agreement could be caused by several factors, such as pine seed abundance or weather affecting success and/or hunting conditions. Pine seed abundance had no apparent effect on hunter success in the spring.

CONCLUSIONS

Most of the turkey surveys in Nebraska do not agree in indicating populations. Direct comparisons of summer data with harvest data are confounded by the effect of pine seed abundance on hunter success. Among the several statistics collected in this study, the combination of hen:poult ratios and abundance of pine seed was the only index of any practical value in predicting fall hunting success.

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EITHER-SEX TURKEY HARVEST IN THE TEXAS PANHANDLE

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Abstract: Either-sex harvests of Rio Grande turkeys *(Meleagris gallopavo intermedia*) were studied from 1969 through 1972 under the Panhandle Game Management Survey in Hemphill and Wheeler Counties. A total of 1,225 turkeys, 9.7 percent of the population, was harvested.

Key words: *Meleagris gallopavo intermedia,* hen/poult ratio

Either-sex Rio Grande turkey hunts were held by the Texas Parks and Wildlife Department under the Panhandle Game Management Survey from 1964 through 1972 under Pittman-Robertson Project W-45-R. In order to determine how the either-sex hunting was affecting the wild turkey population a special study was conducted during 1969-72 in Wheeler and Hemphill Counties.

Turkey flocks were counted in winter and the data correlated with fall harvest data to determine the following: the percentage of the population that was harvested, the percentage of each sex harvested, and an average adjusted population.

An average adjusted population figure was determined by adding the fall harvest to the late winter population.

RESULTS

A total of 1,225 birds were harvested in the study area, an average of 306 birds per year (Table 1). The harvest was highest in 1969, and less but fairly stable for the next three years. Gobblers comprised 53 percent and hens 47 percent of the harvest. The harvest represented 9.7 percent of the total adjusted population.

The average number of birds censused during late winter was 2,836 (Table 2). However because of a lack of time and personnel in 1971 and 1972 not all of Hemphill County was censused, thus a population decrease was recorded. Adults represented 64.8 percent and juveniles 35.2 percent of population. Gobblers average 34.5 percent and hens 65.5 percent of the flock.

The adjusted population of 12,571 birds was determined by adding the total winter census of 11,346 turkey to the fall harvest of 1,225 birds.

CONCLUSIONS

The either-sex turkey harvest of 9.7 percent represents an under harvest. At least 20 percent of the population could be harvested without causing a downward trend in population. At present the destruction of habitat through

brush eradication and the increased poaching, caused by easy-access roads into turkey range developed by oil and gas companies, pose a more serious threat to the population in Wheeler and Hemphill Counties.

Table 1. Number of turkeys harvested in Hemphill and Wheeler Counties, 1969-72.

Year	Gobblers	Hens	Total
1969	232	188	420
1970	128	155	283
1971	107	130	237
1972	182	103	285
Total	649	576	1,225

Table 2. Number of turkeys counted during late winter in Wheeler and Hemphill Counties

	Gobblers		Hens			
Year	Adult	Juvenile	Adult	Juvenile	Sex Unknown	Total
1969	163	208	692	208	1999	3270
1970	253	280	836	280	1611	3260
1971	318	416	806	416	487	2443
1972	359	233	765	233	783	2373

TURKEY HARVEST MANAGEMENT IN NEW YORK

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Abstract: The turkey permit system with mandatory reporting and a pre-hunting season banding program were initiated to determine the effect of varying fall hunting season lengths and hunting pressures on wild turkey (*Meleagris gallopavo silvestris*) populations. In key areas of the state a minimum of 25 percent of the turkey population was taken. Hunting pressure has more than doubled and harvest has quadrupled in the major management area since 1968. In the most heavily hunted region the adult hen and poult populations appear to have reached a maximum density at 3 birds per square kilometer (km^2) of woodland. Factors other than hunting appear to be limiting turkey populations.

Key words: *Meleagris gallopavo silvestris*, population dynamics, hunting pressure

In 1948, after a century of absence, the wild turkey was again reported in New York's southwestern Cattaraugus County (Eaton 1964). Nine years later, the Environmental Conservation Department initiated a trap and transfer program, annually moving small numbers from this established population into new areas of the state that seemed capable of supporting these birds. Today, nearly 52,000 km^2 or two-fifths of New York's total land area has turkeys. As these populations increase, spring seasons are opened to provide hunting recreation over as great an area as possible.

New York's first legal turkey season of the 20th century began as a 3-day fall season in 1959. Data on hunting pressure and the harvest during fall seasons from 1959 through 1967 indicated that the popularity of turkey hunting was definitely increasing. Although spring seasons began in 1968, the major thrust of recent intensive research and management efforts has been directed towards fall hunting, since this aspect of harvest appeared more critical.

This paper presents data on hunting pressure and harvest from fall seasons during 1968-73. It discusses current and future management implications.

We thank William T. Corbett for the many hours spent in the collection of data. We appreciate the efforts of Eugene R. McCaffrey and Marilyn Miles in developing computer tabulations. Dr. Stephen W. Eaton of St. Bonaventure University, banding field supervisor from 1969 through 1973, provided us far more data than mere numbers of birds banded. Also, we extend our thanks to the thousands of unnamed hunters whose cooperation made our work possible. The study was a contribution of Federal Aid in Fish and Wildlife Restoration Project W-81-R.

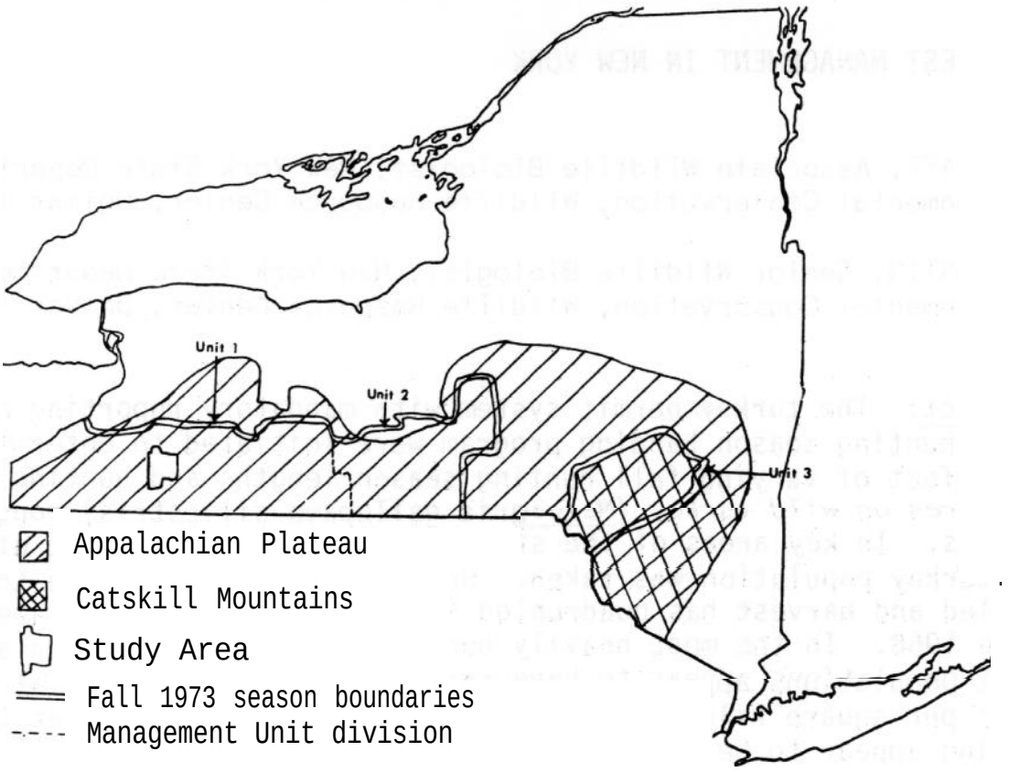

Figure 1. The locations where turkey data were collected in southwestern New York.

METHODS

Data were acquired by a turkey hunter permit system with mandatory reporting (DeGraff 1973), a pre-hunting season banding program, and a wild turkey natality study (Glidden 1975). Age and sex information was acquired through examination of turkey tarso-metatarsi returned by hunters.

In 1968, the permit system went into effect in a 5,679 km^2 area in southwestern New York, Unit 1 in Fig. 1. At that time the season began in early November and was 13 days long. The system required that all turkey hunters acquire a free, special permit from the Division of Fish and Wildlife. All permittees were required by law to return the permit within 48 hours after the close of the hunting season, and to complete a form that indicated the location of hunt and number of days hunted. Successful hunters were required to indicate the date and location of the kill, and to return by mail the lower leg of the killed turkey.

The permit system provided data on hunting pressure and turkey harvest for small units throughout the state.

In 1968, 1969, and 1972 non-reporting permittees were sent a letter urging them to report their hunting activity. This produced a total reporting rate of 80-85 percent. No urging letters were sent during 1970, 1971, and 1973. The voluntary responses were adjusted to simulate an 85 percent reporting rate, thus providing annual comparability for hunting pressure and harvest data presented in Table 1.

Table 1. Turkey hunter data for the fall seasons, 1968 through 1973 in New York.

Items and Units of Measurement	1968	1969	1970	1971	1972	1973
Permits issued (number)	27,160	37,563	33,158	36,326	41,997	50,978
Hunters (number)	15,994	17,426	16,847	18,789	20,868	25,038
Permits utilized (percent)	58.9	46.4	49.2	48.3	50.3	50.9
Hunting pressure (man-days)	42,777	45,257	46,365	65,292	71,819	89,790
Turkeys taken (number)	625	381	558	1,136	1,094	1,654

The first year's permit data were used as a guide to select and establish a 476 km^2 study area (Fig. 1) in which a pre-hunting season banding program was begun in 1969 and continued through 1974. The area selected was about 50 percent woodland, and was representative of most of the turkey range in Unit 1. The banding program was contracted to St. Bonaventure University under the field supervision of Dr. Stephen Eaton.

Band recoveries provide an estimate of the proportion of the turkey population that was legally harvested each fall. It was assumed that the data would reflect the effects of moderate to heavy hunting pressure on Unit 1. The data were not considered representative of Units 2 and 3 which were newly opened to fall hunting in 1969.

A natality study was initiated in 1970 by the Upland Game Bird Project to measure net production of wild turkeys, and provide a means to interpret age and sex data acquired from band recovery and harvest information.

RESULTS

Hunting Pressure

The number of turkey hunters in New York has steadily increased since 1968. In 1973 there were nearly 60 percent more hunters than in 1968, and man-days of hunting pressure increased by 109 percent (Table 1). Most of the total hunting pressure (86 percent) occurred in Unit 1 even though an additional 4,662 km^2 had been opened to hunting after 1968. Opening day and weekend hunter density in the study area, which was initially higher than any other area in Unit 1, climbed from approximately 2 hunters per km^2 of woodland in 1968 to a peak of 5 during the 1973 fall season.

During the statewide 12-day seasons of 1968-70, hunter utilization was high and weekend hunting pressure was maintained in opening-day proportions (Fig. 2). Band recovery data from the study area suggested that a relatively small proportion of the turkey population was being harvested. Consequently, a statewide 20-day season was initiated in 1971 and continued through 1973. During the 12-day seasons hunters averaged 2.7 days per season, and 3.5 days with 20-day seasons. Regardless of season length, hunter success persisted throughout the entire hunting season.

Turkey Harvest

In 1968, 625 turkeys were reported killed in the state by hunters during fall seasons. In 1973, the calculated harvest was 1,654 (Table 1). Approximately 88 percent of this harvest took place in Unit 1. Hunter success increased from a low of one in 46 hunters taking a turkey in 1969 to one in 15 in 1973. Band recovery data indicated that the season extension, coupled with the increased number of hunters, nearly doubled the harvest rate of banded turkeys from 1970 to 1973. Hunters in the study area harvested 25 percent of the adult females and birds of the year (Table 2) under the highest hunting pressure conditions in the state.

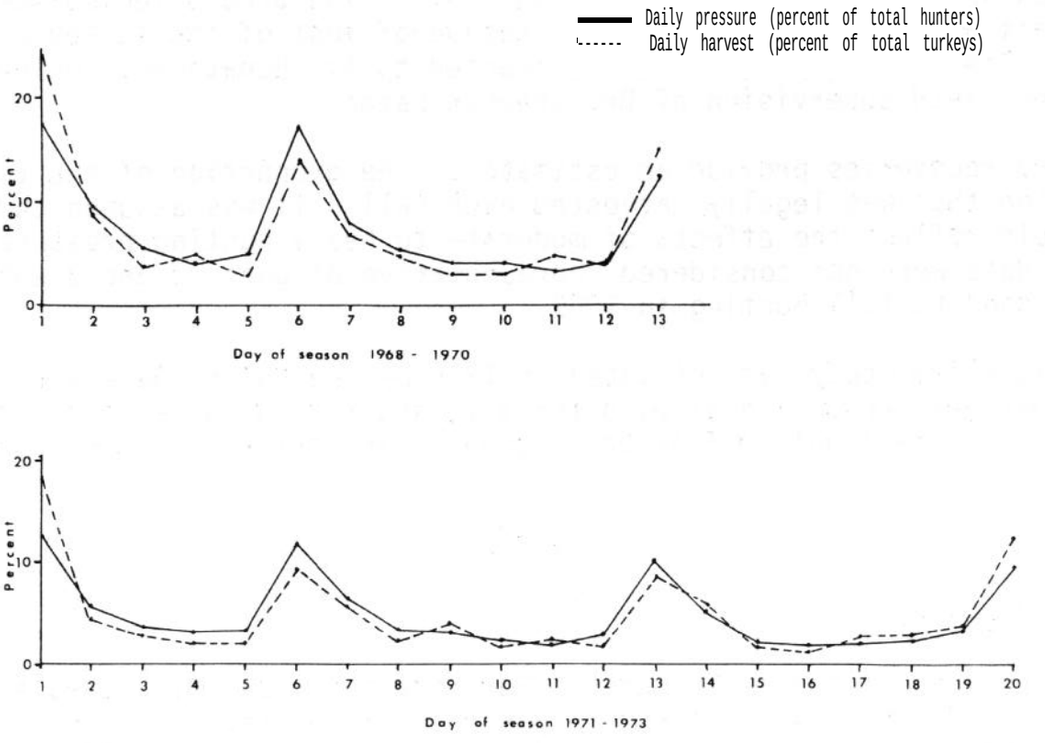

Figure 2. Hunting pressure in relation to turkey harvest during the 13-day season: 1968-70 and the 20-day season, 1971-73, statewide.

Table 2. Number of birds harvested and pre-season population estimates of wild turkey hens and poults in the study area, 1969-73.

Items Measured	1969	1970	1971	1972	1973
Hens & poults banded	69	127	211	280	257
Reported harvest	39	54	125	118	177
Direct band recovery rate (shot birds)	0.13	0.13	0.27	0.18	0.25
Calculated pre-season population[1]	300	415	463	656	708
Turkeys per km^2 of woodland	1.3	1.9	2.1	2.9	3.2

[1]Reported harvest (line 2) divided by direct band recovery rate (line 3).

Table 3. Turkey hens and poults observed during pre-season banding operations in the study area 1969-74.

Items and Units of Measurement	1969	1970	1971	1972	1973	1974
Poults per adult hen (number)	225/40	316/53	394/49	403/75	349/98	358/69
Poults per adult hen (ratio)	5.6	6.0	8.0	5.4	3.6	5.2
Yearling hens/ total hens in banded population (number)	--	13/22	16/23	29/43	26/47	9/29
Yearling hens/ total hens in banded population (percent)	--	59	70	67	55	31

Banding data and first year hunting recoveries for 1971-73 indicated that the adult hen was subject to the same hunting mortality as the young bird. The average first year band recovery for 105 banded adult females was 22 percent, and for 643 banded immature birds, 23 percent.

The band recovery rates presented in Table 2 represent voluntary reports by hunters. Since band reporting occurs via reports from hunters through the permit system, the band reporting rate is assumed to be the same as that of successful hunters returning a turkey leg (90-94 percent).

Turkey Populations

During the pre-season banding period, the field crew documented all observations of poults and hens. The data indicated a rising poult per hen population through 1971, a declining poult per hen population in 1972 and 1973, and a rising population in 1974 (Table 3). Beginning in 1970, each adult hen trapped was examined for age. The percent of banded adult hens that were yearlings appeared to be a direct reflection of the poult per adult hen ratio of the previous year.

Poult per hen ratios in harvest data from the study area were similar to those on Unit 1. Observed ratios were higher by approximately 1 poult per hen than those from harvest data, suggesting either an observation bias in favor of hens successful in rearing broods or a continuing mortality of poults prior to the hunting season.

Direct band recovery rates were used in conjunction with known reported harvests (via the permit system) in the study area to calculate a pre-hunting season turkey population (Table 2). Since virtually all of the birds banded were adult females and poults, this calculation does not include the adult male segment. The rising population, which approached stability by 1973, was strongly related to changes in the poults per adult female in the harvest.

Evidence indicates that the pre-hunting season trapping and banding was biased in favor of hens with broods only. Glidden (1975) found that of 16 radio-tagged hens known to have produced broods, 10 could be accounted for during the pre-season banding period. Of these 10, only five had broods. Since the location of these 10 hens was known during the banding season, attempts were made to bait them for observation purposes. The only hens which could be attracted to trapsites via the conventional bait trapping technique were those hens which had broods.

The average number of young birds produced by the five known successful hens was 4.4, a figure which seems reasonably allied with the observed ratio of 5.2. Since banding ratios are roughly comparable to observed, the suspicion of trapping bias seems to have some credibility. Secondly, one generally considers that young of the year of most game species are more vulnerable to hunting than the adults. This does not appear true in light of the similarity of band recovery rates between adult hens and immatures. Yet it seems reasonable that hens with broods would be as susceptible to the gun considering their social behavior and the techniques generally employed in fall hunting. The implications of these data go beyond mere trapping bias, suggesting that poult per hen indices in harvest data may be largely a reflection of the number of poults each successful hen produced. Certainly some "barren" hens

are shot, which may explain why ratios in harvest data are nearly always somewhat lower than those of field observations. However, there does appear to be a fairly substantial segment of the adult hen population which is neither banded or harvested.

CONCLUSIONS

Hunting pressure and consequent harvest have increased at a much greater rate in the study area than in the surrounding area open to hunting; nonetheless, if we maintain harvest management procedures based upon the heaviest hunting pressure and harvest conditions occurring, we will satisfy our objectives of producing maximum hunting opportunity without jeopardizing the welfare of the turkey. We will therefore continue to use the study area as a gauge by which to measure the effect of harvest management procedures.

In the major management unit, a three-week fall hunting season did not adversely affect the turkey population. However the hunting season should not be extended if the pressure continues to rise.

Maximum turkey populations represented by adult hens with poults appear to stabilize at approximately 3 turkeys per km^2 of woodland. The stability of this turkey population is a result of low productivity in the form of high poult mortality (Glidden 1975), and is not related to any effect of hunting.

Banding and band recovery data strongly favor hens with broods, excluding that segment of the hen population which was not successful in producing a surviving brood. The adult hen which does not produce a surviving brood is harvested at a much lower rate than her successful counterpart.

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SETTING SPRING GOBBLER HUNTING SEASONS BY TIMING PEAK GOBBLING

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Abstract: Wild turkey (*Meleagris gallopavo silvestris*) gobbling activity was monitored in South Carolina during the breeding seasons from 1972-74 in an attempt to establish the most desirable period for holding spring gobbler hunts. The second major peak in gobbling was 26 April in the Piedmont region and one week earlier in the Coastal Plain. Most hens began incubation during the first three weeks in April. The second major peak in gobbling occurred during the peak period of incubation at the primary study area.

Key words : *Meleagris gallopavo silvestris*

Because of state law and sportsmen interest, spring gobbler seasons in South Carolina have traditionally extended from about 15 March through 1 May. Opening and closing dates have varied slightly from the Coastal Plain to the mountains.

An investigation of wild turkey breeding behavior in South Carolina was conducted to determine peaks in gobbling and nesting activities. Data from this study should assist biologists and administrators in establishing spring hunting seasons that provide maximum hunting opportunity under quality conditions, while affording the greatest protection to nesting hens. The study also provided a means of evaluating the impact of state law requiring spring gobbler hunting seasons to close by 1 May in the Piedmont and Coastal Plain.

I am indebted to the Department's district biologists and their aids for collection of data. Thanks are extended to Mr. Wilton Britt and Mrs. Lovella Britt Waugh of McCormick for the use of their farms as the main turkey study area. Dr. Don W. Hayne, Institute of Statistics, provided valuable assistance in planning and in data analysis. I am indebted to John B. Lewis, Missouri Department of Conservation; Lovett E. Williams, Florida Game and Fresh Water Fish Commission; and especially to James R. Davis, Alabama Department of Conservation and Natural Resources for providing guidance in data evaluation and for reviewing this manuscript. This study was a contribution of the Federal Aid in Wildlife Restoration Program, South Carolina Pittman-Robertson Project W-42.

METHODS

Seven gobble-count stations were established at fixed points across the state. Stations 2 and 5 were on unhunted areas. Station 2, the primary station, was located on the Britt Turkey Research Area in the western Piedmont and has been described by Bevill (1973). Observations of gobblers on this area were facilitated by radio tracking techniques used in other concurrent studies of breeding behavior (Bevill 1973, Fleming and Webb 1974).

The area around Station 2 was mostly pastured and heavily used by turkeys during the spring, which increased the opportunity to observe breeding behavior.

From 1972-74, all stations were monitored on alternate dates from 15 March through 30 April. Monitoring at Station 2 extended through 18 May in 1973-74. Gobbling activity was recorded for one hour, beginning 30 minutes before sunrise. The number of gobblers and gobbles heard were recorded in six separate 10 minute intervals.

Gobbling data were analyzed by 10 minute intervals and by totals for each hour of monitoring for each station by year, and for all years combined. Peaks in gobbling and the number of gobblers heard were determined by averaging the totals recorded during the monitoring hour by date for the three years. Peak gobbling intensity was examined in terms of the ratio of gobbles per gobbler, using data from the 20 minute interval just prior to sunrise. A six day moving average was applied to each set of data so as to eliminate the short term effects of those days when gobbling was especially active or depressed.

Weather data were recorded about 30 minutes before sunrise and the variables analyzed by year, station, for all years combined by station, and for all stations combined for all years. Variance, covariance, and simple linear regression methods of analysis were used to test the influence of various weather factors on gobbling.

The peak interval for starting nest incubation was determined from nesting data on six hens radio tracked in 1972, and by back-dating 28 days from the approximate hatching dates of 22 broods of other hens. The approximate age of the broods were determined by the method described by Nixon (1962).

RESULTS AND DISCUSSION

Comparison of Stations

Of the seven stations monitored, only Stations 2 and 5 (the unhunted areas) provided reliable data. Inexplicable sporadic gobbling patterns were noted for all stations on hunted areas, therefore, data collected at these stations were not used in determining peaks of gobbling. Problems in using gobbling data from hunted areas were noted by Davis (1969 unpublished report) in Alabama.

The progression of gobbling at Station 2 from 17 March through 16 May is shown in Fig. 1. The first peak in gobbling from 17-21 March, was attributed to the final breakup of winter flocks and to attempts by subdominant males to win harems of hens (Bevill 1973). The depression in gobbling during late March and early April may be a result of generally poor weather conditions and/or to the abundance of hens accompanying dominant gobblers.

From 8 April through 16 May gobbling became more active, with the longest interval of consistant gobbling occurring from 16-28 April. The peak number of gobbles heard during this interval occurred on 26 April, followed by the

peak number of gobblers heard on 28 April. While a somewhat higher peak in gobbling was observed from 8-12 May, it should be noted that the peak lasted only four days. Davis[1] found that the highest and longest gobbling peak in Alabama occurred from 2-12 April. Data from Ohio (Bailey and Rinell 1967) indicated gobbling patterns similar to those at Station 2. However, these data are not directly comparable because the Ohio data were generated from call count routes and not from fixed stations.

Gobbling patterns at Station 5 (near the coast) revealed some variations from those at Station 2. Peak gobbling occurred about one week earlier on the coastal area with consistant gobbling occurring from 6-22 April.

Gobbling by 10 Minute Intervals

The highest average number of gobbles heard occurred 10 minutes before sunrise (Fig. 2). Gobbles per gobbler generally increased through the entire monitoring hour. In Alabama, Davis (1969, unpublished report) found that total gobbles heard per 10 minute interval and gobbles per gobbler followed

[1]Davis, James R. 1969. Wild turkey investigations - breeding, nesting and brood survival. Alabama Job Completion Report, W-35-R-15, Job #II-E. 52pp.

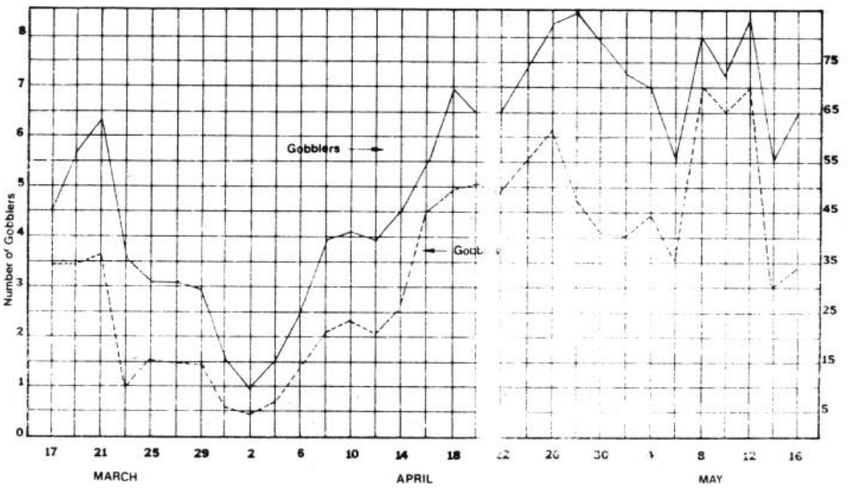

Figure 1. A six-day moving average of gobbles and gobblers heard per count at Station 2, 1972-74.

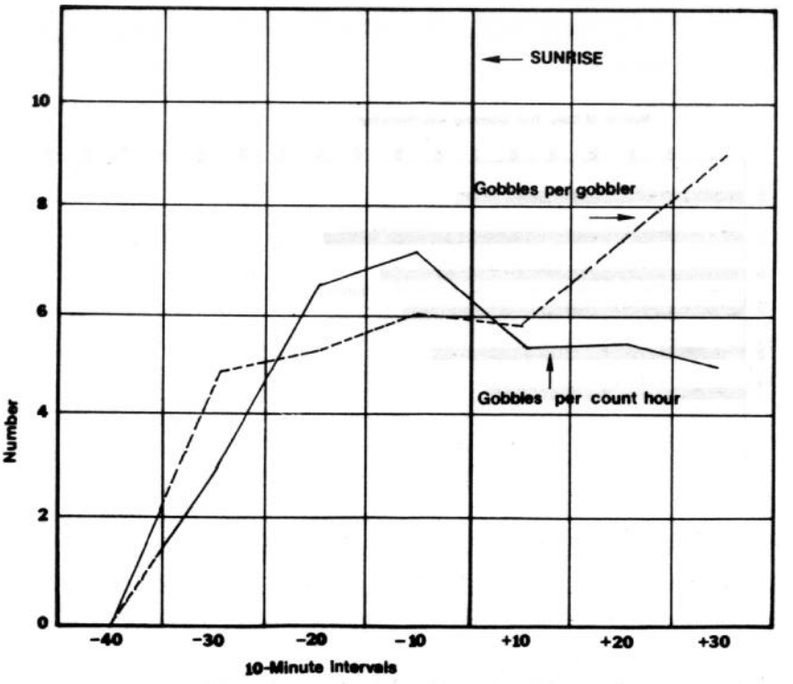

Figure 2. Three years data of gobbling in relation to sunrise from gobble count Station 2, between 15 March and 18 May 1972-74.

similar curves, increasing until sunrise then steadily declining. The continuing increase in gobbles per gobbler that I found was a result of dominant birds engaging in intense competition for hens as the breeding season progressed into late April and May. At this time, two to three older gobblers often engaged in gobbling matches that lasted for an hour or more. It was not uncommon for one bird to gobble over 25 times in 10 minutes. In another study of individual gobbling behavior, one male gobbled 54 times in 10 minutes (Bevill 1973). Although there were only about 50 percent as many males gobbling 30 minutes after sunrise as there were 10 minutes before sunrise, these birds were often the most prolific callers.

During 89 days of monitoring over the three-year period, one or more gobbles were recorded on 53 and 47 mornings respectively in the -20 and -10 minute intervals before sunrise (Fig. 3). These two intervals provided the best time to hear gobbling because birds were usually still on their roosts in trees, where their gobbles would carry over longer distances. The decline in the number of gobblers heard after sunrise was due in part to birds having flown down into the forest where their gobbles were muffled by vegetation and terrain features.

Because gobbling was most consistantly heard during the 20 minutes before sunrise, the number of gobbles per gobbler was plotted for this interval (Fig. 4). This graph shows that the number of gobbles per gobbler was greatest on 26 April, as was the overall peak of gobbling shown in Fig. 1.

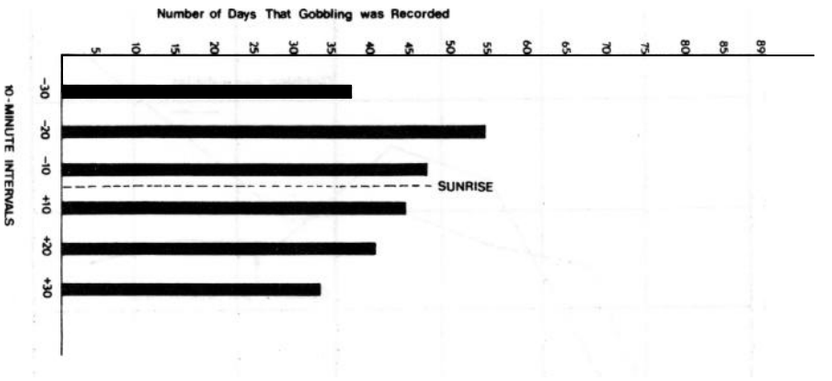

Figure 3. The number of days that gobbling activity was recorded for each 10 minute gobbling interval at Station 2, between 15 March and 18 March and 18 May 1972-74.

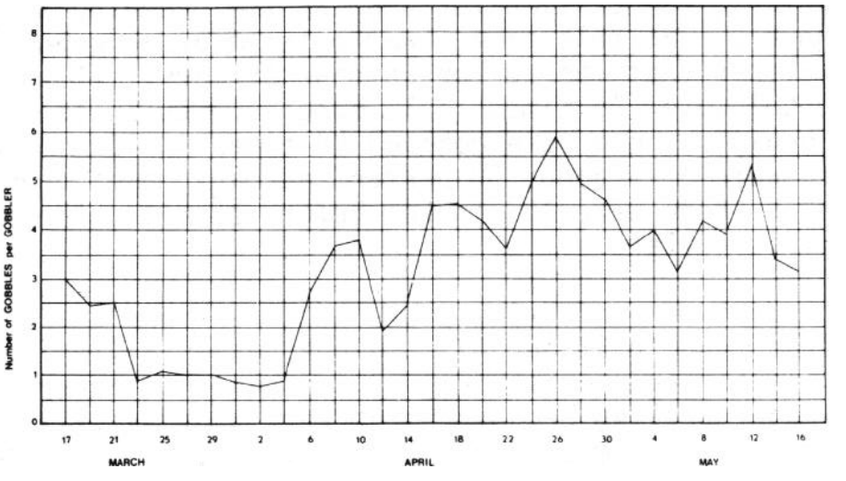

Figure 4. Number of gobbles per gobbler at Station 2, 1972-74, using combined data from the -20 and -10 intervals.

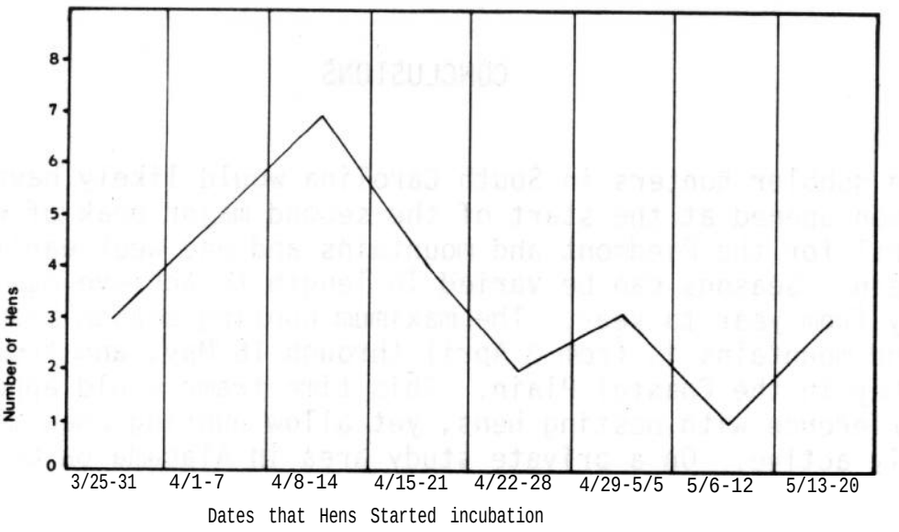

Figure 5. Timing of the start of nest incubation for 28 wild turkey hens observed during the three breeding seasons that gobbling was monitored at Station 2, 1972-74.

Weather and Gobbling

Davis (1971) reported that cloud cover was the single most significant influence on gobbling, with cloudy days depressing activity. Gobbling was most active on clear to partly cloudy mornings, with a dew fall, relatively calm winds, and when there had been no rainfall during the previous 12 hours. Weather information from this study generally supports Davis's conclusions, however, the relationship between weather variables and gobbling was not strong enough to warrant adjustments in gobbling data. It appeared that the influence of weather on gobbling may have been masked by only recording weather conditions 30 minutes before sunrise. Changes in one or more weather variables after that time were not recorded, thus, their effects on gobbling could not be tested.

Nesting Chronology

Most hens started incubation by the third week in April (Fig. 5). The increase in gobbling from 16-30 April (Fig. 1) appears to correspond with the peak of nest incubation. Bailey and Rinell (1967) noted a second peak in gobbling after the bulk of the hens started incubating. The late April peak that I observed supports their conclusions. Using an interval of at least two weeks for fertilization and egg laying before the start of incubation, the peak of mating would have occurred during or shortly after the first gobbling peak in late March.

CONCLUSIONS

Spring gobbler hunters in South Carolina would likely have better success if the season opened at the start of the second major peak of gobbling, or about 8 April for the Piedmont and mountains and one week earlier in the Coastal Plain. Seasons can be varied in length to achieve maximum hunting opportunity from year to year. The maximum hunting season framework for the Piedmont and mountains is from 8 April through 16 May, and from 1 April through 9 May in the Coastal Plain. This time frame would appear to offer least interference with nesting hens, yet allow hunting when gobbling is most consistantly active. On a private study area in Alabama Gardener et al. (1972) found that a hunting season extending from 10 March through 30 April did not result in an over harvest of turkeys or that it adversely influenced nesting success. South Carolina law prohibiting spring gobbler hunting after 1 May should be revised so that sportsmen can fully benefit from the knowledge of peaks in gobbling and nesting gained through this study.

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INDEXES FOR AGING EASTERN WILD TURKEYS

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Abstract: Spur length was the best single variable for determining the age of eastern wild turkeys (*Meleagris gallopavo silvestris),* but a discriminant function involving spur length, beard length, and body weight was more accurate.

Key words: *Meleagris gallopavo silvestris*, spur length, beard length, body weight

This paper shows how spur length, beard length, and body weight are associated with known-age eastern wild turkeys. Such information will aid wildlife managers in analyzing the age structure of turkeys harvested in a gobbler-only spring season.

I wish to express my thanks to John B. Lewis, Missouri Department of Conservation, who made the data available and provided guidance in preparing the manuscript, and to Dr. Gary F. Krause and Carolyn Hebert, University of Missouri at Columbia, for statistical and computer assistance.

LITERATURE REVIEW

Information is sparse concerning spur length, beard length, and body weight of known-age eastern wild turkeys. In Virginia the average spur length for twelve gobblers over two years old was 24 millimeters (mm) with a range of 16 to 19mm (Mosby and Handley 1943). Leopold (1944) also obtained a mean spur length of 24mm for 24 adult males. Schorger (1966) reported a mean spur length of 22mm with a spread of 15 to 32mm for 21 turkeys.

Beard length varies but appears closely associated with age in young birds. Mosby and Handley (1943) measured six juveniles with beards 11 to 55mm long and averaging 33mm. Similarly, Leopold (1944) reported an average beard length of 33mm in juvenile gobblers.

The beard length of adult gobblers does not appear to be a reliable predictor of age. Mosby and Handley (1943) measured three banded gobblers between 12 and 24 months of age with beards ranging from 30 to 122mm, and 11 banded gobblers over 24 months old with beards ranging from 228 to 315mm. Leopold (1944) reported an average beard length of 261mm in 24 adult gobblers. Baldwin (1947) examined eight adult males with beards ranging from 227 to 263mm and averaging 248mm.

The body weight of the eastern wild turkey varies considerably with the season of the year and the age of the bird. Mosby and Handley (1943) reported the weight to be greatest in late winter and early spring, and least in late summer. The average weight of three adult gobblers collected in late spring (Mosby and Handley 1943) was 9.14 kilograms (kg) with a range of 8.85 to 9.33

kg. Leopold (1944) reported an average body weight of 4.76 kg for eight first-year males, and an average of 8.03 kg for 24 adult males. The heaviest male handled by Wheeler (1948) weighed 9.13 kg.

Longevity data of eastern wild turkey gobblers is rare and inconclusive. A gobbler killed in the Santee Swamp of South Carolina was estimated to be over 15 years old (Schorger 1966). In West Virginia five gobblers lived 3.5 years, one lived 4.5 years and one lived 5.5 years (Bailey and Rinell 1965 P-R Progress Report). Mosby and Handley (1943) indicate that the average wild turkey does not live much over five years, but some may survive from ten to twelve years.

METHODS

All turkeys used in the study were harvested during the spring gobbler seasons in twenty Missouri counties from 1962 to 1974. Fifty known-age gobblers were trapped as sub-adults, and fourteen "minimum known-age" gobblers were trapped as adults. Both groups were banded and either released at the trap site or relocated for stocking purposes. Twenty-five sub-adult gobblers in the sample were randomly selected from the 1973 harvest data in two counties.

Gobblers weights were recorded to the nearest one-quarter pound and later converted to kilograms. Spurs were measured from the junction of the spur with the tarsus on the inside edge, to the tip of the spur. Beards were measured from the point of insertion in the skin to the tip of the brush as recommended by Leopold (1944).

RESULTS

Significant differences were found among the age-class means for each variable measured (Table 1). In all cases the age-class 1 (sub-adult) means were significantly lower than the means of other age-classes. Body weight means did not differ for age-classes 2,3,4 and "5", indicating that body weight was a weak indicator of age. Average beard length was not significantly different for age-classes 2, 3, and 4, but each of these were lower than the mean for age-class "5". Spur length means were significantly different among all age-classes with the exception of 3 and 4, and 4 and "5".

Spur length was more highly correlated with age than any other single variable (Table 2). Therefore, a quadratic regression equation was calculated to show the relationship between spur length and age using the data from known-age birds in all age classes except "5". The resultant equation and curve with 95% confidence intervals are shown in Fig. 1.

A discriminant junction (Fisher 1936) was computed to show the best relationship among all three variables for age-classes, 1, 2, 3, 4, and "5". Table 3 shows the discriminant scores that were calculated according to the following formula:

$$u = .0211 \text{ (spur length)} + .0020 \text{ (beard length)} + .0392 \text{ (body weight)}$$

Since the scores are random variables they have a sampling variance. Their standard deviation is 0.1072. An interval, mean score + 1 standard deviation, defines a classification zone for aging birds. This zone provides limits which would include about 68 percent of the score for each age-class.

Table 1. The length of spurs and beards and body weights of gobblers in known age-classes.

Age of Birds	Number of Birds	Spur Length (mm)		Beard Length (mm)		Body Weight (kg)	
Yrs		Mean	sd	Mean	sd	Mean	sd
1	25	6.64	2.27	112.84	26.31	34.04	3.48
2	27	21.96	2.86	240.56[a]	25.88	46.50[a]	3.58
3	11	25.73	4.17	240.40[a]	21.59	48.19[a]	5.64
4	7	27.43[a1]	5.09	228.57[a]	54.90	49.45[a]	5.84
5	2	29.50[ab]	6.36	277.50	3.54	52.36	.77
7	2	35.00	7.07	275.00	21.21	51.26	.77
9	1	35.00	--	265.00	--	44.09	--
"5"[2]	19	30.05[b]	4.24	281.63	28.34	49.85[a]	3.84

[1]Means with a common letter in their superscript are not significantly different (P = 0.05).

[2]A minimum-known age of at least 5 years.

Table 2. Correlation coefficients[1] among measured attributes of 75 gobblers.

	Spur Length	Beard Length	Body Weight	Age
Spur Length		.85	.77	.78
Beard Length			.73	.61
Body Weight				.56
Age				

[1]All values are significantly different from zero.

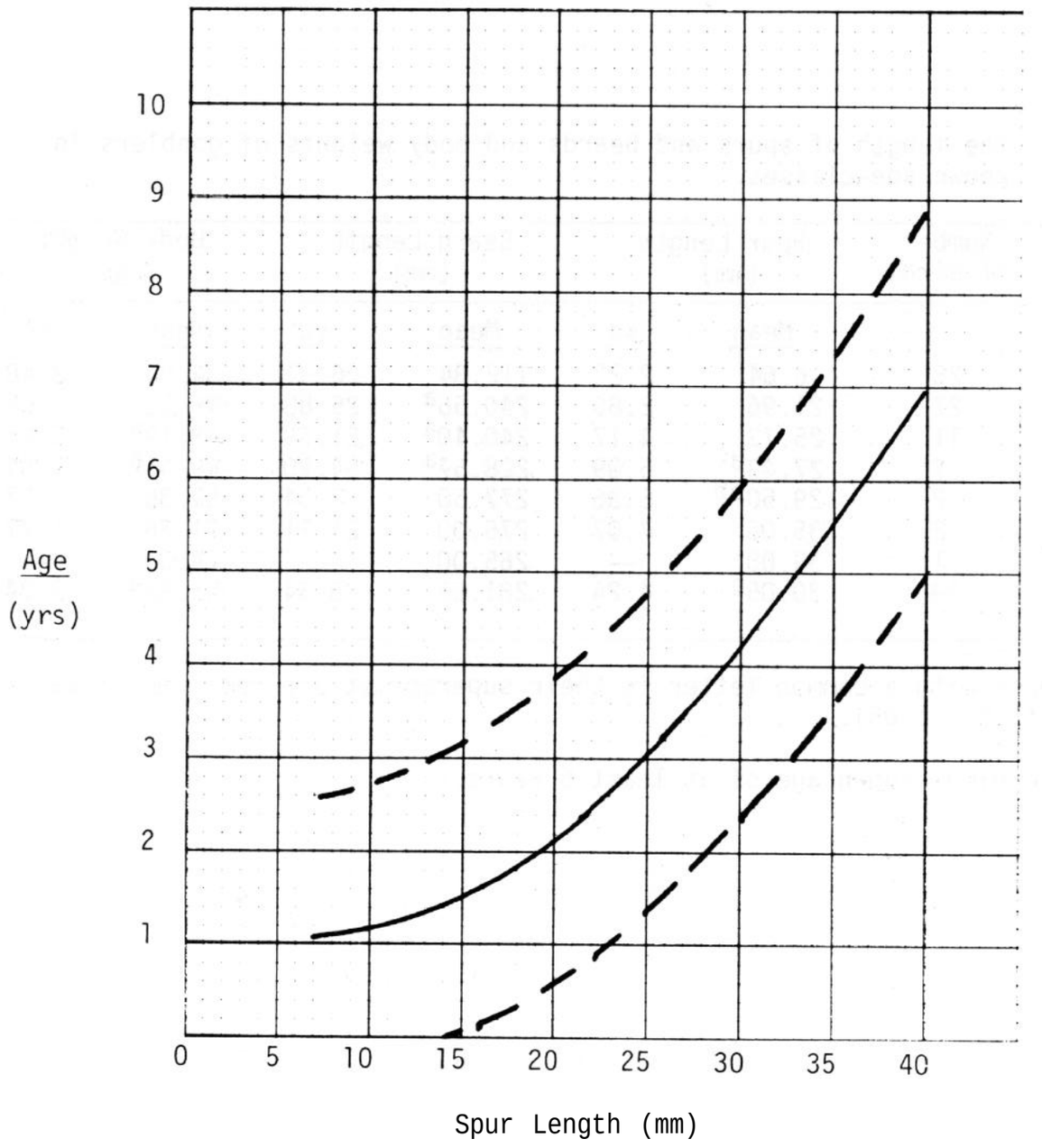

Figure 1. Relationship between age and spur length for 75 spring gobblers.

Table 3. Average discriminant scores for age categories 1, 2, 3, 4, & "5".

Age Category	Mean	Mean + 1 Standard Deviation
1	0.64	0.53 - 0.75
2	1.31	1.20 - 1.42
3	1.40	1.29 - 1.51
4	1.42	1.31 - 1.52
"5"	1.58	1.47 - 1.69

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Spur length differs significantly between age-classes of spring gobblers and can be used by itself or in combination with beard length and body weight to classify turkeys by age in the spring harvest.

The age composition of the harvest helps the manager to analyze the effects of hunting on the overall population. When the harvest consistently runs high to the older age-classes, it could indicate the population is being under-harvested. Conversely, an over-harvest may be indicated when the harvest consistently runs high to the younger age-classes. Data on population structure at Lake Spring indicates that 43 percent of the gobbler population can be harvested without creating a shortage of breeding birds (Lewis and Kelly 1973).

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ECONOMICS OF WILD TURKEY MANAGEMENT

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Abstract: Questionnaires were mailed to the 50 state wildlife agencies and 177 private turkey shooting preserves. Forty-seven agencies and 58 private preserves responded. State responses indicated a general lack of information on expenditures for turkey management. Only three states had viable hatchery programs. Turkey stocking programs were responsible for releasing over 7,000 birds in 1974, the vast majority (6,000) in Pennsylvania.

At shooting preserves, capital investments and annual maintenance costs far exceeded annual incomes. Sixty-two percent of the responding preserves were operated as a secondary source of income, and probably serve as long term investments, tax deductions and/or hobbies.

Key words: Stocking programs, preserves, hunters, hatcheries

Much money is spent each year by State game agencies and private individuals on turkey management, but little is known about the actual costs of operations. In 1951, the average cost per turkey to a hunter in the Texas hill country was $186.98. Expenditures by land owners for supplemental feeds and food patches for turkey and deer were as great as $1,124.75 per annum (Capel, 1951). Rundquist (1973) did not examine operation costs for a private preserve, but suggested that the average hunter attending such facilities spent $17.27 per bird bagged.

This study examines the economics associated with turkey management at both state and private levels. Information was gathered by questionnaires mailed to each of the 50 state wildlife agencies and to 7 private hunting preserves. Names of private turkey preserves were obtained from the North American Shooting Preserve Directory (1973-74). Follow-up letters were mailed to those not responding to the initial letter.

RESULTS

Forty-seven state wildlife agencies and 58 private preserves responded to the questionnaires. Six states indicated that they did not have turkey management programs. Twenty-seven of the 58 private preserves indicated that they did not operate a turkey shooting preserve, even though listed in the 1973-74 North American Shooting Preserve Directory. Twenty-seven (47%) of the questionnaires returned contained usable data.

Table 1. Hectares of wild turkey management areas for 28 states?

States	Size of Management Areas
Alabama	635,844[2]
Arkansas	750,000
California	25,000
Colorado	Undetermined
Florida	4,000,000
Georgia	300,000[2]
Hawaii	15,000
Illinois	25,000[2]
Iowa	21,110[2]
Kentucky	248,000[2]
Louisiana	200,000
Maryland	127,000
Michigan	Undetermined
Minnesota	25,000
Mississippi	700,000
Missouri	51,300[2]
Nebraska	14,000[2]
New Mexico	Undetermined
North Carolina	5,000[2]
Ohio	20,000[2]
Oklahoma	129,000[2]
Pennsylvania	1,200,000
South Carolina	2,775,000
South Dakota	2,500,000
Tennessee	413,239[2]
Texas	66,438[2]
Virginia	1,500,000
West Virginia	215,733

[1]Nineteen states had no turkey management areas; three states did not respond.

[2]Areas where wild turkeys are the featured species.

State Agencies

The information requested and received from state game agencies is discussed below.

State Management Areas

Twelve agencies maintained areas where wild turkeys were the featured species, ranging from 2,025 to 257,516 hectares (ha) and averaging 65,000 ha (Table 1). In addition, 14 states reported areas managed not specifically for but including turkey. These areas averaged 449,340 ha. Three states answered that they maintained large areas of undetermined size. Nine states

indicated that management areas were solely state owned, 12 were without state owned areas, and 20 had areas cooperatively managed by the state. Lands were obtained through cooperative agreements, leased, tax revision, and direct purchase (fee simple and fee title).

Salaries and Maintenance

Only 11 state agencies reported annual maintenance costs for turkey management areas. Seven of the 11 (64 percent) reported annual maintenance cost in the $0-25,000 range (Table 2). The average for these states was $6,929. Twenty-three states did not know the maintenance cost of their facilities for turkey management.

Table 2. Annual maintenance costs for turkey management facilities.

Annual Maintenance Cost	Number of Respondents
$ 0 - 25,000	7
25 - 75,000	1
75 - 150,000	2
150 - 250,000	1
Unknown	23
	34

Twenty-one (54 percent) of 39 states reported that they did not employ personnel specifically for turkey management. The majority (56 percent) of states with personnel budgeted to turkey management employed only one individual. Apparently, most personnel were involved with all game species, and had an apportioned amount of their time allocated for turkey work. Twenty states (51 percent) had 1 to 10 individuals working part-time in turkey management. Total salaries included those paid individuals directly and/or indirectly involved in turkey management. Budgeted salaries ranged from $500 to over $100,000. The greatest number was in the $5-10,000 range (Table 3). The broader salary range of $5-25,000 included 46 percent of reporting agencies.

Funds for turkey management generally came from hunting licenses and Pittman-Robertson funds (Table 4). Tennessee relied solely on funds from turkey licenses.

Twenty-eight states estimated funds budgeted to turkey management. Twelve states reported budgets in the $10-24,999 range for 1975. The remaining states did not know how much they would spend on turkey management for the same period (Table 3).

Table 3. Total salaries paid by for employees in turkey management and expected 1975 turkey management budgets for these states.

Expenditure Range	Number of Respondents	
	Salaries	Management Budget
None	3	
$ 1 - 4,999	5	3
5 - 9,999	10	4
10 - 24,999	8	12
25 - 49,999	2	3
50 - 99,999	5	1
100,000 or above	1	5
Unknown	5	11
	39	39

Stocking Programs

Twenty-nine states reported that they had a stocking program. States without stocking programs either had very small populations or relied solely on natural increase for restocking. Three states maintained hatcheries. Numbers of eggs hatched yearly by Kentucky, Texas, and Pennsylvania were 40, 450, and 6,000, respectively. Eggs were obtained solely from brood stock. None of the states with stocking programs charged for birds released on private lands. A total of 7,242 turkeys were released by 20 states during 1973. Of this number, 2,776 (38 percent) were released on private lands and

Table 4. Origins of funds for state turkey management programs.

Source of Funds	Number of Respondents
Hunting Licenses Only	10
Turkey Licenses	1
Turkey Permits	2
Hunting Licenses and Pittman-Robertson Funds	24
Unanswered	2
	39

Table 5. Turkeys released on state and private lands by 20 states during 1973.

State	Number of Turkeys Released	
	Private Lands	State Lands
Alabama	20	.
Arkansas	-	254
California	119	-
Georgia	67	.
Illinois	14	-
Iowa	55	.
Kansas	21	9
Kentucky	13	21
Massachusetts	-	20
Minnesota	16	-
Mississippi	14	29
Missouri	115	9
North Dakota	-	35
Ohio	26	6
Oklahoma	255	28
Pennsylvania	2,000	4,000
South Carolina	11	12
Tennessee	22	17
Virginia	-	19
Washington	8	7
Total	2,776	4,466
Mean	174	319

4,466 (62 percent) on state lands (Table 5). Pennsylvania released the greatest number of turkeys (6,000) and Illinois the least (14). The average number of birds released per state was 174 for private lands and 319 for state lands.

Public Services

Twenty-four states had turkey education programs, 14 had none and 1 declined to answer.

Twenty-four of the states responding had turkey management areas for public hunting. Texas, Oregon, Wyoming, Mississippi, Colorado, and Tennessee charged hunting fees.

Private Turkey Preserves

Questionnaires were returned by private hunting preserves from California, Idaho, Illinois, Iowa, Kansas, Missouri, Minnesota, Ohio, Texas, Utah,

Wisconsin, and British Columbia (Canada). Data obtained from these respondents are presented below.

Acreage and Capital Investments

The average size of turkey shooting preserves was 406 ha (range, 11 - 3,040 ha; n=23), the average value per ha was $3,259 (range, $493 - 12,346; n=19). Purchase price for preserve lands averaged $1,118 per ha and ranged from $123 to $6,172 per ha (n=15). Hence, the total average investment in land alone was approximately $453,906. At current prices, the investment is estimated at $1,322,640. Two preserves leased their lands entirely. One paid $4.94 and the other $24.69 per ha per year for a total annual cost of $4,000 and $15,000, respectively.

Capital investments (other than land) included vehicles, feeders, weapons, planting equipment, pens and enclosures, and miscellaneous items such as housing and dining facilities (Table 6). Sleeping and dining facilities for hunters required the largest capital investment. Cost of these facilities ranged from $10,000 to $40,000 and averaged $22,714 (n=7). Vehicles required the second largest expenditure, averaging $4,930 (range, $1,00-12,000; n=7) per preserve.

Annual Cost of Operation

Major costs for operating a turkey preserve included labor, transportation, equipment maintenance, and advertising. Seven of 15 respondents had operation costs below $5,000. Number of employees ranged from 1 to 5 but averaged only one individual per operation. Salaries ranged from $1,000 to $24,000 per annum. Most of the preserves had annual labor costs of less than $5,000. Sixty-three percent of employees reported by preserves were permanently employed, while the remainder were hired on a seasonal basis.

Fourteen of 26 preserves advertised for hunters. The mean annual cost of advertising for 10 preserves was $685 (range, $25-2,000). Most of these

Table 6. Capital investments of private turkey hunting preserves.

Commodity	Number of Respondents	Investment	
		Mean	Range
Feeders	8	$ 444	$ 50 - 1,000
Weapons	4	1,425	500 - 3,000
Planting Equipment	5	2,800	500 - 6,000
Pens and Enclosures	10	3,185	350 - 10,000
Other[1]	2	42,500	25,000 & 60,000

[1]Includes guest housing (for non-hunters), garages, out-buildings, etc.

were centered around magazine advertisement. The remainder relied primarily on word-of-mouth and reputation to attract hunters.

Turkey Stocking and Maintenance

The majority of respondents (77 percent) maintained free-running gobblers and hens for hunting. The average number of turkeys stocked at any one time was 57 (range 2-250); more immature birds ($\bar{x}$=33.4; n=27) were stocked than mature gobblers ($\bar{x}$-17.1) or hens ($\bar{x}$=28.5; n=27). Sixty-one percent of the birds were obtained from hatching eggs, with an average price per egg of $1.43. Prices paid for mature gobblers and hens averaged $15.73 and $14.29, respectively.

Hatching success ranged from 20 to 100 percent, with the majority in the 40 to 80 percent range. Poult survival rates also ranged 20 to 100 percent, 48 percent of which were in the 60 to 100 percent range.

Twenty-one of 26 (81 percent) preserves fed free-running birds, but there was considerable disagreement concerning types of feeds and feeding methods. Approximately half of the 26 preserves maintained food patches during some time of the year. Species planted included grains and grasses, legumes, and composites; however, grains and grasses were generally (88 percent) used. Feeds given directly to birds through supplemental feeding programs included grains, legumes, high protein fish oils, commercially prepared turkey feed and, in one case, a "secret formula". The total annual cost of these supplemental feeding and food patch programs averaged $16.58 per bird (range $8.83-20.00; n=13).

Hunting and Services Provided Hunters

Seven of 27 (26 percent) hunting preserves provided lodging and dining facilities at an average of $7.00 and $10.50 per day, respectively.

Only 8 respondents reported number of hunters, hunting success, and fees charged. Numbers of hunters ranged from 25 to 200, with an average of 83. Hunting success was approximately 77 percent, with an average of 64 (range, 42-80) turkeys being taken each year. The fee per bird ranged from $17.50 to $30.00, with an average of $24.

Owner and Operation

Five preserves listed their operation as a primary source of income, and sixteen as a secondary source of income.

Most of the owners were graduated from high school and 25 percent held college degrees. Mean age was 52 years, ranging from 23 to 80 years. Hence, the average preserve operator is an older individual who generally has a non-professional education.

CONCLUSIONS

Although state game management agencies and private preserves appear to have similar management objectives (i.e., propagation of turkeys for hunting)

the two are confronted by largely different problems. Most of the problems encountered in turkey management by state agencies can be traced to the large land areas which they control. Due to the size of their land holdings and the generally insufficient staff, state agencies are forced into extensive forms of game management. Intensive programs for any single species are limited. Where turkey programs have been initiated, management has often been limited to native birds, since most states have been unable to get an adequate number of birds to stock large areas. Turkey establishment is also hindered by the enforcement problems associated with patrolling the large areas under state control.

Apparently, there are many difficulties associated with the initiation and maintenance of hatchery programs. Birds produced by hatcheries are of inferior quality for stocking purposes. Most brood stock has been inadvertantly selected to be docile in order to facilitate handling. This results in a bird which lacks the ability to adapt to free-running situations. When hatchery reared birds are released on management areas they are likely to end up at the nearest landowner's henyard, starve, or be killed by predators. We do feel, however, that many of these problems can be overcome, and that further research in this direction might be fruitful.

Private preserves are characterized by intensive management procedures on relatively small areas. The private operator usually controls access to his land by fencing or other means to prevent poaching. Due to feeding operations and predator control, they can stock birds that probably would not survive in a less controlled environment.

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THE ESTHETICS OF WILD TURKEY HUNTING

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Abstract: The esthetic appeal of wild turkey hunting stems from its ability to satisfy our needs for the total experience - companionship, challenge, anticipation, test of skills, anxiety, success, reward, all in an environment that produces the right stimuli to all the senses. Turkey hunting is the truly authentic experience. Esthetically, it's the real thing!

Key words: Beauty, scenery, emotional experience, outdoor recreation

Many years ago when my son was almost twelve years old, I was determined to make him a skillful wild turkey hunter. Every day when he wasn't in school, I would jolt him out of his sack early in the mornings and walk him up and down the Blue Ridge Mountains of Virginia until dark. When we flushed turkeys in the fall, I forced him to sit in a blind motionless in all types of weather.

We both nearly froze numerous times while I attempted to teach him how much fun it was to hunt turkeys. I vividly recall many days in zero weather with snow on the ground, forcing my favorite child to freeze his fanny while I desperately yelped in the turkey blind so that he could kill a turkey. During the springtime, wanting to brag about my son's big gobbler, we would get up even earlier and hunt harder. I couldn't understand, even as the boy grew older, why he obviously did not enjoy with enthusiasm my favorite form of outdoor recreation.

One day we were driving home from the mountains after another discouraging day chasing turkeys. I apologized to the boy for not having assisted him to kill a big black bird.

I'll never forget his reply which eventually taught me more about the actual essence of turkey hunting than I had previously learned throughout my lifetime. "Dad, when will you ever realize that I don't have to kill a turkey in order to have a good time hunting? I had a wonderful time today just being with you and looking at all that beautiful scenery up there in those Blue Ridge Mountains." Out of the mouths of babes...

When the Committee assigned me this topic, I immediately realized that I had absolutely no scientific data on which to base the paper. To my knowledge, no research work has ever been published on this subject, so of necessity, this presentation will concern itself with a personal, admittedly biased, philosophical treatment of the subject. This, undoubtedly, will be one of the few papers in the history of wildlife management with no statistics, no computers, no data, and no visual aid.

Even Webster’s dictionary was not much help in the preparation of this manuscript. The definition of esthetics describes it as "pertaining to beauty or beautiful". Now, in all of my 27 years of pursuing the wild turkey, I have honestly never observed a beautiful male wild turkey hunter. Most of them, as a matter of record, have been some of the "ugliest hogs in the lot".

Some writers, more skilled than I, could doubtlessly write volumes about the beauty of the turkey itself and I will attempt to do this later in the paper. However, let's be completely candid about the subject.

When you make a critical examination of the individual parts of a turkey, they honestly aren't too appealing. I don't believe there are many objects in nature any uglier than the head of a wild turkey. It is naked and snake-like, covered with all types of bumps. The drab hens, well equipped for their mission in life, could hardly be described as beautiful (except, of course, to a sexy gobbler). By human standards, a female with a naked pinhead along with bony scaly legs would not win any beauty contests.

In elaborating on the esthetics of wild turkey hunting, I will not mention again the end product of every so-called successful hunt - the inevitable blood, guts, and feathers. And if you really want to elaborate on ugliness, what is any more distasteful than the spongy, bloody breast of an adult spring gobbler? This is certainly not my favorite part of hunting America's largest game bird!

Whenever we attempt to analyze why wild turkey hunting is such an appealing sport, we would, of necessity, have to consider where and when it is carried out. The right environment certainly adds an essential dimension to our hunting experience.

In Virginia, we are fortunate in having magnificent mountain scenery, especially during the fall and winter. Thus, when we consider turkey hunting in the autumn, we naturally think about colored leaves, crisp morning temperatures and invigorating climbs into the Blue Ridge or Appalachian Mountains. I’m certain that all the states represented here today have similar beauty spots in their turkey range.

Usually, most of the lovely leaves have already fallen by the time that turkey season arrives, so autumn hunting in our state is stalking through the ridges and mountains. It is hunting the oaks, beech, dogwoods, and grape thickets searching for the characteristic scratchings, tracks, and droppings that are a dead giveaway to an experienced hunter.

The trees, mountains, streams, waterfalls and at times, patches of snow are a wonderful part of hunting the big black birds in the fall and winter. Take away this emotional experience and you emasculate the real lasting soul of the hunt!

It’s the mountain cabin with a roaring fire of oak and hickory; the fellowship of delightful companions; and on occasion, a huge gobbler hanging from the rafters of the back porch. This is turkey hunting at its best!

In reality, the esthetics or beauty of wild turkey hunting is typified by the proud grandeur of an adult gobbler during springtime. What other living creature is more magnificent or exciting than a puffed up, fanned out gobbler in full strut? At a distance he appears to be all black but at closer range, in full sunlight, the feathers are a delightful blend of green, purple, brown, black, and tan. The gobbler head appears to change rapidly from white to red to blue, perhaps depending on his moods. His trophy beard is always the focal point of a turkey hunter's attention.

A graceful wild turkey in flight is a marvelous sight to observe. Every turkey hunter will attest to the fact that turkeys are adept at becoming airborne and rapidly flying out of gun range. The velocity of their flight, either flapping with huge wings or soaring with set wings off the top of a mountain, is always an awesome demonstration.

I can't seem to make up my mind whether I prefer hunting turkeys in the springtime or in the fall-winter season. It's somewhat like making that tough choice between a blond or a red head. I personally like them both!

Spring gobbler hunting has a special charm and appeal of its own for several reasons. Not only are we hunting the largest and most thrilling of our upland game birds, but the associated warming weather and nature's emergence at this season of the year usually produces a most delightful experience.

So what's the big deal or appeal? What is there about spring gobbler hunting that motivates normally intelligent individuals to get out of a warm bed in the middle of the night? What is this strange mania that drives gobbler hunters temporarily away from their families and jobs? Some turkey hunters undoubtedly sacrifice themselves in order to harvest their season's limit or to be able to boast about their 22 pound bird. We all know that a wild turkey is just as delicious as a domestic variety. However, I'm certain that many are driven by an inward urge or need for a most unique, ever exciting, experience.

We have just lived through about six months of cold temperatures, bare trees, ice, snow, mud, and drabness in the out-of-doors. Suddenly and dramatically, the sap begins to rise! Dogwoods, redbuds, forsythia, and other trees and shrubs start blooming. The grass takes on a greenish tinge. All birds start singing and thinking about nesting. After seemingly endless months of waiting, the spring gobbler season has arrived, and we turkey hunters become an integral part of nature's awakening. I have great compassion for those poor unfortunate souls who live in cities, states, or countries without wild turkeys. They have surely missed a most thrilling and meaningful experience if they have never observed or felt a morning in May hunting the King of them all.

There is surely no more thrilling, appealing, and almost reverent time of the year than at 4:30 A.M. on an April or May morning in Virginia. Let's relive a typical spring morning.

It's still dark even though you arose around 3:00 A.M. and drove furiously without breakfast, to be on your favorite ridge by daybreak. It’s plenty chilly, your gun is loaded and you are nervously accumulating all the necessary callers and camouflage equipment. The excitement is terrific! Will

the old boys gobble this morning? How many other hunters will be out here this morning competing for old granddad? Will I be able to call up the gobbler or will I goof up with my call or my questionable shooting ability? All these thoughts and more rush through your mind as the darkness persists.

Suddenly, over on the ridge, a whip-poor-will trills it's excited monotonous call. Occasionally a great horned owl may mournfully answer. Another bird calls, then other species awaken to a new day. One by one, all of nature's birds and insects join in a delightful symphony of sound. The cardinals, thrushes, wrens, bob-whites, and doves, all lend their voices to the music. Frequently in our mountain habitat a grouse drums farther up on the ridges. One of the last to open up is the beloved crow. Squirrels appear from all directions scurrying through the leaves and sounding somewhat like approaching turkeys. Gradually everything gets a little lighter and brighter. The trees, shrubs, and spring flowers appear out of the darkness. Talk about esthetics - the sounds, the sights, and even the fresh fragrance of springtime all blend together into a beautiful three dimensional extravaganza.

Everything is now complete except for one important detail! Where are the gobblers? Why haven't they opened up? You become apprehensive and frantic - why didn't I go some place else this morning? Did someone kill that old boy yesterday? Suddenly, out of the rhapsody of music thunders that most thrilling of all sexual calls - gobble-gobble-gobble. It's almost anticlimatic at this stage.

It is needless to describe in detail to this audience what happens next. Each experience calling in an adult gobbler is different, always breathtaking, forever thrill producing. Who can ever forget the sudden breaking of a twig in back of you, the slow maddening thump-thump that comes both from a strutting approaching gobbler and from your frantically racing, pounding heart?

It's real tough to breathe as you search in all directions trying not to move a muscle.

Finally, you spot a black, or white, or red, or blue object. Is that a black angus bull calf, a black Volkswagon? No, it's the biggest damn game bird in the world and its moving toward your hiding place!

Why can't I keep this old double barrel from jumping up and down? It must weigh a ton! Fleas and mosquitoes are in my eyes, ears, and throat! How can I get off another yelp without the gobbler seeing me? What a tremendous beard that bird is dragging! Suddenly, he is thirty feet in front - to the side or in back of you! All you need to do really is shoot that great big target. But by this time, you are completely strained and drained. As you frantically raise your gun and aim at that patriotic head of red, white, and blue, you realize that bagging or missing the gobbler is really immaterial. You instinctively know that you have already experienced outdoor recreation at its very finest!

THE CROWD GOES TURKEY HUNTING

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Abstract: The comeback of the wild turkey has resulted in a great increase of turkey hunters, and signs of decreasing spring hunting quality. An estimated 3 percent of sampled Ohio and West Virginia hunters expressed discontent with "too many hunters in the woods." It is believed that qualitative turkey management must now begin to parallel quantitative management. Although hunting success is still generally good, it may be necessary to limit the number of hunters to conserve the quality hunting experience. In turn, turkey hunters lamenting the loss of solitude must be prepared to pay, either in terms of leasing private hunting range or in seeking out marginal ranges that are not crowded.

Key words: Hunting quality, game, hunting ethics and traditions, leases

The comeback of the wild turkey has meant more than just another game species returning to the American hunting scene. It marked the return of a traditional form of hunting that had been virtually forgotten in some states, and which had never existed in many others.

In what many believe to be its finest form--spring gobbler hunting--the sport was unique. It not only involved the wiliest and most prized of all game birds, and demanded highly refined skills on the part of the hunter, but also entailed a special hunting season that has no counterpart. These factors combine to meet every requirement for sporting excellence--to the delight of hunters who quickly learned to appreciate it.

The enthusiasm of such men was infectious, and as the wild turkeys increased and spread, so did the hunters who sought them. John Lewis (1975) reported that in 14 spring seasons, Missouri turkey hunters increased 3,900 percent and the turkey harvest soared 6,000 percent--with hunting success averaging 16 percent. Analagous increases occurred in other states. Shortly after West Virginia began spring turkey hunting there were 9,000 hunters. This jumped in one year to 14,000 hunters, and last spring it had increased to about 30,000 hunters. And yet, the wild turkey resource has apparently absorbed such hunting pressure without deleterious effects. It appeared, and still appears, to be a game manager's dream come true.

But early in the game, a small cloud began to appear over the spring turkey ranges--a cloud--that grew in proportion to the new hunters who were flocking to the woods. The shadow appeared to fall mainly on the hard core of turkey hunters who, like other pioneers, began to resent the growing tide of newcomers. This has occurred to some degree in the public hunting ranges of each of our four subspecies of wild turkey. But it appears to be most prevalent in the ranges of the eastern wild turkey, and particularly in parts of the East and Midwest.

The complaints vary in detail and intensity, but are invariably based on the conviction that the growing number of turkey hunters is tarnishing the quality of the sport, especially in spring hunting.

Often, this amounts to actual interference with one hunter by another. A caller may actually be working a gobbler and have the bird coming in when another hunter attempts to intercept the turkey, either by moving in and calling nearby, or by physically trying to head off the bird. An eastern turkey hunter told me recently of being in the woods well before daylight, waiting to work some birds that were roosted not far away. As he waited for shooting time, another hunter sneaked in and shot a turkey off the roost. Later in the morning, when the hunter had cooled off enough to begin working a gobbler, another hunter intercepted that bird and shot it.

Last spring a turkey hunter told me of sitting on a remote ridge and having an interesting flirtation with a gobbler until a four-wheel drive vehicle came slowly through the woods down the ridge, dropping off turkey hunters as it went.

My good friend, A. B. "Bud" Jackson (personal communication), an experienced turkey hunter, hunted each morning of the 13-day Missouri turkey season last spring. He told me that he was actively interfered with on six of those 13 mornings while working gobblers. He says that he has seen a noticeable deterioration of turkey hunting quality in Missouri during the past four or five years--a period in which spring turkey hunters have nearly trebled from about 10,000 hunters in 1970 to over 26,000 hunters (Lewis 1975).

Roger Latham (personal communication) tells me that he is often discouraged about the quality of modern turkey hunting in Pennsylvania. Twenty years ago, Roger says that he could consistently call up birds throughout the entire fall season, and one year he called in 17 gobblers that he could have shot. In recent years, the possibility of this "had grown almost nil." During the first few days of the season, a good caller will almost certainly call up more hunters than turkeys, sometimes with fatal results. And later in the season, when the hunters have thinned out, the birds are often so call-shy that they do not respond.

An eastern turkey biologist told me recently, "The same thing is ruining our turkey hunting that has ruined our deer hunting--crowds of hunters wandering around through the woods, indifferent to techniques and traditions."

On the other hand, expert hunters in Missouri, Pennsylvania, West Virginia, and other major turkey states have told me that they enjoyed wonderful hunts last spring and fall, with plenty of action and a minimum of human interference. They are men who know turkey hunting well, and cannot be doubted.

Is the problem, then, more imaginary than real? Is it just the usual grumbling of a few crusty old-timers who are reluctant to share their woods with anyone? And if there is a real problem, what is its magnitude?

Donahoe and McKibben (1973) have reported that after the first modern Ohio turkey season in 1966, one responding hunter of 299 said: "There are too many other hunters in the area for good hunting." In 1967 this complaint had increased to 18 hunters, or one hunter in 32. In 1968, one hunter in 39

complained that there were too many hunters in the field for good hunting, and in 1969 one hunter in thirty made this complaint.

In West Virginia there is a 10,125-hectare (ha) hunting range that is virtually enclosed by a road system which lends itself well to interview stations (Thomas et al. 1973). Much of the region is wooded, with hunting for squirrels, turkey, and deer. During four fall hunting seasons, the hunters frequenting this area were interviewed. About one-third of them proved to be "home-range" hunters who had hunted the area more than once; the remainder were hunters who were there for the first time. The "home-range" hunters, by the way, took 41 percent more turkeys than did the new-comers. Of the"home-range" hunters who said that they did not plan to return to the area for more hunting, 6 percent gave "too many hunters" as the reason. Of the one-visit hunters who did not plan to return, none gave that as a reason.

In each of these studies--one in Ohio and the other in West Virginia--it appears that about 3 percent of a contacted hunter sample expressed discontent with "too many hunters in the woods."

Does this indicate, then, that the shadow of declining hunting quality is falling on only three turkey hunters out of every hundred? And if this is so, is the problem so minor that it warrants little serious consideration? I believe that a significant problem now exists, and that it will grow more serious. The problem of deteriorating turkey hunting quality falls on every hunter, even though only 3 percent of those hunters may be sensitive enough to feel its shadow.

But is it reasonable for the tail to wag the dog? In making any management decisions on this, is it reasonable for 3 percent of the turkey hunters to influence the hunting of the other 97 percent? It is not only reasonable, but essential. The arbiters of the quality hunting tradition have always been in great minority--and although they may sometimes be accused of conceit and even arrogance, their standards have upheld the sporting tradition. Without that fussy minority there might be no conservation, and the art of hunting might be degraded to a simple act of butchery.

If the art of hunting is to be preserved, there must be arbiters of hunting quality--keepers of the flame, if you will. In turkey hunting, these have traditionally been the old-timers who transmitted wisdom, tradition, and cedar box calls to the next generation. But even if there were enough of them to go around, it wouldn't be enough. The game management agency must be in there too.

It's a responsibility that not all game agencies happily accept. They point out, and rightfully so, that they have their hands full just trying to understand the resource and maintain it at optimum levels. The staff doesn't include sociologists or psychologists; they are concerned with basic wildlife populations and habitats, and equitable hunting opportunity, and are likely to feel that the perpetuation of hunting quality and ethical tradition is the basic responsibility of the hunters themselves.

But like it or not, the maintenance of hunting quality has become an essential aspect of game management. Quantitative game management is no longer enough--it must be qualitative as well. The harvest of a turkey

population must be promulgated on biological balance, of course, but that harvest must also be commensurate with a quality hunting tradition.

We are besieged by anti-hunters who accuse the game manager of being a butcher boy concerned solely with meat supplies. In their view, we are "biostutes" --that is, biologists who have sold their virtue to the bloody hunters and munitions makers. One way to de-fang such critics is to not only maintain viable wildlife populations, but do all we can to maintain a high level of ethics and traditions in the course of enjoying that wildlife. The hunter has two solid defenses against his enemies: the support of professional game management, and the maintenance of an ethical hunting tradition. Lacking either of these, the noble sport of hunting can never endure.

And just what comprises quality turkey hunting, anyway? Simply a fair chance to kill a trophy bird? Maybe. Or it may be a chance to hunt the bird as a free and solitary agent, employing traditional skills in traditional ways. Ortega y Gasset has said: "Man does not hunt in order to kill--he kills in order to have hunted." If there's an exception to this, it is with the wild turkey. A genuine turkey hunter needn't kill a wild turkey to have hunted it. Indeed, some of the most vivid accounts of turkey hunts aren't of how a particular gobbler was killed, but how that gobbler was not killed. In turkey hunting, quality is not necessarily reflected in success.

On the other hand, good turkey hunting success may occur in conditions that are not conducive to the best quality of hunting. Good hunting success has been reported for Missouri turkey ranges where hunter densities exceeded what some critics believe to be the maximum for quality hunting. The majority of hunters in such ranges undoubtedly feel that their hunts are quite enjoyable--but they are hunting under the growing shadow and the game manager must be aware of it.

As the capacity to provide quality turkey hunting declines with the rising number of hunters, an obvious solution is to limit the number of hunters without curtailing the basic turkey management program. This puts the game agency between a rock and a hard place. It means telling the public that although there may be an underharvested turkey population, it is necessary to limit hunting in order to maintain quality. In Missouri, for example, it may be possible to field up to 50,000 turkey hunters and sustain a 10 percent hunting success rate without jeopardizing the resource. Denying 30,000 of those hunters a chance to hunt turkeys, in an effort to improve the quality of hunting for perhaps 20,000 hunters, could put the game agency in a sensitive position.

Then perhaps an agency could offer "come one, come all" hunting in the majority of its public forest lands and reserve other public turkey ranges for highly limited "quality" hunting. There are precedents for such action in big game management and it might be applicable on some turkey range as well-although there are some obvious pitfalls.

Several states now limit the number of their hunters. This is most commonly practiced in "new" turkey states with limited range and recently established flocks. Iowa's 1974 spring hunting, the first in modern history, was limited to 450 permits. Next spring this will be increased to 825. Illinois issues 1,200 spring hunting permits. An Ohio report (Donahoe and

McKibben 1973) has noted: "It should be realized . . . that everyone who wishes to hunt turkeys in Ohio may not do so every year if quality hunting is to be maintained." That statement was made on the basis of an annual issue of 1,000 permits.

There may be another gain here, for such limiting of turkey permits can be planned to equitably distribute hunting pressure. In free-for-all situations, reports of outstanding hunting success in certain areas may cause a concentration of hunters in those areas, either on a very local or regional basis, with subsequent decrease in quality and the result that some marginal areas are virtually overlooked. This is unfortunate, for those marginal areas may be a significant component of the turkey hunting range, particularly for spring hunting, which Bailey (1973) believes to be the type of hunting most feasible in marginal turkey range and at low population levels.

Paralleling such management methods are the information-education programs that attempt to promote the concepts and practices of quality hunting. Roger Latham, for one, is dubious about the effectiveness of current I & E programs in teaching a major segment of the public to cherish and preserve ethical hunting traditions. He fears that the traditional turkey hunter is lost in the crowd, and is likely to remain so. After nearly 25 years in the conservation I & E business, I'm inclined to agree. I do feel that an information-education effort could make great contributions to quality hunting. However, it requires a level of funding and support that the average I & E section will probably never receive. But although I & E efforts may always fall short of the ideal, they must be made. If nothing else, there is reason to believe that efforts promoting quality turkey hunting may gain the attention of our secondary audience, and serve to show the non-hunting public and even some anti-hunters that the conservation agency doesn't run a meat market.

Gerald Wunz (personal communications) tells me that the older hunting leases range from 49 cents to $1.23 per ha, with new leases bringing as much as $2.47 per ha or more. Such hunting leases are often several thousand ha in extent and may range up to 2,025 ha. They are customarily managed for deer and turkey, with carefully planned food plots and clearings, and managed woodlands. A 1,215-ha hunting lease in Alabama that lets for 49 cents per ha may be enjoyed by a dozen club members at an individual lease fee of $50 per year.

At the mention of such an arrangement, of course, the typical one-gallus hunter is heard to wail: "But I can't afford private hunting like that! How about the little man?" (Translation: "All I can afford is a $2 hunting license because I'm supporting a station wagon and a camper, and my summer cottage needs color TV.")

I am told that leased turkey hunting may be O.K. for the Southeast, but that it is not practical nor possible in other parts of the eastern turkey's range--particularly in regions where the primary turkey range is on national forest or other public lands. But there are likely to be extensive private lands in the main turkey ranges of every state where purist turkey hunters are fed up with crowds of novices, and privacy is a commodity that can be bought.

One thing is certain: anyone wanting quality hunting of any kind from now on must be prepared to pay more in terms of some kind of coin: in terms of money, time, effort, or all three. This is something that the dedicated

veteran turkey hunter seeking classic turkey hunting must recognize. There are limits to what he should expect for a $5 turkey permit.

Still, this fact of life does not relieve the game management agency of the responsibility of creating and maintaining quality turkey hunting as far as it is able. Potter et al. (1973) have noted: "The growth of hunting, coupled with relatively little potential for change in the amount of game land available, indicates that the numbers of hunters will have to be managed carefully--perhaps limited to maintain opportunities for quality hunting of whatever kind." The capacity to provide hunters with the satisfactions they seek may decline before either the amount of game or sheer physical space becomes a limiting factor. Thus, in the future, people will become an increasingly important element of game management (Potter et al. 1973).

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