Click here to go to the table of contents

WILD TURKEY MANAGEMENT

CURRENT PROBLEMS AND PROGRAMS

EDITED BY

GLEN C. SANDERSON AND HELEN C. SCHULTZ

ILLINOIS NATURAL HISTORY SURVEY, URBANA

THE MISSOURI CHAPTER OF THE WILDLIFE SOCIETY

AND

UNIVERSITY OF MISSOURI PRESS • COLUMBIA, MISSOURI

University of Missouri Press, Columbia, Missouri 65201
ISBN 0-8262-0133-4
Library of Congress Catalog Number 72-87838
Printed and bound in the United States of America

Photographs by California Department of Fish and Game for Figure 14;
Lovett E. Williams, Jr. for Figures 18-23 and 47;
Hilburn O. Hillestad for Figure 28; J. Eddie Harrison for Figure 29.

"The experience of managing land for wildlife crops
has the same value as any other form of farming;
it is a reminder of the man-earth relation."

-Page 184. Aldo Leopold, *A Sand County Almanac*

PUBLISHERS' FOREWORD

The publication of *Wild Turkey Management* is a cooperative effort in the truest sense. In addition to the contribution of time and talent by each of the contributors, and by the editors, material financial support of publication was forthcoming from the following agencies and organizations: Missouri Department of Conservation; Bureau of Sport Fisheries and Wildlife; U.S. Department of Agriculture, Forest Service; Missouri Cooperative Wildlife Research Unit; and the Wildlife Management Institute. Other funds were made available by the University of Missouri through the channels of the Press.

A special word of acknowledgment must be directed to Glen C. Sanderson and Helen C. Schultz, of the Illinois Natural History Survey. Their thoughtful organization of the materials for this volume and their skilled editing of the manuscript prior to its receipt by the publishers showed a care and professionalism of the highest order, and enabled publication to move forward efficiently and with minimum delay.

To the contributors, to the organizations that supported publication, and to the editors, we express our appreciation, In the fact of its publication, *Wild Turkey Management* manifests in a special way the cooperative spirit that has long characterized the conservation and wildlife movement in this country.

THE MISSOURI CHAPTER OF THE WILDLIFE SOCIETY

UNIVERSITY OF MISSOURI PRESS

FOREWORD

The reintroduction of the wild turkey into ranges from which it had been extirpated, and its establishment in seven western states that are beyond the ancestral range of the wild turkey rank among the outstanding successes of wildlife research and management in the United States. The annual harvest of the wild turkey has increased almost threefold within the past 20 years, and it is now suggested that huntable populations may be established in every one of the United States except Alaska.

These achievements with management of wild turkeys in their native ranges, reintroducing them into previously occupied ranges, and extending their range into previously unoccupied areas did not occur until emphasis was removed from the use of game-farm hybrid stocks in projects of restoration or establishment and placed on the use of wild-trapped stock and habitat improvement.

In spite of these accomplishments there are many unanswered questions and unsolved problems confronting researchers and managers. The First National Wild Turkey Management Symposium, sponsored by the Forest Game Committee of the Southeastern Section of The Wildlife Society, was held in Memphis, Tennessee, February 12-13, 1959. Ten years later, a number of researchers and managers working with the wild turkey believed that the time had come to hold another symposium, and the Forest Game Committee of the Southeastern Section began to make plans to sponsor the second symposium. Because the wild turkey is now widely distributed throughout the United States and is an important game species in many states outside the Southeastern Section, several biologists, managers, and administrators felt that it would be appropriate for the second *national* symposium to be held in another section of the United States.

Accordingly, the North Central Section and the Missouri Chapter of The Wildlife Society asked the parent Society and the Southeastern Section for permission to sponsor the Second National Wild Turkey Symposium. Both the Society and the Section readily agreed to honor the request. The North Central Section appointed a national program committee to arrange for the program of the Symposium. The Missouri Chapter, in cooperation with the Missouri Department of Conservation and the Missouri Cooperative Wildlife Research Unit, University of Missouri, handled all local arrangements. The Symposium was held at the Ramada Inn, Columbia, Missouri, on February 10-12, 1970.

The editors of this book were not chosen until after the program was established. Thus, there was no opportunity to provide editorial guidelines for the participants prior to the meeting. Some reports did not meet standards for publication, others were withdrawn because the authors did not have time to revise them, and one participant had made arrangements to have his report published elsewhere. For these reasons, not all reports presented at the Symposium are included in the book; however, all participants are listed in the appendix.

Richard M. Sheets and Lloyd LeMere, technical illustrators for the Illinois Natural History Survey, redrew several of the figures, and Wilmer Zehr, photographer for the Illinois Natural History Survey, made copies of original drawings for some of the figures.

G.C.S.
H.C.S.

CONTENTS

I. **Restorations and Introductions of the Wild Turkey,** 1

Lyle E. Peterson and Arthur H. Richardson
1. Merriam's Wild Turkey in the Black Hills in South Dakota, *3*

Stephen W. Capel
2. Introduction of Rio Grande Turkeys into Kansas, *11*

Dan F. Dickneite
3. Restoration of the Eastern Wild Turkey in Missouri, *19*

Robert W. Donohoe and Charley E. McKibben
4. Status of the Wild Turkey in Ohio, 25

Dennis D. Wigal
5. Status of the Introduced Rio Grande Turkey in Northeastern Iowa, *35*

Robert E. Dreis, Clarence F. Smith, and Lewis E. Myers
6. Wisconsin's Wild Turkey Restoration Experiment, *45*

F. J. Ignatoski
7. Status of Wild Turkeys in Michigan, *49*

Harold T. Harper and Walton A. Smith
8. California's Turkey Stocking Program, *55*

Gerald D. Wise
9. Restoration of the Wild Turkey in Indiana, *65*

Henry S. Mosby
10. The Changed Status of the Wild Turkey over the Past Three Decades, *71*

II. **Movements, Nesting Ecology, and Brood Studies,** ***77***

Lovett E. Williams, Jr., David H. Austin,
Tommie E. Peoples, and Robert W. Phillips
11. Observations on Movement, Behavior, and Development of Turkey Broods, *79*

James J. Hurt, Ross A. Lock, and Karl Menzel
12. Movement of Merriam's Turkey in the Pine Ridge of Nebraska, *101*

Hilburn 0. Hillestad
13. Movements, Behavior, and Nesting Ecology of the Wild Turkey in Eastern Alabama, *109*

Larry H. Barwick and Dan W. Speake
14. Seasonal Movements and Activities of Wild Turkey Gobblers in Alabama, *125*

James R. Davis
15. Movements of Wild Turkeys in Southwestern Alabama, *135*

III. **FOOD HABITS, DISEASE, AND PREDATION,** *141*

Leroy J. Korschgen
16. April Foods of Wild Turkeys in Missouri, *143*

Virgil E. Scott and Erwin L. Boeker
17. Seasonal Food Habits of Merriam's Turkeys on the Fort Apache Indian Reservation, *151*

Annie K. Prestwood, Forest E. Kellogg, and Gary L. Doster
18. Parasitism and Disease Among Southeastern Wild Turkeys, *159*

Daniel O. Trainer
19. Some Diseases of Wild Turkeys from Texas and Wisconsin, *169*

James Earl Kennamer and William H. Lunceford, Jr.
20. Armadillos Tested as Potential Egg Predators of Wild Turkeys in the Mississippi Delta, *175*

IV. **TECHNIQUES OF TURKEY MANAGEMENT,** *179*

R. Wayne Bailey
21. Restoring Wild-Trapped Turkeys to Nonprimary Range in West Virginia, *181*

Karl Menzel and James J. Hurt
22. Releases of Merriam's Turkeys in Nontypical Habitat, *187*

Gene Rush
23. The Hen-Brood Release as a Restoration Technique, *193*

Gerald A. Wunz
24. Evaluation of Game-Farm and Wild-Trapped Turkeys in Pennsylvania, 199

Ben C. Crockett
25. Quantitative Evaluation of Winter Roost Sites of the Rio Grande Turkey in North-Central Oklahoma, *211*

Lovett E. Williams, Jr., David H. Austin, Tommie E. Peoples, and Robert W. Phillips
26. Capturing Turkeys with Oral Drugs, *219*

James S. Lindzey and David D. Wanless
27. Problems in Wild Turkey Management and Research, 229

V. HABITAT MANAGEMENT, 233

George P. Dellinger
28. Habitat Management for Turkeys in the Oak-Hickory Forests of Missouri, *235*

H. L. Holbrook
29. Management of Wild Turkey Habitat in Southern Forest Types, *245*

Horace G. Gore
30. Land-Use Practices and Rio Grande Turkeys in Texas, *253*

Donald M. Hoffman
31. Some Effects of Weather and Timber Management on Merriam's Turkeys in Colorado, *263*

Jack Ward Thomas, James C. Pack, John D. Gill, and R. Wayne Bailey
32. Even-Age Management, Turkeys, and Turkey Hunters-A New Study, *273*

VI. CENSUS TECHNIQUES AND HARVEST MANAGEMENT, *277*

Robert L. Cook
33. A Census Technique for the Rio Grande Turkey, *279*

Harley G. Shaw
34. The Roadside Survey for Merriam's Turkeys in Arizona, *285*

John B. Lewis and Gene Kelly
35. Mortality Associated with the Spring Hunting of Gobblers, *295*

Jack Ward Thomas, Rodney G. Marburger, and Calvin* Van *Hoozer
36. Rio Grande Turkey Migrations as Related to Harvest Regulation in Texas, *301*

Vaughn *M. Rundquist*
37. Pen-Reared Wild Turkeys as Shooting-Preserve Game, *309*

Laurence R. Jahn
Summary: Needs and Opportunities for Managing Turkey Populations, *317*

LITERATURE CITED, *325*

APPENDIX: LIST OF CONTRIBUTORS, *345*

INDEX, *351*

I

RESTORATION AND INTRODUCTIONS OF THE WILD TURKEY

Henry S. Mosby

Beginning in the early 1950's, interest in the wild turkey as a sporting species was rekindled in practically every one of the continental states. The prospects of reestablishing, or establishing, our largest upland game bird brightened considerably, largely because of the successful capture of wild, free-ranging birds for programs of restoration and introduction. Perfecting the technique of cannon-netting wild turkeys probably was the major factor in what proved to be phenomenally successful programs of turkey restoration. Other factors that contributed to successful programs in many states included better legal protection, improved forest conditions, and enthusiastic public support of the program. In addition to restoring extirpated populations within the ancestral range, transplanting turkeys across ecological barriers has permitted states that formerly did not include the wild turkey in their faunal lists to do so now.

The first section of the book details some of these restoration activities. The reports indicate that there has been a 2.8-fold increase in the wild turkey population in the continental United States in the last 2 decades. It now seems possible that the wild turkey may be on the game-bird list of every state in the Union, except Alaska. Perhaps one of the most amazing results of the restoration programs has been the demonstrated ability of several of the races of wild turkeys to adapt to ecological conditions far more extreme than was formerly thought feasible for these birds. Eastern and Merriam's turkeys have done quite well in areas that have extreme snow depths and sub-zero temperatures in winter. The Rio Grande turkey has been successfully introduced throughout the Southwest but does not appear adapted to those areas having more than 30 inches of rainfall. Restoration efforts have placed or replaced the wild turkey on the game-bird list of about a dozen states within the last 15 years, and I fervently hope that the number of states will increase!

This page has been intentionally left blank to preserve the continuity of the original document.

1

MERRIAM'S WILD TURKEY IN THE BLACK HILLS OF SOUTH DAKOTA*

Lyle E. Petersen and Arthur H. Richardson

ABSTRACT

Eight wild-trapped Merriam's turkeys *(Meleagris gallopavo merriami)* were introduced into the Black Hills of South Dakota in March 1948. Two booster plantings of wild-trapped birds, one of 15 in 1950 and one of 6 in 1951, completed the introduction. Reproduction from this basic stock was trapped and transplanted throughout the Black Hills during the 1950's. The Black Hills flock reached its peak of approximately 5,000 to 7,000 birds about 1960. Since 1960 a total of 255 turkeys have been trapped, banded, and released on site. A 30.1 percent band return has been made on males and a 2.0 percent return on females. Analysis of 64 crops showed Kinnikinick *(Arctostaphylos uva-ursi)* seed, ponderosa pine *(Pinus ponderosa)* seed, and bur oak *(Quercus macrocarpa)* acorns to be the most important spring-summer food items taken. Oat *(Avena sativa)* seed, wheat *(Triticum aestivum)* seed, pine seed, and acorns were the most important fall-winter food items. One verified death due to parasites was recorded. Examination of 40 intestinal tracts and two carcasses revealed the presence of 13 species of parasites. A total of 13 turkey nests were reported, all on east-facing slopes. Clutch size for complete nests averaged 12.2. Brood data collected May 15 through September 15 each year indicated an average brood size of 6.5 young per hen for the years 1963 through 1969. The first fall hunting season was held in 1954 and fall hunting seasons have been held each year since 1957. Spring seasons have been held each year since 1962. Success has ranged from 8.3 percent to 29 percent for fall seasons and from 11.7 percent to 19.6 percent for spring seasons.

AREA

The Black Hills are considered to be an isolated extension of the Rocky Mountains and are located on the west-central border of South Dakota. They extend approximately 120 miles in a north-south direction and approximately 50 miles in an east-west direction. Elevations vary from approximately 3,000 feet to 7,242 feet. In general, the uplift is 3,000 to 4,000 feet above the surrounding prairie. Precipitation varies from 18 inches at the lower elevations to 28 inches at the higher elevations. The forest complex is dominated by ponderosa pine, with white spruce *(Picea glauca)* occurring as a codominant in the higher, moister drainages (Froiland 1962). Quaking aspen *(Populus tremuloides)* occurs on old burns throughout the hills as a stage in succession. Bur oak occurs in limited stands in the northern and central Black Hills at lower elevations. Other infrequent mast species are American elm *(Ulmus americana)*, green ash *(Fraxinus pennsylvanica)*, ironwood *(Ostrya virginiana)*, paper birch *(Betula papyrifera)*, and other more numerous shrubby species.

* Financed in part by Federal Aid Projects W-75-R and W-95-R.

HISTORY

Historically, the eastern wild turkey *(M. g. silvestris)* inhabited the Missouri River bottoms and many of its tributaries in southeastern South Dakota (Edminster 1954). Wild turkeys, however, were never known to inhabit the Black Hills. The initial plant of wild turkeys in the Black Hills was made in March 1948, when 8 wild-trapped Merriam's turkeys, received from New Mexico, were released in the northern Black Hills west of Spearfish. Additional plants of wild-trapped birds-one of 15 from Colorado in 1950 and one of 6 from New Mexico in 1951-were made near Custer and Hot Springs, respectively. This basic stock of 29 birds grew to a population of approximately 1,000 turkeys in the Black Hills by 1952.

In an effort to expedite distribution, the Department of Game, Fish and Parks made *leapfrog plants* from wild stock throughout the 1950's. These transplants were made in the Black Hills and in available habitat on prairies in western South Dakota. The Black Hills flock probably reached its peak of an estimated 5,000 to 7,000 birds about 1960.

TRAPPING

Since 1950 a total of 545 turkeys, including transplants, have been trapped and handled. Techniques used for capture during the period of trapping and transplanting consisted of baiting with unthreshed oat straw, and ear and shelled corn *(Zea mays)*. When the birds became accustomed to using the bait, they were captured with cannon projection nets. In 1964, the cannon net was replaced by 60- X 60-foot cotton-mesh drop net. Recently, walk-in traps constructed of electrical conduit frames and mesh wire have been employed; baiting procedures have remained the same. Both of the latter systems appear to be superior from the standpoint of physical damage, since they do not rake the birds, as does the cannon net.

BANDING

Since 1960 a total of 255 turkeys have been banded and released on site in the Black Hills. Table 1 shows the number of turkeys banded, by age-class, and the number of band returns by hunters. Band returns have been made on 30.1 percent of the males and 2.0 percent of the females, and a total band return of 13.7 percent has been made since 1960. One reason for the disproportionately high return of bands for males may be that they are hunted during two seasons each year.

Table 1. Turkeys banded and band returns since 1960 in the Black Hills, South Dakota.

		Band Return	
Age-Class and Sex	Number Banded	Spring	Fall
Adult toms	45	20	0
Juvenile toms	58	7	4
Adult hens	67	0	1
Juvenile hens	80	0	2
Unknown	5	0	1
Total	255	27	8

From band returns, an average longevity of 174 days and an average movement of 4.5 miles was recorded for 27 spring-killed gobblers. An average longevity of 534 days and an average movement of 12.0 miles were recorded for 8 fall-killed turkeys.

A greater movement for spring-killed gobblers would be expected, since banding operations are normally accomplished on traditional winter areas. When the spring season opens, usually during the first week of April, turkeys are on or near their winter areas. During the fall season, however, the birds have not moved to the lower elevations but are well distributed over their range. Band returns from spring hunters would be expected to indicate lower average longevity, since, in spring, the gobblers are hunted sooner after banding, which allows less time for natural mortality to occur than is the case with turkeys hunted in fall.

Since 1950, weight data have been obtained for turkeys trapped for transplanting and banding. Body weights, by age and sex, of 266 of these birds trapped in January and March are shown in Table 2. Comparable weights have been reported by Hoffman (1962) for wild Merriam's turkeys in Colorado.

Table 2. Body weights of Merriam's turkeys trapped since 1950 in the Black Hills, South Dakota.

	January		March	
	Number	Mean (lbs)	Number	Mean (lbs)
Adult males	10	18.5	37	19.2
Adult females	56	10.2	4	11.0
Juvenile males	43	13.0	30	13.2
Juvenile females	57	9.2	29	8.8

FOOD HABITS

The crops of 64 turkeys have been analyzed for food contents since the spring of 1965. Of these, 31 crops were collected during the period April through September and 33 during the period October through March. With the exception of one poult collected in June, data presented are based on subadults and adults of both sexes. Food items taken were measured by volume and rated by percentage of total volume and by percentage of occurrence (Table 3). Food items rating less than .01 percent of the total volume have been omitted.

Kinnikinick seed, ponderosa pine seed, and bur oak acorns, in that order, furnished the greatest amount of plant material during the spring-summer period; grasshoppers were the single most important animal food taken. Oat seed, wheat seed, pine seed, and acorns furnished the greatest volume of plant material during the fall-winter period. Grasshoppers were again the single most important animal matter consumed. Waste grain and grasshoppers in crops collected in fall and winter can be attributed to turkeys frequenting harvested fields, which are more apt to be blown free of snow than are areas highest in natural foods. Pine seed is no doubt the most abundant of the naturally occurring plant foods, since the Black Hills area experiences frequent and heavy seed production as compared with the rest of the ponderosa pine range (G. A. Erickson, personal communication). Observations indicate that turkeys in the Black Hills use waste grain wherever available. However, waste grain may not be essential for the survival of turkeys in the area.

Table 3. Percentage of food items in 31 spring-summer crops and 33 fall-winter crops, 1965 through 1969, in the Black Hills, South Dakota.

Species	Part Utilized	April-September Percent Volume	April-September Percent Frequency	October-March Percent Volume	October-March Percent Frequency
Plant Matter					
Avena sativa	Seed	3.1	22.6	20.0	24.2
Triticum aestivum	Seed	Tr[a]	16.1	16.0	18.2
Pinus ponderosa	Seed	16.3	29.0	12.9	48.5
Quercus macrocarpa	Seed	15.8	12.9	12.2	24.2
Arctostaphylos uva-ursi	Seed	16.7	32.2	9.1	36.4
Gramineae	Leaves	8.6	83.9	5.9	81.8
Anemone patens	Flower heads	8.2	29.0	1.0	3.0
Symphoricarpos spp.	Seed	2.9	19.4	3.3	45.4
Rhus radicans	Seed	3.9	16.1	Tr	3.0
Ostrya virginiana	Seed	0.1	3.2	1.6	6.1
Hordeum vulgare	Seed	2.2	6.4	0.0	0.0
Sporobolus spp.	Seed	1.5	3.2	0.6	9.1
Pinus ponderosa	Seed wings	Tr	16.2	1.5	18.2
Setaria spp.	Seed	0.0	0.0	0.4	15.2
Crataegus chrysocarpa	Fruit	0.1	6.4	0.3	3.0
Physalis spp.	Fruit	0.0	0.0	0.3	3.0
Vitis spp.	Fruit	0.8	3.2	0.0	0.0
Rosa spp.	Fruit	0.5	9.7	0.2	15.2
Symphoricarpos spp.	Leaves	0.3	3.2	0.1	15.2
Zea mays	Seed	2.9	6.4	0.0	0.0
Mahonia repens	Fruit	0.0	0.0	1.4	12.1
Carex filifolia	Leaves, stems	0.2	3.2	0.0	0.0
Sorghum vulgare	Seed	0.2	9.7	Tr	6.1
Allium spp.	Bulb	0.1	3.2	0.0	0.0
Polygonum spp.	Seed	0.0	0.0	Tr	15.2
Aster spp.	Seed	0.0	0.0	0.1	9.1
Agropyron spp.	Seed	0.1	3.2	Tr	3.0
Ambrosia spp.	Seed	0.1	3.2	0.0	0.0
Helianthus spp.	Seed	0.0	0.0	Tr	15.2
Betula papyrifera	Leaves	0.0	0.0	Tr	3.0
Taraxacum spp.	Leaves	0.1	6.4	0.1	3.0
Bromus tectorum	Seed	0.0	0.0	Tr	3.0
Trifolium spp.	Leaves	1.4	6.4	2.7	21.2
Ribes spp.	Fruit	3.5	3.2	Tr	3.0
Juniperus spp.	Leaves	0.0	0.0	2.6	9.1
Poa pratensis	Seed	0.0	0.0	2.3	12.1
Pinus ponderosa	Needles	0.0	9.7	Tr	33.3
Onosmodium occidentale	Seed	0.0	0.0	0.2	12.1
Unidentified Gramineae	Seed	0.0	0.0	0.4	15.2
Unidentified Forbs	Seed	0.0	0.0	0.7	3.0
Animal Matter					
Grasshoppers		6.3	22.6	3.7	66.7
Millepedes		0.7	38.7	Tr	18.2
Crickets		0.0	0.0	Tr	6.1
Beetles		0.2	16.1	0.1	36.4
Spiders		0.0	3.2	0.0	9.1
Snails		0.1	3.2	0.0	0.0
Wasps		0.0	0.0	Tr	15.2
Small bones		Tr	6.4	0.0	0.0
Earthworm		Tr	3.2	0.0	0.0
Unclassified insects		0.1	3.2	0.0	0.0
Unclassified material		2.4	38.7	0.5	51.5
Grit		0.4	45.2	0.4	57.6

[a]Tr = trace, <0.05 percent.

PARASITES

No large-scale die-off of turkeys has been known to occur in South Dakota. Only occasional reports of dead turkeys have been received, and in only one case have parasites been verified as the cause of death. Results of examination of 40 intestinal tracts (M. L. Boddicker, personal communication) for endoparasites and of 2 carcasses for ectoparasites appear in Table 4. With the exception of the verified death due to parasites, which were collected from a turkey carcass found in August, all other parasites were collected from turkeys killed during regular hunting seasons in April, October, and November.

Table 4. Frequency of occurrence of parasites found in intestinal tracts of 40 Merriam's wild turkeys and 2 carcasses, 1965 through 1968, in the Black Hills, South Dakota.

Common Name	Parasite	Birds Examined	Birds Infested
Tapeworm	*Metroliasthes lucida*	40	38
Tapeworm	*Amoebotaenia sphenoides*	40	17
Tapeworm	*Raillietina cesticillus*	40	11
Tapeworm	*Choanotaenia infundibulum* (tentative)	40	1
Fluke	*Echinostoma revolutum*	40	3
Fluke	Unknown species	40	1
Cecal worm	*Heterakis gallinarum*	40	6
Chewing louse	*Chelopistes meleagridis*	2	2
Chewing louse	*Menacanthus stramineus*	2	2
Chewing louse	*Oxylipeurus p. polytrapezius*	2	2
Mite	Unidentified Analgesoidea mite	2	2
Mite	Unidentified Sarcoptiforme mite	2	1

Although many of the samples checked contained large numbers of immature tapeworms, which indicates a potential problem of infestation, volumes were low. Data thus far collected indicate the need for more collections throughout the year before any valid conclusions regarding parasites can be reached.

REPRODUCTION

A total of 13 turkey nests have been reported since 1964; of these, 9 have been observed by Game Department personnel. All nests reported have been on slopes facing east. The degree of slope has varied from approximately 5 percent to 75 percent. All nests have been in relatively sparse timber or cut-over areas and have been placed under fallen trees or logging slash. Of the nests observed, six were considered to be complete. Clutch size ranged from 10 to 17 and averaged 12.2 for the six nests. Edminster (1954) reported that clutch size for wild turkeys varies from 5 to 17 and averages 10 or 11. Human disturbance is known to have caused desertion of at least five nests, and two nests are known to have successfully hatched. For the two successful nests, a total of 18 eggs hatched out of a possible 21.

Turkey brood data are used as a measure of reproductive success and are acquired by Department biologists and wardens and by personnel from the U.S. Forest Service between May 15 and September 15, each year. All personnel are requested to record the hens and the number of young observed during routine field assignments. This method of collecting data was established in

Table 5. Reports of single hens with broods and groups of hens with broods, 1963-1969, in the Black Hills, South Dakota.

	Single Hens with Broods			Hens with Broods			All Hens with Broods
Year	Hens	Young	Mean Number per Brood	Hens	Young	Mean Number per Brood	Mean Number per Brood
1963	11	100	9.1	59	432	7.3	7.6
1964	9	57	6.3	30	244	8.1	7.7
1965	13	94	7.2	71	475	6.7	6.8
1966	20	190	9.5	78	434	5.6	6.4
1967	17	142	8.4	22	140	6.4	7.2
1968	19	139	7.3	99	533	5.4	5.7
1969	15	109	7.3	72	385	5.3	5.7
Average			8.0			6.1	6.5

1963. Since Forest Service and Game Department personnel work throughout the Black Hills, turkey brood reports are widely distributed. Data collected from turkey brood observations from 1963 to 1969 are summarized in Table 5.

Single turkey hens with broods have had a consistently higher number of young per brood than the average number of young per hen in groups consisting of one brood and two or more hens. This difference may be attributed to nonbreeding or to unsuccessful hens or to young gobblers becoming associated with the broods. Young gobblers that have been observed with these groups are suspected to be birds hatched in July and August of the previous year.

HUNTING SEASONS

The first hunting season in the Black Hills was held in the fall of 1954, when 750 resident licenses were issued. Fall hunting seasons have been held each year starting in 1957, and licenses for hunting turkeys in the Black Hills have been unlimited for residents since 1959. An unlimited number of non-

Table 6. Summary of fall turkey seasons, 1954-1968, in the Black Hills, South Dakota.

Year	Season (dates inclusive)	Number of Licenses Authorized	Number of Licenses Sold	Projected Kill	Projected Percent Success
1954	Dec. 4-12	750	750	156	21.0
1957	Oct. 12-24	2,500	2,326	465	20.0
1958	Oct. 15-Nov. 5	2,200	2,144	622	29.0
1959	Oct. 24-Nov. 15	No limit	2,570	437	17.0
1960	Oct. 29-Nov. 20	"	2,214	184	8.3
1961	Oct. 14-Nov. 12	"	2,270	508	22.4
1962	Oct. 13-Nov. 15	"	1,860	309	16.6
1963	Oct. 12-Nov. 15	"	2,079	410	19.7
1964	Oct. 12-Nov. 15	"	2,346	392	16.7
1965	Oct. 16-Nov. 14	"	3,549	689	19.4
1966	Oct. 12-Nov. 30	"	4,308	1,051	24.4
1967	Oct. 14-Nov. 30	"	3,433	388	11.3
1968	Oct. 12-Nov. 30	"	4,647	1,073	23.1
Total			34,496	6,684	19.4

residents have also been allowed to hunt turkeys during the fall seasons since 1962. A report card is issued to hunters as part of the hunting license, but because it is not mandatory for hunters to return their report cards, a 50 percent return is not uncommon. In projecting hunter success, we have arbitrarily considered nonreporting hunters to be 50 percent as successful as reporting hunters. As indicated in Table 6, license sales have ranged from 750 to 4,647, and the projected success has varied from 8.3 percent to 29.0 percent for fall hunting seasons. Success for fall seasons 1966 and 1967 for the adjacent states of Montana and Wyoming have been reported (Capel 1970) as 23 percent and 30 percent, respectively. During the same period, the Black Hills experienced a slightly lower success rate of 18.5 percent.

Spring gobbler hunting in the Black Hills was initiated in 1962, when 750 licenses for residents were authorized and 540 were sold. Since 1967, nonresidents have participated in spring hunting seasons, and licenses for spring hunting seasons have been unlimited for both residents and nonresidents. Dates of spring gobbler seasons, license sales, and hunter success are summarized in Table 7.

The legal kill of turkeys in the Black Hills since 1960, in comparison with the estimated fall population of 7,000 birds, does not appear excessive.

Table 7. Summary of spring gobbler seasons, 1962-1969, in the Black Hills, South Dakota.

Year	Season (dates inclusive)	Number of Licenses Authorized	Number of Licenses Sold	Projected Kill	Projected Percent Success
1962	April 5-25	750	540	63	11.7
1963	April 1-30	1,000	621	102	16.4
1964	April 1-30	1,000	931	113	12.1
1965	April 10-May 9	1,000	965	194	20.1
1966	April 10-May 8	1,000	1,000	196	19.6
1967	April 8-May 7	No limit	1,197	198	16.5
1968	April 6-May 5	No limit	1,480	252	17.0
1969	April 5-May 4	No limit	1,858	253	13.6
Total			8,592	1,371	16.0

This page has been intentionally left blank to preserve the continuity of the original document.

2

INTRODUCTION OF RIO GRANDE TURKEYS INTO KANSAS*

Stephen W. Capel

ABSTRACT

In the late 1950's, a few Rio Grande turkeys *(Meleagris gallopavo intermedia)* emigrated into Kansas from Oklahoma, but early trapping efforts within Kansas were fragmented, and transplants met with failure. In 1966 and 1967, trades with Texas and Oklahoma brought 161 wild-trapped Rio Grande turkeys to Kansas for release at 14 sites. In 1968, Kansas adopted the drop-net trapping technique, which had been 'developed in Oklahoma, and trapped 82 turkeys for transplanting purposes during 1968 and 1969. To date, a total of 22 transplants and 6 supplemental releases have been made throughout Kansas, employing 278 wild-trapped Rio Grande turkeys from Kansas, Oklahoma, and Texas. Winter flock counts during the winter of 1968-69 indicated a minimum of 489 turkeys at 23 release sites. In south-central and southwest Kansas, transplants have usually proven successful, with populations of 90, 76, and 60 birds resulting from releases of 12 birds each at the three most successful sites. The turkeys have fared poorly in both eastern and northern Kansas. Precipitation in excess of 30 inches per year appears to be detrimental to reproduction in eastern Kansas, but no reason can be advanced for the poor success observed in northern Kansas. At four sites, subadults were the only males released. Broods were produced at three of the four sites the first summer. Breeding chronology at these three sites appeared to be the same as the general hatch curve for the state. The future of Rio Grande turkeys in Kansas is bright provided that stream channeling and timber clearing, which destroy the prime habitat along the creeks, do not increase markedly.

The eastern wild turkey *(M. g. silvestris)* was not abundant in Kansas, but a few occurred over the eastern two-thirds of the state along the watercourses (Goss 1891, Taft 1952). It was eliminated from Kansas by 1900 (Taft 1952). For over 50 years there were no turkeys in Kansas nor was there much hope that there would ever be turkeys in Kansas again. Sporadic but unsuccessful efforts were (and still are) made by private individuals to establish the turkey through releases of pen-reared birds.

In the late 1950's, Rio Grande turkeys began to emigrate into Kansas from flocks in northern Oklahoma that had been established as a result of trapping and transplanting operations. The presence of a few small flocks in southern Kansas brought attention to the possibility that turkeys might be reestablished in the state.

In 1959, Kansas Game Protectors made arrangements with the trapping crew of the Oklahoma Department of Wildlife Conservation to help trap part of a large flock (no estimates of its size were made) of turkeys that had moved

***A contribution of the Federal Aid in Wildlife Restoration Act, Kansas Project, W-23-R and W-35-D.**

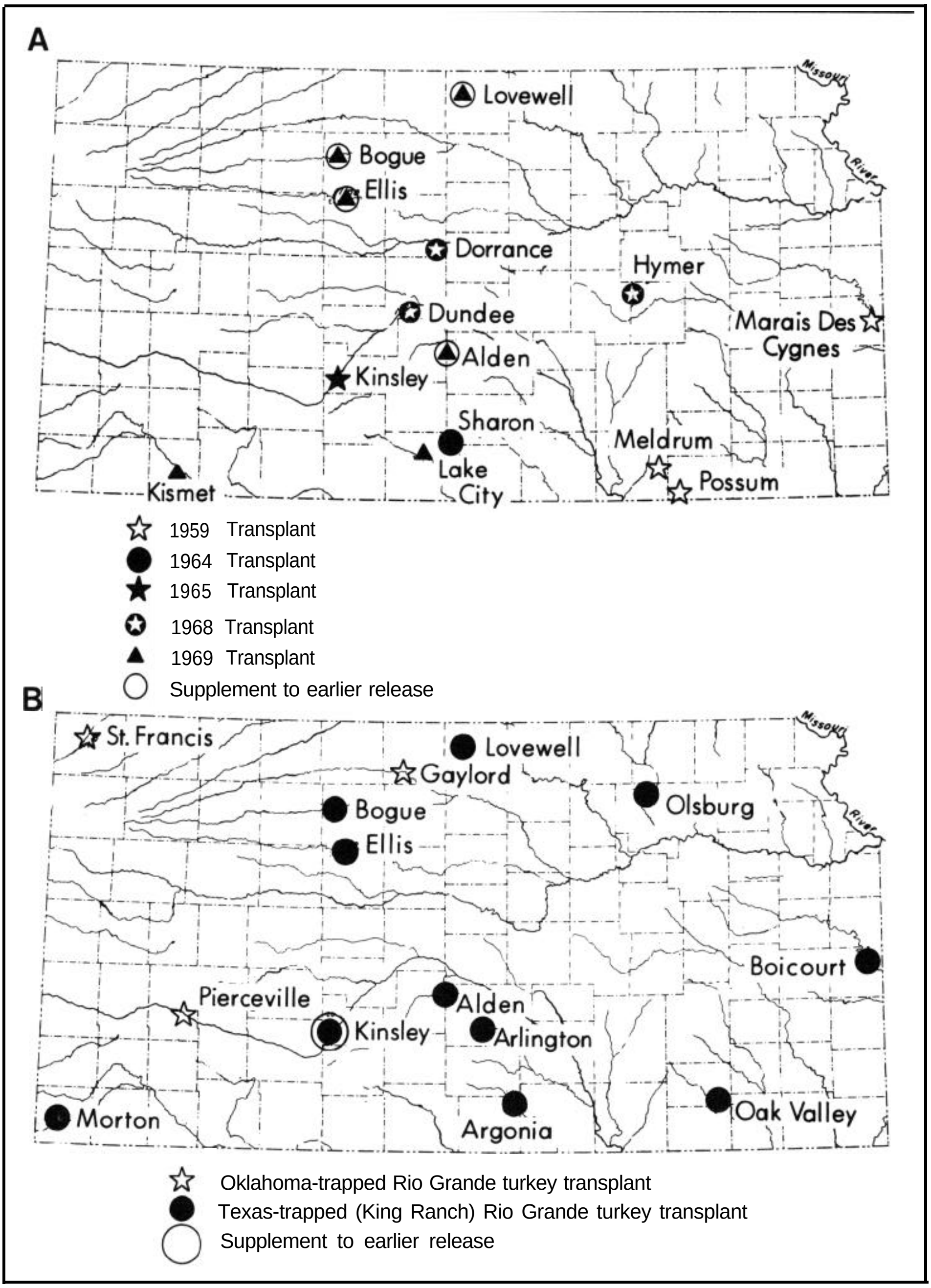


Figure 1. A (top). Locations of Rio Grande turkeys trapped in Kansas and transplanted, 1959-1969. B (bottom). Locations of Rio Grande turkeys livetrapped in Texas and Oklahoma and transplanted in Kansas in 1966 and 1967.

into Kansas from Oklahoma along the Arkansas River. Forty-six turkeys were trapped. Of these, 20 birds were returned to Oklahoma, and 26 were transplanted to three release sites in Kansas (Figure 1A). Accurate records regarding these transplants are lacking, but there is little doubt that they were failures.

A formal effort to study turkeys was initiated in 1962 by the Kansas Forestry, Fish and Game Commission. Initial work included investigations into population inventories, habitat requirements, and inventories of potential range. These investigations prompted the decision to place major emphasis on the Rio Grande turkey for initial stocking efforts. Trades for wild-trapped Rio Grande turkeys were arranged with the Texas Parks and Wildlife Department and with the Oklahoma Department of Wildlife Conservation. In addition, the Commission began its own trapping and transplanting program.

TRAPPING AND TRANSPLANTING

During the first few years of the program, trapping was done with cannon nets. Because of equipment problems, small turkey flocks, and limited efforts, only nine turkeys were caught in two trapping seasons.

Table 8. Status of Rio Grande wild turkey populations during the winter of 1968-69 at 23 release sites in Kansas.

Transplant Site	Year Released	Source of Turkeys	Number of Birds Released: Hens	Number of Birds Released: Toms	Winter Populations 1968-69[a]
Alden	1966	Texas	9	3	
Alden	1969	Kansas	4	2	9
Arlington	1966	Texas	9	3	76
Argonia	1966	Texas	9	3	60
Bogue	1966	Texas	9	3	
Bogue	1969	Kansas	4	6	15
Boicourt	1966	Texas	9	3	0
Dorrance	1968	Kansas	4	2	5
Dundee	1968	Kansas	4	2	4
Elkhart	1966	Texas	9	3	92
Ellis	1966	Texas	9	3	
Ellis	1969	Kansas	4	2	12
Gaylord	1967	Oklahoma	8	4	45
Hymer	1968	Kansas	9	6	6
Kinsley	1965	Kansas	4	3	
Kinsley	1966	Texas	4	1	36
Kismet	1969	Kansas	11	4	15
Lake City	1969	Kansas	8	4	12
Lovewell	1966	Texas	9	3	
Lovewell	1969	Kansas	4	2	14
Mantis des Cygnes	1959	Kansas	8	4	0
Meldrum	1959	Kansas	4	3	0
Oak Valley	1966	Texas	9	3	5
Olsburg	1966	Texas	9	3	21
Pierceville	1967	Oklahoma	8	4	20
Possum	1959	Kansas	4	3	0
St. Francis	1967	Oklahoma	8	4	14
Sharon[b]	1964	Kansas	1	1	28
Total			191	87	489

[a]Winter populations were minimum counts by Commission personnel, with duplications deleted.
[b]Supplement to a small flock that had moved in from Oklahoma in 1963.

The Oklahoma drop-net system, in which mechanical shackles are actuated by electrical squibs (Jacobs 1967), was adopted in 1967. During 1968, Commission personnel caught 67 turkeys; 27 were transplanted to new locations (Table 8), and 40 were released at the trap sites. The second year of operation yielded 74 turkeys; 55 of these birds were transplanted. Most of the releases consisted of 12 birds each, either 8 hens and 4 toms or 9 hens and 3 toms, and were made during January, February, and March. The Commission transplanted 82 Kansas-trapped turkeys to five new release sites and made supplemental releases at four previously stocked sites during 1969 (Figure 1A).

A total of 161 wild-trapped turkeys, obtained from Texas and Oklahoma in 1966 and 1967, were released at 14 sites (Figure 1B, and Table 8). This start, and the success of the trapping method used in 1968 and 1969, made the Commission independent of further trades and brought about the recommendation that the agency rely on birds trapped in Kansas.

SUCCESS OF TRANSPLANTS

By the end of 1969, releases totaling 278 wild-trapped turkeys had been made. The winter flock counts in 1969 indicated populations in these transplant areas of at least 489 turkeys (Table 8). These are minimum counts, based on observations by Commission personnel, with suspected duplications deleted.

Several of the releases have been successful. The 12-bird Elkhart release on the Cimarron River in Morton County, which is in extreme southwestern Kansas, has been the most successful transplant (Figure 1B and Table 8). During January 1969, flocks of 20, 30, and 34 birds and several small flocks were counted along a 30-mile stretch of the Cimarron. Because of excellent brood production during the summer of 1969, the Kismet release, also on the Cimarron River, appears to be successful. The Arlington release on the Ninnescah River resulted in a winter population of 76 turkeys. After an initial setback due to a once-m-a-hundred-years flood that resulted in the late-summer loss of all of the first year's production, the Kinsley release on the Arkansas River seems successful. The Pierceville release on the Arkansas River has become firmly established, in spite of the loss of three of the eight hens immediately after the release. These three hens, as a group, left in a southward direction almost immediately after release and spent several days in the *wheat desert* of southwest Kansas, more than 20 miles from the nearest timber, before reports of their status ceased. The remaining birds at Pierceville have consistently remained within 1 mile of the original release site.

The Argonia release on the Chikaskia River also appears to be successful, despite marked nomadic tendencies in the turkeys during the first few years. No apparent shortcoming in the habitat or other factors explain the initial wanderings. It is too early to determine the outcome of subsequent transplants, but Commission personnel have high hopes for those made during 1969 in south-central Kansas. Releases made on the major rivers and streams of south-central and southwestern Kansas appear to have the best chance for success.

Rio Grande turkeys are not well adapted to eastern Kansas. That part of the state has the same conditions that restrict this subspecies in Texas and Oklahoma (Glazener 1967), where annual rainfall greater than 30 inches appears to be the limiting factor. Sufficient transplants have not been made to determine the exact eastern limits of this subspecies in Kansas, but annual rainfall in excess of 30 inches appears to be the barrier in Kansas also. Two Linn County releases-Marais des Cygnes and at Boicourt-in an area of about 40 inches annual rainfall met with failure, although two broods were produced over a

O-year period at the latter site. Five releases have been made in areas of 30 to 35 inches annual rainfall. These releases, for practical purposes, have been failures. A few adults remain at the Oak Valley site, one of the release areas, but production has been limited. Since the full-grown birds released did show an ability to survive and few broods have been reported, it appears that habitat in areas with more than 30 inches annual rainfall can support adult birds but severely hampers either brood production or brood survival. There is insufficient information regarding the specific cause of poor productivity; however, without adequate production these populations have not been able to maintain themselves.

It appears that northern Kansas is not optimum Rio Grande turkey range either. The limiting factors have gone undetected to date. The Rio Grande turkeys are transplanted along the Kansas-Nebraska line over 300 miles north of their historic range (Aldrich 1967), but extreme winter conditions alone are probably not the direct cause of the turkeys' failure to prosper. During the winter of 1968-69, a flock of 14 turkeys endured record snowfall in excess of 40 inches and temperatures to -20 F. There were still 14 turkeys in the flock the following spring. However, of the six releases in northern Kansas, only the Gaylord release has succeeded without benefit of supplemental releases. Even with supplemental releases, the potential for population growth at the other northern sites is questionable. The Nebraska Game and Parks Commission also has observed its Rio Grande turkey populations stagnate at low population levels (Hurt 1968).

SUBADULT BREEDING

There are several instances of subadult toms breeding successfully in Kansas. Subadult, as used here, means full-grown birds in their first breeding season. During the trapping and transplanting operations, it was not always possible to include an adult tom with each release. Age determination was based on several criteria: length of spur; conformation of tail and greater upper secondary coverts; and shape and wear of primary wing feathers. In three of the four transplants where subadult toms were the only males released, broods were produced the following spring (Table 9). The Commission tried to make all releases in areas where there were no domestic turkeys, and the possibility is remote that any toms, either domestic or pen-reared, were at any of these sites. Also, the birds were trapped too far in advance of the breeding season for the hens to have been bred by adult toms in the original flocks. Lewis and Breitenbach (1966) reported that at least some subadults are physiologically capable of breeding. These circumstances and observations indicate that subadult toms can breed when no adult toms are present.

Three broods were produced at the Hymer and Arlington release sites, and two were produced at Ellis (Table 9). The broods averaged 5.4 poults. From a

Table 9. Observations of Rio Grande turkey broods during the first summer after release in Kansas at sites where the only males present were subadults.

Release Site and Year of Release	Number of Broods	Number of Poults	Number of Birds Released	
			Toms	Hens
Hymer (1968)	3	15	5	8
Ellis (1966)	2	11	3	9
Arlington (1966)	3	17	3	9
Dorrance (1968)	0	0	2	4
Total	8	43	13	30

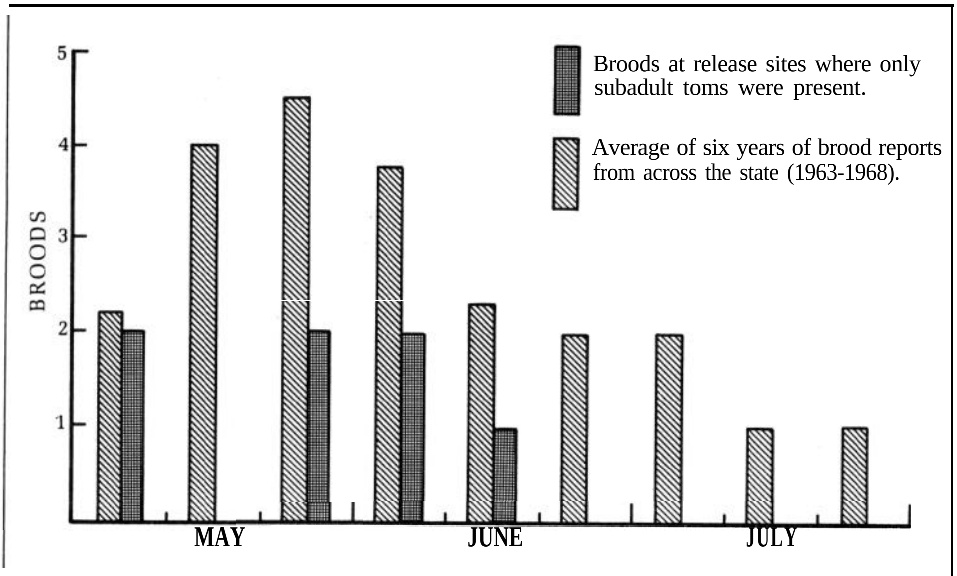


Figure 2. Chronology of hatch at release site where only subadult toms were released as compared with the average chronology of hatch for all reported broods in Kansas, 1963-1968.

comparison of the hatch curve at these release sites, where subadult toms were the only males present, with the statewide hatch curve (averaged for the years 1963 to 1968), it appears that the breeding chronology is not basically different (Figure 2).

FUTURE POTENTIAL

There is little doubt that Rio Grande turkeys can survive in Kansas. The full extent of their potential range is unknown, but it appears that they will be able to occupy suitable habitat in the western two-thirds of Kansas, principally in areas of less than 30 inches annual rainfall. They probably will be progressively less successful the farther north in the state they are stocked. The prime range in Kansas is in the three tiers of southern counties westward from Sumner, Sedgwick, and Harvey counties.

Since southwestern Kansas is the best turkey range, the Commission plans to concentrate transplanting efforts there for the next few years. The planned transplanting program should create a turkey population density sufficient to support a limited turkey season by 1975.

A large number of land-use practices could adversely alter the turkey habitat over large areas within Kansas. Turkeys are associated with the river bottoms, and the US. Army, Corps of Engineers, has several proposals for permanently flooding limited areas within the potential turkey range in Kansas. A much more severe threat is in the Corps's proposed channeling of several rivers within established turkey range in Kansas. The biggest undertaking would be a project on the Arkansas River from John Martin Dam in Colorado to Great Bend, Kansas. This project would affect more than 250 miles of prime turkey range in southwestern Kansas, and the extensive timber removal associated with channeling would eliminate some of the highest quality and most extensive turkey habitat in the state.

Other land-use practices detrimental to turkey habitat are already in operation. In spite of various federal land-retirement programs, timber clearing along the river bottoms is becoming an increasingly popular method of gaining more farmland. With the advent of more sophisticated irrigation equipment and increased tax valuation of river bottomland, even more sections of potential and occupied habitat will be lost by this practice.

Another practice that has taken its toll of post-blackjack oak *(Quercus stellata* and *Q. marilandica)* habitat is the misuse of B-3 under the Agricultural Conservation Program of the Agriculture Stabilization and Conservation Service. B-3 was originally approved as an herbicide spray program to reclaim brushy pastureland. It has been used increasingly to remove climax timber stands to promote grass growth. When B-3 is used in this manner, watershed damage is great, and there is a serious loss of turkey habitat. Until now, only marginal Rio Grande turkey habitat has been destroyed; however, the potential habitat for eastern wild turkeys, which the Kansas Forestry, Fish and Game Commission has considered introducing, is threatened. One of the few areas that would probably support eastern turkeys is the post-blackjack oak range, now being sprayed with B-3. Extensive spraying has reduced the potential for turkeys and perhaps even eliminated it.

The outlook for turkeys in Kansas appears favorable unless these land-use practices are widely adopted. If they are not, the state probably can look forward to a turkey season in the 1970's, and eventually may be able to support a population of 5,000 turkeys.

This page has been intentionally left blank to preserve the continuity of the original document.

3

RESTORATION OF THE EASTERN WILD TURKEY IN MISSOURI

Dan F. Dichneite

ABSTRACT

Missouri's pre-Columbian wild turkey *(Meleagris gallopavo silvestris)* population is estimated to have been 250,000 to 400,000 birds. Settlement in the late 1800's reduced virgin forests by 50 percent and eliminated the turkey from more than 83 percent of its original range. Early restoration work was oriented toward use of game-farm birds. Fifteen thousand were released from 1925 to 1944, but the effort proved to be a costly failure. Since 1954, only native wild turkeys have been used, with great emphasis placed on local landowners' protection of birds released. A total of 1,421 turkeys have been released on 73 areas in 58 Missouri counties from 1954 to 1970. The restoration program has been successful in establishing huntable populations of wild turkeys throughout most of the state. During spring gobbler seasons from 1960 to 1970, licensed hunters have taken 7,236 gobblers.

HISTORIC RANGE AND NUMBERS

Missouri's pre-Columbian wild turkey population is estimated to have been from 250,000 to 400,000 birds distributed throughout the state, except for the prairies of western and northwestern Missouri (Schorger 1966: 61). Carrying capacity is estimated at 5 to 8 birds per square mile throughout the 50,000 square miles of forest habitat.

Flocks numbering in the hundreds were common early in the 19th century. In the winter of 1810-11, Audubon reported turkeys near Cape Girardeau in southeast Missouri and wrote about "what would be said to [be] a gang of Wild Turkeys-several hundred trotting along a sand-bar of the Upper Mississippi" (Schorger 1966: 53). Early settlers found turkeys in seemingly endless supply and slaughtered hundreds of them by the most efficient methods, without regard for the resource.

DECLINE

Missouri's presettlement forests were mature oak *(Quercus* spp.), hickory *(Carya* spp.), and shortleaf pine *(Pinus echinata)* suitable for saw logs, mine timbers, and other large products. Forests played an important role in the state's early development. They provided wood products vital to agricultural and industrial progress and were used in large quantities, without much thought to the future (Gist et al. 1950). A rapid decline in the forest resource followed exploitation and was further accelerated by clearing of woods for farms. Virgin forests totaling 31 million acres were reduced by 50 percent (Ring et al. 1949). This extensive deforestation, along with uncontrolled burning and free-range grazing, seriously reduced turkey habitat (Lewis 1967). By the mid-to-late

1800's, the range occupied by turkeys had dwindled to portions of northeastern and southern Missouri. The range was further reduced to the Ozark region and southeastern lowlands by 1910. Turkeys were found in only 45 of Missouri's 114 counties in 1935, with sparse populations in most of these (Bennitt and Nagel 1937). A 1942 inventory showed fewer than 4,000 birds in 31 Ozark counties (Leopold and Dalke 1943). Distribution and population reached their lowest points in 1952, when fewer than 2,500 turkeys were present in the most inaccessible parts of 14 Ozark counties (Lewis 1967). The turkey was eliminated from more than 83 percent of its original range in less than 100 years (Dalke et al. 1946).

EARLY RESTORATION EFFORTS

Quality of birds liberated was not considered during early restoration. Turkeys were bought and produced for release on refuges then in existence. Some birds were put out in pens, fed, protected day and night, and released when they reached a certain age-usually 10 to 12 weeks. The Missouri Game and Fish Department Annual Report in 1928 stated: "A new method of propagating turkeys was inaugurated by the Department last spring when it was decided to purchase domesticated hens from farmers whose flocks may have become mixed with wild turkeys. They were released on refuges with the native wild gobblers already on the properties." Birds were purchased from B. K. Leach, owner of the Lost Trail Game Farm near Lesterville in Reynolds County, from 1937 to 1944. Mr. Leach had developed a *wild* pen method of breeding and achieved a relatively wild turkey on his game farm. These birds resulted from breeding domestic Woodmont hens and their descendants with native gobblers. Succeeding generations took on additional characteristics of the native wild turkey. Lost Trail turkeys had passed through 10 generations of backcrosses by 1942, and it was estimated that such crosses had resulted in a semi-domestic bird with 98 percent wild characteristics (Clark 1947).

From 1925 to 1944, 14,821 turkeys were released on several areas of southern Missouri. These plantings of game-farm birds were a costly failure. Total cost for the birds probably exceeded $100,000, and it was evident by 1944 that game-farm turkeys were not the answer to Missouri's problems (Leopold 1943).

Native birds, on the other hand, were responding to the added protection afforded by refuges. A personnel shortage created by World War II delayed initiation of an effective restoration effort until 1954. While this program was developing, one last test of game-farm birds was made. In 1954-55, 237 game-farm turkeys of supposedly high quality were released on two isolated areas in northern Missouri, but these releases were soon classed as failures.

In summary, the release of more than 15,000 pen-reared turkeys during a 30-year period, at a cost exceeding $100,000, added virtually nothing to the statewide population. Furthermore, hybridization with native stock may have weakened some of the wild turkeys ranging near release sites. The one possible benefit was that pen-reared birds may have served as a buffer between wild birds and predators, including man. Vulnerability of hybrid turkeys was indicated by the fact that, even though more than 14,000 turkeys had been liberated from 1925 to 1942, only 4,300 turkeys were present in the state according to the 1942 survey. At least two-thirds of these birds were on range where no liberations had been made and were outside the sphere of influence of any such liberations (Leopold 1943).

CURRENT RESTORATION EFFORTS

Emphasis switched from semi-domestic birds to native wild birds in 1945. The new program had a slow start, because the only source was birds caught in deer *(Odocoileus virginianus)* traps during deer restoration, The major effort began in 1957, after intensive management on five Ozark refuges (Figure 3) had resulted in an annual production of surplus birds that could be removed for restocking. Desirable changes in land use and in public attitude also occurred; equally important was adaptation of the cannon-net trap to permit efficient turkey trapping (Lewis 1967).

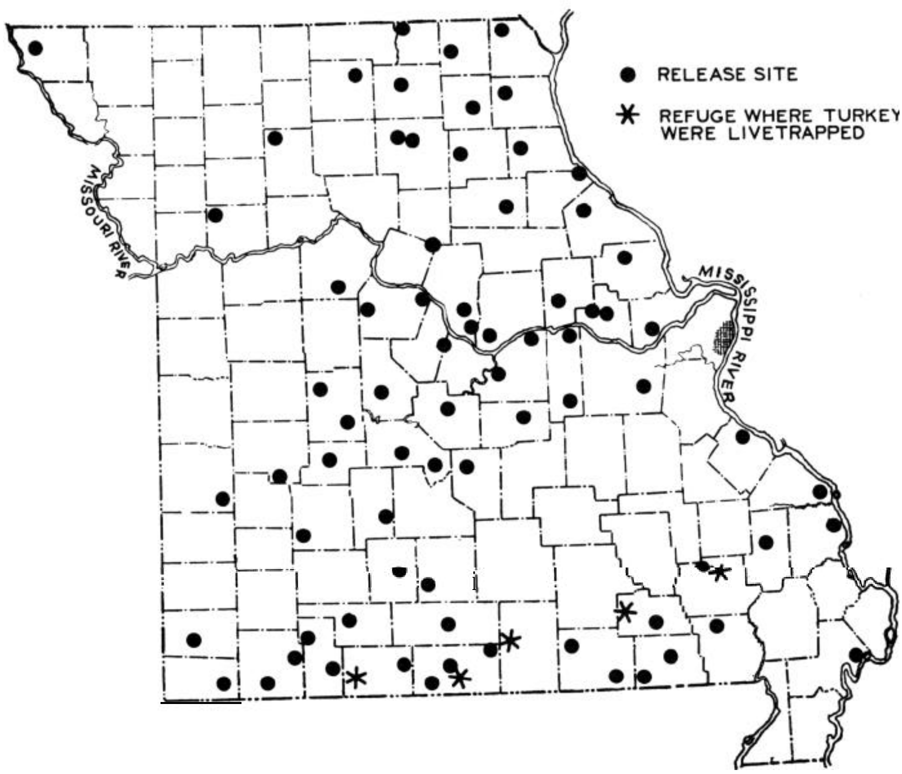


Figure 3. Refuges at which turkeys were livetrapped and release sites in Missouri, 1954-1970.

In the trapping and transplanting program, several steps precede actual release of birds. A request from local residents is the first step. The prospective restocking site is then thoroughly investigated by a biologist in company with the local conservation agent and interested citizens. The investigation includes examination of aerial photos and ground surveys to determine the amount, size, and type of timber available, the amount and distribution of open areas, the presence of a permanent water supply, attitude of local landowners, and the presence of chronic burning and/or overgrazing. Generally, 15,000 acres of suitable, if not optimum, range is the smallest release site considered.

If habitat conditions appear satisfactory, the release is given tentative approval, and restocking petition forms are sent to the local conservation agent and to cooperators for circulation among landowners in the area. The petition serves an essential purpose in several respects. It not only makes landowners aware of the program but also makes them parties to the release by eliciting their support. In addition, it provides a list of potential contacts for an annual poult survey. If most of the people living inside the release area agree, by signing the petition to protect the birds, a release is given final approval. The favorable attitude of people living in a prospective release area has been the real key to successful restocking efforts, not only with wild turkeys but also with the earlier deer and beaver *(Castor canadensis)* restocking programs as well.

Surveys of prospective release areas and circulation of petitions are handled during the spring and summer. A public meeting is held after the completed petitions have been received and prior to actual release of the birds during winter. At this meeting, local residents are given particulars on the release of turkeys in their area and, through a slide series, are shown the general habitat requirements, life history, and methods of trapping and transporting wild turkeys. Protection of the released *brood stock* is emphasized. Local Department of Conservation personnel are invited to attend by the conservation agent who arranges the meeting, and they often participate in the program.

TRAPPING

Turkey trapping begins in October and usually extends through March, because cool weather during this period minimizes loss of birds in transit. Also, depletion of natural foods in winter increases responsiveness of the birds to bait (whole kernel and cracked corn). Trapping activity begins with the baiting of trap sites in areas commonly used by the birds. The cannon-net trap is set as soon as birds are using the bait routinely. A 30- X 50-foot net of 2-inch mesh is used with three cannons. The record number of turkeys taken in a single net shot is 28, but the catch is usually 3 to 5 birds.

Birds are aged, sexed, weighed, and banded with leg and wing bands before being placed in individual transfer crates for shipment to release sites. Crates are designed to hold one bird, with little room allowed for movement of the bird during transit. The interior of the crate is lined with smooth masonite and covered with foam padding on the top and wire mesh on the bottom. Birds have been confined up to 3 days without apparent ill effect, but usually they are kept in crates less than 24 hours. Scheduling of releases is handled by the program supervisor who either advises the trapper to haul the birds to a release site or arranges transportation by Department aircraft. The specific release point is picked beforehand (usually at the time of the public meeting) and, weather permitting, all birds are released at the same spot until that stocking is completed. Releases, which are made in the ratio of 1 adult gobbler to 2 hens, total from 12 to 24 birds. When dispersal and population levels are satisfactory, the county is opened to hunting during the spring gobbler season, usually within 4 to 5 years after the original release is completed.

SUMMARY OF RESTORATION EFFORTS

Trapping has been extended to private, federal, and state lands outside the managed refuges since 1957. By the spring of 1970, 1,421 turkeys were restocked in 73 areas in 58 Missouri counties (Figure 3). Almost all releases have been successful in reestablishing huntable populations in areas uninhabited by the wild turkey immediately prior to restocking.

One of the best examples of what can be accomplished with suitable habitat and the favorable attitude of local citizens is the result of a release made in Sainte Genevieve County. This county had no wild turkeys immediately prior to the winter of 1955, when 7 adult gobblers and 15 hens were released. A spring gobbler season was permitted in 1960, Missouri's first open season after a 23-year closure. Sainte Genevieve County has been a part of the open territory since that date, and in the subsequent 11 seasons 692 legal gobblers have been shot there. In addition, Department of Conservation personnel have trapped 66 birds in the county for restocking elsewhere in the state. Thus, from an initial restocking of 22 birds 15 years ago, hunting and trapping have realized a total return of 758 turkeys, with a thriving population still in that county and birds dispersing into adjoining counties.

FUTURE RESTORATION WORK

Missouri's program of turkey restoration, which utilizes native wild birds, has been successful in restoring this valuable game bird to much of its former range in Missouri. Missouri will probably terminate intensive wild turkey restocking within the next 2 or 3 years. Even now, releases are being made to fill in areas between sites of prior restockings and to boost low populations in others. A few releases in submarginal habitat will also be made, but only on an experimental basis. Expansion of the wild turkey range into the west and northwest prairie, northern riverbreaks, and Mississippi lowland regions of the state does not appear feasible.

ECONOMICS OF THE PROGRAM

Currently, the cost of trapping and releasing each turkey at a restocking site is approximately $300. We have released birds from 1954 to 1969 at a cost of $333,000, and we expect that successful restoration throughout the available range will cost a total of $420,000.

Revenue from the sale of turkey-hunting permits from 1960 to 1970 was $300,000, and at the present rate, expenses incurred for the wild turkey restoration program will be reimbursed during the next 4 years, which coincides rather nicely with anticipated termination of the program. Reestablishment of the wild turkey over much of its ancestral range in Missouri is, of course, the most important aspect of the program.

HUNTING SEASONS

Missouri's first turkey season in nearly a quarter of a century was the spring gobbler season in 1960. During the 3-day season in 14 counties, 698 hunters killed 94 gobblers (Table 10). The number of hunters and of gobblers has increased as the length of the season and the number of counties open to hunting increased. Poor poult production forced a reduction in length of season during 1968 and 1969 (Lewis 1969a).

Table 10. Spring gobbler seasons, 1960-1970, in Missouri.

	Season		Number of	Gobblers
Year	Days	Counties	Hunters	Killed
1960	3	14	698	94
1961	3	14	1,001	155
1962	3	16	1,408	182
1963	4	19	1,828	357
1964	4	22	2,961	369
1965	4	25	2,982	476
1966	5	29	4,273	576
1967	7	32	6,698	1,191
1968	5	35	8,078	1,270
1969	5	38	7,576	959
1970	7	41	10,758	1,607

Turkey populations in 22 of the 41 counties open to hunting in 1970 were a direct result of the turkey restoration program. Hunters have harvested 7,236 gobblers during the past 11 seasons in Missouri. Prospects appear good for opening 1 to 3 additional counties each year until hunting is eventually open in more than 75 of the 114 counties in Missouri.

4

STATUS OF THE WILD TURKEY IN OHIO*

Robert W. Donohoe and Charley E. McKibben

ABSTRACT

The wild turkey (*Meleagris gallopavo*), which once inhabited the entire state of Ohio, was extirpated from Ohio about 1904. In 1952, the Division of Wildlife began a concerted effort to restore the turkey. Releases using game-farm turkeys failed, but those using wild-trapped stock succeeded, and today the wild turkey is established in all of the major forest lands in the state. A total of 87 turkeys have been taken during four spring gobbler hunts.

During the initial phases of the turkey reintroduction program, wild turkeys were obtained from West Virginia, Missouri, Alabama, Kentucky, Texas, Arkansas, and Florida. Appreciation is expressed to these states for their cooperation and coordination in supplying wild-trapped turkeys to Ohio.

F. B. Chapman, C. E. Knoder, and the late C. A. Dambach, all formerly with the Ohio Division of Wildlife, were instrumental in the early phases of the reintroduction program. C. E. Knoder had the major responsibility for the program for 10 years. R. W. Bailey has acted as consultant several times for Ohio's turkey program. His knowledge and suggestions have been extremely helpful. E. S. Thomas and M. B. Trautman made early records of wild turkeys in Ohio available for use in this report. M. W. McClain prepared Figures 4 and 5.

HISTORICAL REVIEW

The wild turkey has been returned to Ohio after many years of absence, but unlike the native population, it is now confined to only a small portion of its original domain. From reports in the literature, it is clear that originally the wild turkey inhabited the wooded areas of the entire state (Wright 1915, Bent 1932:328, Williams 1950:48, Schorger 1966:51-52). Records of observations and shootings between 1802 and 1884, compiled from early newspapers and county histories, document the wide distribution of the turkey in Ohio (E. S. Thomas, Ohio Historical Society, personal communication, 1966).

The exact time of the wild turkey's disappearance from Ohio is difficult to determine. Jones (1903:85) said: "This, the noblest of the game birds, is all but extinct within the state. It should not be placed upon the list of extinct species until the southern counties between the Scioto river and Cincinnati have been more thoroughly worked. It may be present there still."

Writing about the birds of Lucas County, Campbell (1940: 65) said: "Apparently the last of these [the wild turkeys] one-time common residents of the county was seen near Berkey, Ohio, in 1892 by E. H. Ray. He states that they

*** Contribution from Federal Aid in Wildlife Restoration Project (Ohio) W-105-R.**

were not common in the Oak Openings, but preferred the hardwood forests which grew about its borders." Campbell (1940: 65) further stated: "General Status In Ohio: Now extirpated from Ohio, the last strongholds being in northwestern and southern counties. Disappearance took place in most sections between 1850 and 1890."

Trautman (1940:228), in his study of the birds of Buckeye Lake, mentions that the last eastern turkeys were seen in central Ohio sometime between 1853 and 1870. Chapman (1938:656) noted that the last wild turkey taken in Ohio was from Adams County, about 1904.

At the time of the earliest land surveys, the entire state was forested, with the exception of prairie openings in the western half (Gordon 1969). However, by 1838 and continuing until the 1860's, lumbering was an important industry (Gordon 1969:24), as was the charcoal-iron industry from 1826 to 1916 in six southern Ohio counties (Collins and Webb 1966). Between 1800 and 1940, Ohio forest land decreased from 25 million acres to 3,708,000 acres (Gordon 1969: 10).

Habitat destruction, coupled with the apparent absence of a bag limit in the early turkey laws and the long hunting seasons between 1857 and 1888-from 154 days to 76 days (Dambach 1948)-must have contributed substantially to the disappearance of the turkey.

REINTRODUCTION

The Division of Wildlife has conducted a concerted turkey program since 1952. The regeneration of large forest areas in southeastern and south-central Ohio due to abandonment of farmland, the purchase of thousands of acres of these forest lands by the Division of Forestry for timber management, and the need for a new game species in the nonpheasant *(Phasianus colchicus)* range were factors leading toward reintroduction (Knoder 1955:2, 1957: 12-13, Chapman 1953:20-21). Initially, unavailability of wild birds for release resulted in the use of game-farm birds (Knoder 1955: 3-4).

Reintroduction with Game-Farm Turkeys

In the summer of 1952, 73 game-farm turkeys were purchased from the Woodmont Club in western Maryland and the Pennsylvania Game Commission. Fifty-three of these turkeys-2 adult gobblers, 11 juvenile gobblers, 10 adult hens, and 30 juvenile hens-were released in October 1952 on the 900-acre Turner Ridge Refuge in Vinton County. The remaining turkeys were held at the Waterloo Experiment Station, Athens County, for brood stock.

Sickels (1959) reported that from 1952 to 1957, 1,400 game-farm turkeys were reared at the Waterloo Experiment Station and released in several large forested areas of southeastern and south-central Ohio.

Releases of game-farm turkeys were discontinued because (1) propagation was difficult, (2) the resultant stock showed too many characteristics of the domestic turkey, (3) survival and reproductive rates were low in the wild, (4) the birds were easy prey for poachers, and (5) the birds were susceptible to blackhead disease (Knoder 1957).

Reintroduction with Wild Turkeys

Agreements with the states of West Virginia, Missouri, Alabama, Kentucky, Texas, Arkansas, and Florida for wild-trapped turkeys were initiated in 1956

Table 11. Stocking of wild turkeys, February 1956 through October 1969, in Ohio.

Stock	Area Stocked	Approximate Size (acres)	County	Date of Release	Number: Gobblers	Number: Hens	Source of Stock
M. g. silvestris	Raccoon S.F.[a] and vicinity	20,000	Vinton	Feb. 1956	2	4	West Virginia
				Sept. 1956	1	3	West Virginia
				Feb.-Mar. 1957	2	4	West Virginia
				Oct. 1957	1	1	West Virginia
				Subtotal	6	12	
M. g. intermedia	Shawnee S.F.	57,752	Scioto, Adams	Mar. 1957	4	20	Texas
M. g. silvestris				Jan. 1959	5	0	Alabama
				Feb. 1959	0	1	Alabama
				Mar. 1959	1	5	Alabama
				Mar. 1959	1	8	Arkansas
				April 1959	0	1	Alabama
				Dec. 1959	2	4	Missouri
				Feb. 1960	0	3	Missouri
				Mar. 1961	3	0	Missouri
				Subtotal	16	42	
M. g. osceola	Telegraph Ridge Unit, Wayne National Forest and vicinity	40,000	Lawrence	Mar. 1957	2	4	Florida
				Nov. 1964	4	0	Raccoon SF.
				Feb. 1965	1	7	Hocking S.F.
				Subtotal	7	11	
M. g. silvestris	Scioto Trail S.F.	9,150	Ross, Pike	Aug. 1959	1	0	Kentucky
				Sept. 1959	0	1	Kentucky
				Sept. 1960	0	5	Kentucky
				Dec. 1960	5	0	Missouri
				Jan. 1961	0	5	Alabama
				Feb. 1961	0	2	Missouri
				Subtotal	6	13	
M. g. silvestris	Pike S.F.	10,585	Pike, Highland	Sept. 1960	2	2	Raccoon S.F.
				Oct. 1960	4	0	Raccoon S.F.
				Feb. 1961	0	1	Raccoon S.F.
				Feb. 1961	0	5	Missouri
				Subtotal	6	8	
M. g. silvestris	Wayne National Forest and vicinity	70,000	Washington, Monroe	Oct. 1961	6	5	Missouri
				Jan. 1962	2	0	Missouri
				Feb. 1962	0	2	Missouri
				Mar. 1962	0	4	Missouri
				Sept. 1962	2	5	Missouri
				Oct. 1962	0	4	Missouri
				Feb. 1963	2	0	Missouri
				Subtotal	12	20	
M. g. silvestris	Zaleski S.F. and vicinity	40,000	Vinton, Athens	Winter 1961	11	4	Waterloo Expt. Sta. breeding pens
				Sept. 1961	0	2	Raccoon S.F.
				Oct. 1961	6	3	Raccoon S.F.
				Nov. 1961	2	0	Raccoon SF.
				Oct. 1965	4	3	Hocking SF.
				Dec. 1965	1	5	Hocking S.F.
				Nov. 1966	1	0	Hocking SF.
				Jan. 1967	2	6	Hocking SF.
				Feb. 1968	1	0	Tar Hollow S.F.
				Subtotal	28	23	

Table 11. (Cont.)

Stock	Area Stocked	Approx-imate Size (acres)	County	Date of Release	Number Gob-blers	Number Hens	Source of Stock
M. g. silvestris	Hocking S.F. and vicinity	10,000	Hocking	Aug. 1962	2	7	Raccoon SF.
				Sept. 1962	9	7	Raccoon SF.
				Feb. 1963	4	0	Missouri
				Mar. 1963	0	5	Raccoon S.F.
				Subtotal	15	19	
M. g. silvestris	Tar Hollow S.F. and vicinity	16,500	Ross, Vinton, Hocking	Aug. 1963	3	0	Raccoon S.F.
				Sept. 1963	6	13	Raccoon S.F.
				July 1964	3	1	Zaleski S.F.
				Aug. 1964	0	2	Raccoon S.F.
				Sept. 1964	3	0	Raccoon SF.
				Oct. 1964	4	1	Raccoon SF.
				Nov. 1964	0	3	Zaleski S.F.
				Subtotal	19	20	
M. g. silvestris	Wayne National Forest and vicinity	40,000	Athens, Hocking	Nov. 1966	5	0	Hocking SF.
				Dec. 1966	2	1	Hocking SF.
				Jan. 1967	0	10	Hocking SF.
				Subtotal	7	11	
M. g. silvestris	Brush Creek S.F. and vicinity	12,000	Adams, Pike, Scioto	Sept. 1963	2[b]		Scioto Trail S.F.
				Feb. 1968	5	0	Tar Hollow S.F.
				Mar. 1968	0	11	Tar Hollow S.F.
				Subtotal	5	11	
M. g. silvestris	Shade River S.F. and vicinity	5,000	Meigs	Sept. 1968	2	0	Hocking SF.
				Oct. 1968	0	8	Hocking S.F.
				Feb. 1969	2	0	Tar Hollow S.F.
				Subtotal	4	8	
M. g. silvestris	Bloomfield Township	11,000	Jackson	Feb. 1969	2	0	Tar Hollow S.F.
				Mar. 1969	0	5	Tar Hollow S.F.
				Subtotal	2	5	
M. g. silvestris	Wayne National Forest	5,000	Morgan, Perry	Oct. 1969	4	9	Waterloo S.F.
				Oct. 1969	2	0	Raccoon S.F.
				Subtotal	6	9	
				Grand Total[b]	139	212	

[a]S.F. - State Forest.
[b]Sex was not determined for two turkeys.

and continued through 1963. During this time, turkeys were livetrapped and shipped by air, rail, and truck to Ohio for immediate release on designated forest sites of at least 9,000 acres. In 1960, the Division of Wildlife began its own livetrapping and transplanting program within the state. On September 2, 1960, two adult gobblers were livetrapped in Raccoon State Forest, Vinton County. This was the first record of turkeys captured with a cannon-net trap in Ohio.

From February 1956 through October 1969, 353 wild turkeys were transplanted to various forest areas (Table 11). Of these, 142 turkeys were received from other states, and 211 turkeys were livetrapped in Ohio. The 6 Florida turkeys (*M. g. osceola*) transplanted to the Wayne National Forest in Lawrence County and the 24 Rio Grande turkeys *(M. g. intermedia)* from Texas transplanted to the Shawnee State Forest were unsuccessful transplants.

The trapping of wild-reared turkeys, coupled with the longevity records ob-

Table 12. Longevity records from wild-trapped turkeys in Ohio.

Band Number	Sex	Age at First Capture	Date of First Capture	Date: Shot by Hunter	Date: Found Dead	Date: Last Capture	Approximate Age (years)
485	♀	Juv	9-5-61			3-12-63	1.5
488	♀	Juv	9-5-61			10-9-65	4.1
584	♀	Juv	9-26-61		5-2-67		5.7
581	♀	Ad	9-26-61			11-20-64	3.2[a]
469	♂	Juv	10-2-61	5-10-68			6.6
5021	♂	Ad	1-4-62	5-5-66			4.3[a]
332	♀	Juv	8-15-62			2-18-65	2.5
427	♂	Juv	9-27-62	5-10-68			5.7
428	♂	Juv	9-27-62	5-6-66			3.7
429	♀	Ad	9-27-62			1-11-67	4.3[a]
430	♀	Juv	9-27-62			1-11-67	4.3
434	♂	Juv	9-27-62			2-18-65	2.4
438	♂	Juv	9-27-62			10-20-65	3.1
441	♀	Juv	9-27-62			1-11-67	4.3
5551	♂	Ad	2-20-63	5-4-66			3.2[a]
368	♂	Ad	8-26-63	5-5-67			3.8[a]
231	♀	Juv	9-6-63			3-13-69	5.5
218	♂	Ad	10-20-65	5-6-67			1.6[a]
222	♀	Juv	12-17-65			10-1-69	3.8
224	♂	Juv	12-17-65	5-8-69			3.4
197	♂	Ad	2-20-68	5-7-69			1.2[a]

[a]Minimum age.

tained from banded birds retrapped or shot (Table 12), documents the re-establishment of the turkey in Ohio.

Reintroductions of wild turkeys in Ohio have been limited to the Hill Country area (Figure 4), which contains the bulk of the public and private forest land in the state. The Hill Country contains 4,400,000 acres of commercial forest land (DeBald and McCay 1969: 2). The major forest types and their percentages in the Hill Country are oak-hickory *(Quercus-Carya),* 52.3 percent; elm-ash-cottonwood *(Ulmus-Fraxinus-Populus),* 18.4 percent; maple-beech-birch *(Acer-Fagus-Betula),* 15.5 percent; and oak-pine *(Pinus),* 6.8 percent (DeBald and McCay 1969 : 37). Turkeys have been located in all of these forest types and are now established in 15 counties within the Hill Country (Figure 4).

Trapping and harvest records indicate that Ohio's best turkey populations are in Ross, Hocking, and Vinton counties (Table 11 and Figure 4). A snow-track census in Harrison Township (Tar Hollow State Forest), Ross County, on February 22, 1968, revealed two turkeys per Section.

Turkey stocking in Ohio's large public forest land is completed. In the future, experimental stocking will be tried in less extensive forest tracts-5,000 acres or less-within the Hill Country.

HARVEST

A total of 12,946 applications for free turkey permits were received for Ohio's four spring 4-day seasons, 1966-1969 (Table 13). In each of the 4 years, 500 applications were randomly selected at a public drawing in early April. Each successful applicant in 1967, 1968, and 1969 was allowed to apply for a

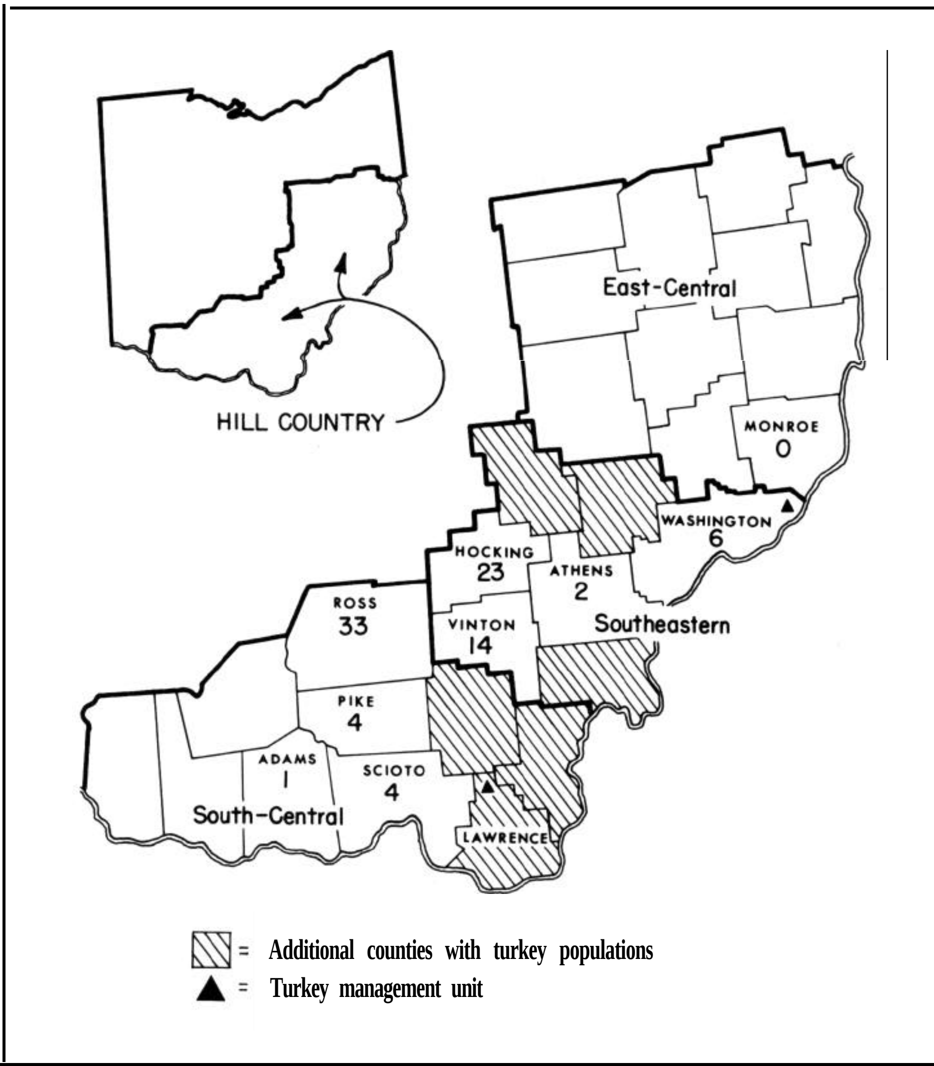


Figure 4. The Hill Country of Ohio, showing the total turkey kill in nine open counties for four spring hunts (1966-1969).

guest permit; all eligible hunters were sent information on where and how to hunt turkeys in Ohio.

There have been 3,257 permits issued for Ohio's four modern spring hunts (Table 13). Each eligible hunter was allowed one bearded turkey, to be taken by shotgun or longbow between 5 : 00 AM and 12 noon (EST). Each successful hunter was required to bring his turkey to a checking station for tagging. Eligible hunters were asked to answer questions printed on a self-addressed postcard that was attached to the turkey permit.

A total of 87 turkey gobblers-77 adults and 10 immatures-were killed during the four spring hunts (Table 13). One hunter in 26 was successful in bagging a turkey. The 87 successful hunters made kills in eight of the nine

Table 13. Hunting statistics, turkey gobbler seasons, 1966-1969, in Ohio.

	1966 May 4-7	1967 May 3-6	1968 May 8-11	1969 May 7-10	Total
Number of applicants for turkey permits	2,659	2,853	3,038	4,396	12,946
Number of turkey permits issued	500	898	914	945	3,257
Number who returned questionnaires and said they hunted at least one day[a]	299	582	648	720	2,249
Number of successful hunters	12 or 1:25	18 or 1:32	20 or 1:32	37 or 1:19	87 or 1:26
Number of people who returned their questionnaire and said they did not hunt[a]	173	161	121	106	561
Number of people who did not return their questionnaire and could not be contacted[a]	28	155	145	119	447
Number of turkeys heard by all who hunted[b]	708	1,582	1,874	2,040	6,204
Number of turkeys seen by all who hunted[b]	277	410	468	513	1,668
Number of unsuccessful hunters who said they had a shot or shots at a turkey	6	5	4	4[c]	19
Number of hunters who said there were too many other hunters in area for good hunting	1 or 1:299	18 or 1:32	21 or 1:31	24 or 1:30[d]	64 or 1:35
Number of townships in which turkeys were reported seen and/or heard	37	40	41	47	61

[a]Two telephone follow-up surveys were required to reach this figure in 1966; one mail follow-up was required each year thereafter.
[b]This figure probably includes duplications.
[c]One turkey shot at with longbow.
[d]This figure includes disturbances by dogs, horseback riders, mushroom pickers, and motorcycle riders.

open counties (Figure 4). The weight distribution of the harvested birds is shown in Figure 5.

DISCUSSION

In the early 1950's, biologists identified four requirements for a successful reintroduction of the wild turkey in Ohio: (1) large tracts of relatively undisturbed forest land, (2) good release stock, (3) protection, and (4) continued availability of wild land. Ohio has provided these requirements. After

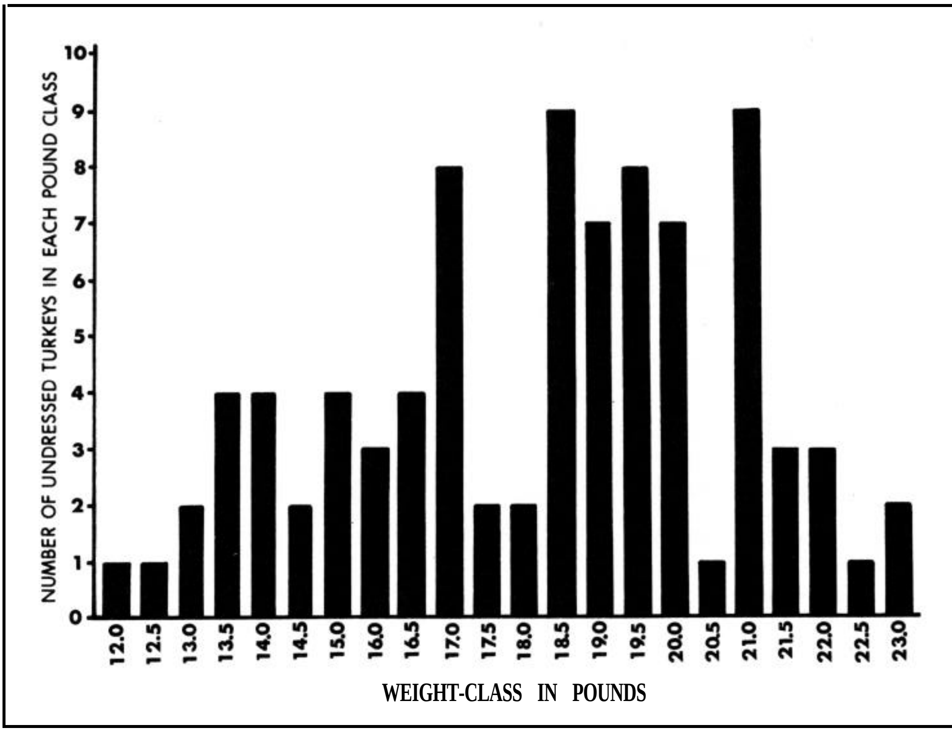


Figure 5. Weights of wild turkeys killed in Ohio, 1966-1969. Turkeys weighing 12 pounds to 12 pounds, 7 ounces = 12.0-pound weight-class; those weighing 12 pounds, 8 ounces to 12 pounds, 15 ounces = 12.5-pound weight-class.

14 years, with the use of wild-trapped stock, turkeys are now reestablished in all of the state's major forests. The future of the turkey program will depend largely on the continued availability of wild land and the success of stocking in less extensive forest tracts.

DeBald and McCay (1969: 14) stated: "Forest area in the Hill Country should continue to increase at the current rate of about 2 percent annually-at least through the next decade." Whether this forest expansion will provide a better environment for turkey survival in Ohio, with almost 11 million residents (Eis 1969), remains to be seen. Demands on the forest community for wood products and recreational facilities (camping areas, hiking trails, lakes, roads) are becoming greater each year.

Ohio, in cooperation with the U.S. Forest Service, has established two wild turkey management units on the Wayne National Forest (Landes et al. 1966, Donohoe et al. 1967) (Figure 4). The unit in Washington County is 4,300 acres and will be expanded to 10,000 acres. The unit in Lawrence County is 15,000 acres and will be expanded to 25,000 acres. Lands to be acquired for both units qualify for purchase with funds authorized by the Land and Water Conservation Fund Act of September 3, 1964 (U.S. Department of Agriculture 1964). The purpose of the management units is to provide a forest environment that is relatively undisturbed by human activity, although hunting of turkeys and other forest game species is permitted. Since each area is managed with emphasis on turkey production, timber management is coordinated to maintain the forest habitat. Timber harvests are planned so that at least 60 percent of each management unit is maintained as mast-producing, pole-sized, or larger stands. Additional wild turkey management units are being planned for state forest lands for the future.

The four modern spring turkey seasons in Ohio were successful on the basis of hunting success, birds seen and heard, and hunters' comments. The increase in turkey-permit applicants and in hunters each year (Table 13) indicates that interest in the new sport is growing. The four seasons have also helped in assessing the reestablishment of the state's turkey population. Total kill figures from certain townships (Laurel in Hocking County, 14; Brown in Vinton County, 9; Harrison and Franklin in Ross County, 12 and 15, respectively) suggest thriving populations. On the other hand, some forest regions believed to have good populations, on the basis of the number of birds stocked and the number of reproductive seasons, have not produced the expected results. Only four turkeys have been killed in the 57,000-acre Shawnee State Forest in Scioto County; the same number have been killed in the 10,000-acre Pike State Forest in Pike County. It is difficult to explain the differences in kill among forest areas, but harvest may not be a good indicator of turkey abundance.

The present permit system allows for a potential of 1,000 hunters. If all hunt at the same time and are evenly distributed over the areas open to hunting, there should be plenty of space for quality hunts. Unfortunately, an even distribution of hunters has not always resulted, even with less than 1,000 actual hunters each year. Word of a successful hunt travels fast, and often hunters congregate in a small area on succeeding days. For the present, we believe that allotment of a set number of permits by forest or county is unnecessarily restrictive and poses a number of administrative headaches. Some townships have received little hunting pressure. Better publicity on hunting opportunities in these townships should help spread the hunting pressure in future seasons.

A mandatory checking system is desirable so that data on hunting pressure, kill by county and township, and by age, weight, longevity, and food habits of the turkeys can be collected. Also, with Division of Wildlife personnel manning the checking stations, the system provides a means of improving public relations.

The future of turkey hunting in the state will depend on the population status in areas now supporting turkeys and in newly stocked areas. The spring gobbler season should continue to be a part of Ohio's hunting regulations as long as field investigations and data from checking stations give evidence of sustaining or increasing populations. In the future, more counties will be open for hunting; based on the kill figures from the four open seasons in the late 1960's, it is conceivable that the spring hunt will run for 2 weeks (late April-early May). For these 2 weeks, more than 1,000 permits probably could be issued, depending on the number of counties open for hunting. The longer season could be split into two or three segments, with different groups of hunters assigned to each segment. It should be realized, however, that everyone who wishes to hunt turkeys in Ohio may not do so every year, if quality hunting is to be maintained.

This page has been intentionally left blank to preserve the continuity of the original document.

5

STATUS OF THE INTRODUCED RIO GRANDE TURKEY IN NORTHEASTERN IOWA* †

Dennis D. Wigal

ABSTRACT

After the extirpation of the eastern wild turkey *(Meleagris gallopavo silvestris)* in Iowa, several unsuccessful attempts were made to reestablish turkeys in the wild. Then, during the winter of 1960-61, 39 Rio Grande turkeys *(M. g. intermedia)* from Texas were introduced in the Yellow River State Forest in Allamakee County, Iowa. The population was studied in three northeastern Iowa counties from June 1966 through September 1967; concentrated field studies were centered in and near the Paint Creek Unit of the forest. Although reproduction has occurred each year since the introduction, poult survival has seemingly been sporadic. Nevertheless, sight records collected through September 1967 show extension of the turkeys' known range every year since the stocking. Verified sightings have been made across the Mississippi River in Wisconsin and up to 41 miles from the release area in Iowa. The turkey population is being suppressed by an unknown factor or factors. Lack of adaptability of Rio Grande turkeys to the northeastern Iowa climate may be a limiting factor. The absence of truly extensive turkey habitat may also limit the population, which appears relatively stable but probably has never exceeded 100.

The eastern wild turkey inhabited the forested regions of early Iowa but by about 1910 had been exterminated (Musgrove et al. 1941). The first attempt to reestablish turkeys with wild-trapped stock was made by the Iowa State Conservation Commission on November 18, 1960. Twenty Rio Grande turkeys trapped near Sonora, Texas, were released in the Paint Creek Unit of the Yellow River State Forest, Allamakee County, Iowa (Figure 6). On March 7, 1961, a second release of 19 Rio Grande turkeys from the same source was made near the first release site. A total of 29 hens and 10 gobblers was released.

Intensive field investigations to determine the extent of establishment of Rio Grande turkeys in northeastern Iowa were made through the summer of 1966 and winter of 1966-67; lesser field effort was expended during the spring and fall of 1966 and the spring and summer of 1967. That work served as the basis of a study by Wigal (1968) while a graduate research assistant at Iowa State University. Many of the data collected before initiation of the study were secured from records of the Iowa State Conservation Commission. More recent information has been obtained from Whitney and Haugen (unpublished data), who studied the Rio Grande turkeys during the summer of 1969 with the assistance of a National Student Foundation grant.

*** Journal Paper No. 6439 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project No. 1665. A contribution of the Iowa Cooperative Wildlife Research Unit, financed jointly by the Iowa State Conservation Commission, Iowa State University, Bureau of Sport Fisheries and Wildlife, and the Wildlife Management Institute.**

† Editors' note.-This report is essentially the same as Wigal and Haugen (1968); however, some additions, deletions, and editorial changes have been made.

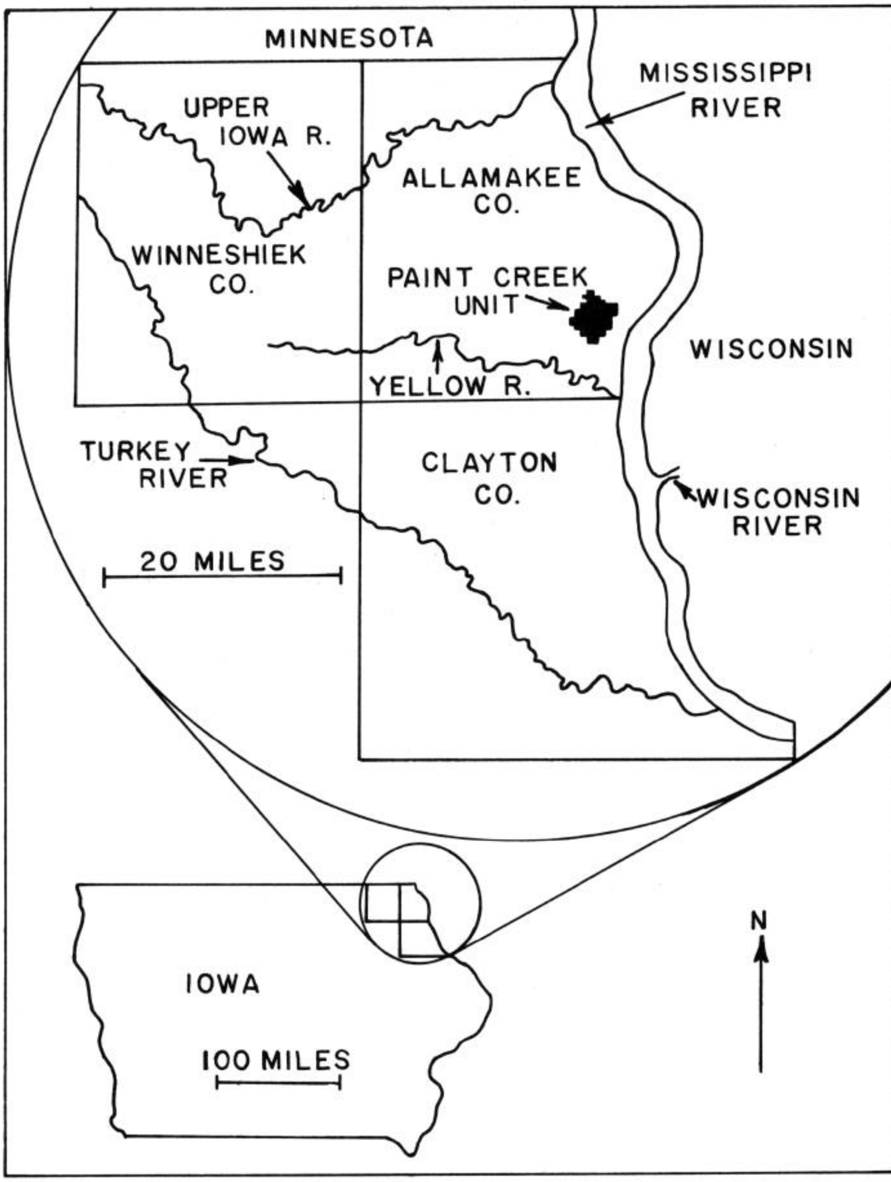


Figure 6. Extensive Rio Grande turkey study area, northeastern Iowa.

For his guidance during the study and for critical review of the manuscript, the author is grateful to Dr. Arnold 0. Haugen, leader of the Iowa Cooperative Wildlife Research Unit. Appreciation is also extended to Dr. Eugene D. Klonglan, Assistant Superintendent of Biology, Iowa State Conservation Commission, for supplying state records. Finally, many farmers and other residents of northeastern Iowa deserve thanks for their help, as do Iowa State Conservation Commission employees Jack McSweeny, Manager of the Yellow River Forest, and George Kaufman; Conservation Officers Jerry Hoilien, John Horton, and John Hoth; ASCS office managers W. Oliver Eno, Erick C. Flaskerud, and Seth Huisman; and Winneshiek County Extension Director E. J. Weigle.

STUDY AREA

General investigations in northeastern Iowa were conducted in an extensive study area composed of parts of Clayton, Allamakee, and Winneshiek counties (Figure 6). Concentrated field studies were centered in a 2,600-acre study area in the southeastern portion of the Paint Creek Unit of the Yellow River State Forest and adjoining private land. The Paint Creek Unit, totaling 3,300 acres, is the largest of the seven units that compose the 5,400-acre Yellow River State Forest.

Most of the Yellow River State Forest, and especially the Paint Creek Unit, is managed for timber, wildlife resources, and outdoor recreation. Forty ponds have been constructed throughout the forest, and food patches of corn (*Zea mays)* are planted every year to supplement the winter food supply for wildlife, particularly turkeys. Selective cutting of timber is practiced each winter.

Much of the three-county study area is characterized by a somewhat rugged terrain created largely by three major drainage systems-the Upper Iowa, Yellow, and Turkey rivers. Valley walls vary from gentle, soil-covered slopes to sheer limestone cliffs 400 to 600 feet high (Hoslett 1965). The widespread limestone formations in the region are permeated with caves, sinkholes, and subterranean streams. Springs are numerous.

The dominant forest type in the Paint Creek Unit, mixed hardwood, is typical for most of Clayton, Allamakee, and Winneshiek counties. The lower slopes and edges of flood plains in the region are dominated by sugar maple *(Acer saccharum),* black maple *(A. nigrum),* basswood *(Tilia americana),* butternut *(Juglans cinerea),* and American elm *(Ulmus americana).* White oak *(Quercus alba),* red oak (*Q. rubra*), bitternut hickory *(Carya cordiformis)* , and shagbark hickory (C. *ovata)* are dominant on the upper slopes and the uplands of the Paint Creek Unit. Conifers are represented in greatest quantity by red cedar *(Juniperus virginiana),* growing most abundantly on rocky hillsides; ground juniper *(J. communis),* common locally; and white pine *(Pinus strobus),* found scattered along stream courses.

Most of the land in northeastern Iowa is either under cultivation or in pasture; the rest is mainly forested. A survey in 1954 indicated that 24 percent of Clayton, 32 percent of Allamakee, and 13 percent of Winneshiek counties were in timber (Thornton and Morgan 1959). In the Yellow River State Forest, several upland plains formerly under cultivation are now planted with conifers and forage grasses.

METHODS

More than 300 persons living in northeastern Iowa and Prairie du Chien, Wisconsin, were questioned about the presence and ranges of turkeys in the area. Among those interviewed were farmers, rural mail carriers, county extension agents, office managers of the Agricultural Stabilization and Conservation Service, state conservation officers, personnel of the Yellow River State Forest and Effigy Mounds National Monument, managers of the Upper Mississippi River Wildlife and Fish Refuge, state fisheries biologists, state foresters, fishermen, hunters, hikers, and campers. Many of these cooperators acted as intermediaries by “spreading the word” and were consulted periodically.

In addition to interviews, information was also sought through newspapers, radio programs, and questionnaires. Every report of a turkey sighting or other pertinent information received indirectly was checked at the primary reporting source when feasible.

Considerable time was spent on foot searching for turkeys and for field evidence of their presence. Actual observation of turkeys was the purpose of the search, but tracks, droppings, feathers, and scratchings were noted when found. The searching was also done by car during early morning and evening hours.

SURVIVAL AND REPRODUCTIVE SUCCESS

Evidence suggested that most of the turkeys survived their first northeastern Iowa winter in 1960-61 and showed signs of accepting their new environment. The number and sizes of broods reported during the summer of 1961 indicated that the turkeys had good reproductive success that year. Klonglan (1962) reported sightings of seven broods totaling 58 birds in and near the Paint Creek Unit during that summer.

Average brood sizes have not been calculated, because no full-time investigator was on hand to verify sightings during most of the rearing seasons. In addition, many of the records obtained through interviews were too vague to be considered accurate. The data are sufficient, however, to show that reproduction occurred each breeding season. Records indicate that production was good in 1961, 1965, and 1967 and poor in 1962, 1963, 1964, and 1966. Whitney and Haugen (unpublished data) found low production on the Paint Creek Unit in 1969. They sighted only three broods within a 3-mile radius of the fire tower on the area where, the previous year, at least six broods were seen.

The original study's records of brood sizes frequently reveal the low numbers of poults per brood, especially in the years of low overall production. Small brood size may be a result more of low poult survival than of low hen fecundity. Six records of broods containing at least 12 young each show that northeastern Iowa Rio Grande turkeys commonly lay normal-sized clutches. This figure falls within the range of average clutch sizes (10.0 to 13.7) tabulated by Schorger (1966) from studies involving four races of wild turkeys.

The best-documented and most dramatic evidence of low production involves the summer of 1966, when field investigations began. The only reports of turkey nests that spring were supplied by three farmers whose properties lay adjacent to or near the Paint Creek Unit. Two of the farms reportedly had one nesting hen each, and the third was thought to have four nesting hens.

The first brood sighted in 1966 consisted of seven poults; by early August it had declined to four. Every other brood sighting reported for the summer consisted of either one or two poults, a reflection probably of low poult survival. On August 15, the author made the first of three observations of a single poult accompanied by three adult hens. These turkeys were joined in late summer by a fourth adult hen, also without a brood.

During the only other summer that a full-time investigator studied the Rio Grande turkeys, findings were only slightly more encouraging. Whitney and Haugen (unpublished data) found that one brood with 10 to 12 poults on June 23, 1969, had only 5 poults remaining in early September.

DISPERSAL

Each year through the completion of the original study, there was an extension of the Rio Grande turkeys' known range (Figure 7 and Table 14). Sightings were made in all directions from the release area, although most of those reported through 1965 were in southeastern Allamakee and northeastern Clay-

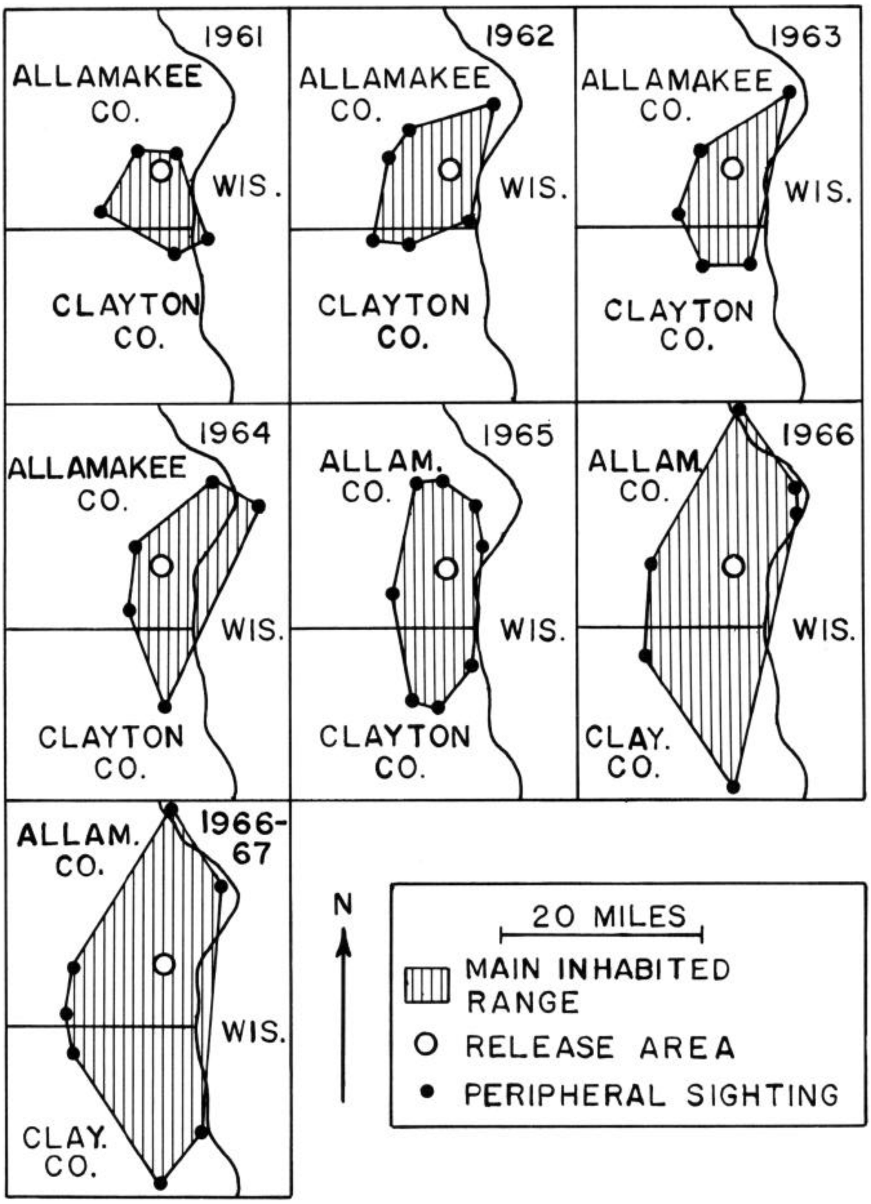


Figure 7. Extension of range of Rio Grande turkeys from 1961 to September 1967 in main inhabited range of northeastern Iowa.

ton counties, particularly in Allamakee. All of the land is considered the main inhabited range (Figure 7).

To show the yearly expanding range, all observations (as reported by farmers and other residents) were plotted on a detailed map of the extensive study area according to the year in which they were made. By joining the outermost locations of observations in the area of concentrated sightings (southeastern Allamakee and northeastern Clayton counties), the main inhabited ranges for each year were determined.

Beginning in 1963, turkeys were observed to the west and northwest of the release area in Winneshiek County. These sightings, however, are not included

Table 14. Main inhabited range of Rio Grande turkeys based on sight records, from 1961 through September 1967, in northeastern Iowa.

Year	Sighting Farthest from Release Area (miles)	Direction of Sighting Farthest from Release Area	Location of Sighting (county)	Square Miles of Range
1961	8.5	South	Clayton	71
1962	9.5	Southwest	Clayton	100
1963	10.0	Northeast	Allamakee	108
1964	14.0	South	Clayton	139
1965	14.5	South	Clayton	149
1966	22.5	South	Clayton	316
1966-67	22.5	South	Clayton	343

in the main inhabited range because each is too far removed from the concentrated population of turkeys in southeastern Allamakee and northeastern Clayton counties. Much of the intervening land is intensively cultivated farmland and unsuitable as turkey habitat. Moreover, these observations are too few and too widely distributed over a broad area to accurately reflect inhabited range. At the end of the 1961-1967 study, however, there was a small population of turkeys in northeastern Winneshiek County.

The main inhabited range occupied each year through September 1967 is listed in Table 14. Not all of the area in the range listed for each year supported turkeys; the ranges in 1966 and 1966-67, for example, encompassed considerable farmland. Range data for 1966-67 were combined, because the study was terminated before the end of 1967.

Evidently, most of the Rio Grande turkeys have remained in Iowa, but sightings of turkeys (mostly unverified) have been made in Wisconsin, indicating that the Mississippi River is not necessarily a barrier to the turkeys' dispersal eastward. In addition, several unverified and one verified report of turkeys on Mississippi River islands were received.

It appears significant that sightings at the greatest distances from the release area were made in 1966 and 1967. Evidently, the Rio Grande turkeys were continuing to extend their range at that time. The farthest verified sighting was made 41 air-line miles from the release area in west-central Winneshiek County, and several other sightings were made more than 25 air-line miles from the release area. However, the greatest distance believed to be in the main inhabited range was 22.5 miles south of the release area (Table 14).

Reports of several observations were obtained from areas that appear unsuitable for turkeys. Of particular interest is a sighting made in the summer of 1964, 16 air-line miles northwest of the release area. A flock of 8 to 10 turkeys was seen temporarily in a 15-acre woodlot located in the center of a 70-square-mile open area. This record indicates that the Rio Grande turkeys will move through areas almost devoid of forest cover. In an agricultural region such as northeastern Iowa, however, cornfields and other agricultural crops are probably essential as cover for turkeys to move from one timbered area to another. During the winter, when corn and other crops have been harvested, the turkeys restrict their range to wooded areas.

DISCUSSION

The Rio Grande turkey population is being suppressed by an unknown factor or factors. Predation, diseases, and parasites were not studied, so their effects are unknown. The Rio Grande turkey's inability to adapt to northeastern Iowa is probably a limiting factor.

Of particular concern is the response of the Rio Grande poults to inclement Iowa weather. Excessive poult mortality due to cold, wet weather may explain the apparent sporadic survival of the Rio Grande turkeys from spring to fall.

Rainfall constitutes an obvious weather difference between the native Rio Grande turkey range and northeastern Iowa. The immediate area in which the original Rio Grande turkeys were trapped in Texas-near Sonora-has a mean precipitation of about 22.5 inches per year (U.S. Weather Bureau 1960). On the other hand, the annual precipitation in the release area in northeastern Iowa (and most of Clayton, Allamakee, and Winneshiek counties) is 32 to 34 inches (Oschwald et al. 1965).

The amount of rainfall occurring during the turkey hatching season of each region is probably even more significant than the difference in annual precipitation. In northeastern Iowa most hatching occurs during June and July, whereas reports summarized by Bailey and Rinell (1967b) indicate that the hatching season for Texas peaks in May and June. During these respective hatching-season months, Allamakee County has an average rainfall of 8.17 inches, 2.55 inches greater than the 5.52-inch average reported for the Sonora, Texas, area (Reed 1941).

According to Glazener (1967), rainfall appears to be one of the most significant natural factors influencing geographical distribution of the Rio Grande race. Annual precipitation within its native range varies from about 16 inches on the west to approximately 32 inches on the east (Glazener 1967). Thus, the precipitation averages for northeastern Iowa fall just within the upper limits of rainfall in the Rio Grande turkey's native range.

Climographs representing temperature-precipitation conditions for reporting weather stations nearest the capture area in Texas and the release area in Iowa show a wide climatic divergence between the two regions (Figure 8). According to Odum (1959), such differences strongly indicate that the climatic factors involved may be sufficiently different to have limiting effects on introduced animals. Thus, the climatic differences shown in Figure 8 indicate that the Rio Grande turkey was a poor choice for release in northeastern Iowa.

Although the Iowa climate may adversely affect young poults, observations of adult Rio Grande turkeys in severe winter weather and during all seasons have shown that they seem to tolerate the Iowa climate. On several occasions, a flock of seven gobblers was observed walking during temperatures as low as -12 F. They were also observed moving about, seemingly unhindered, during three separate snowstorms and through snow up to 12 inches deep.

Another condition that may contribute to suppression of turkey numbers is insufficient turkey habitat. When the Rio Grande turkeys were stocked, it was estimated that only about 10,000 acres of turkey range, including both state and private land, were available for the birds in the area of the release. Roughly 45 percent of this acreage is forested (Haugen 1961).

The relative openness of the Iowa range, while not ideal by standards of habitat for the eastern turkey, probably conforms more closely to that feature of the Texas Rio Grande turkey range. However, differences in land-use practices and in vegetative types between Iowa and Texas appear great enough to negate the importance of any similarity in percentage of forest cover.

Even the most extensive forested areas in northeastern Iowa-for example, the Bierbaum Woods in Clayton County, the Yellow River State Forest, and the southeastern corner of Allamakee County (along the Yellow River)-are closely

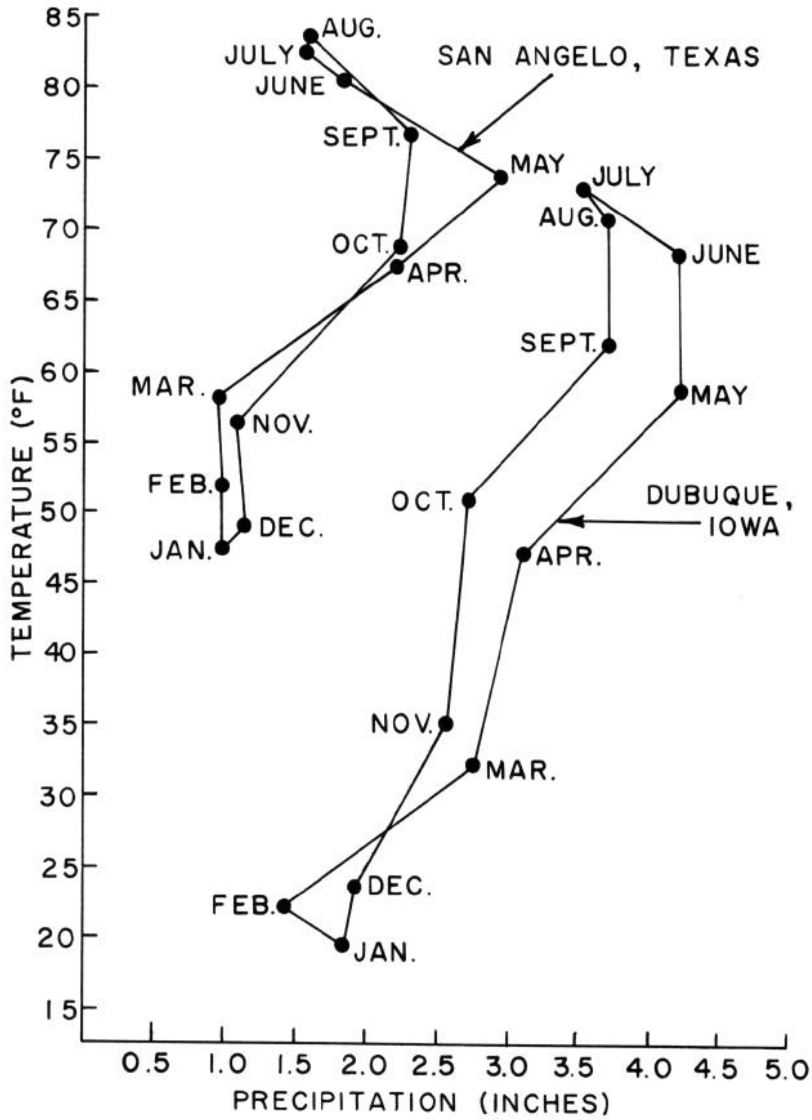


Figure 8. Climographs representing the correlation of monthly averages of temperature and precipitation for San Angelo, Texas, 1921-1950 (U.S. Weather Bureau 1960), and for Dubuque, Iowa, 1931-1955 (U.S. Weather Bureau 1959).

associated with farmland. In these forests, there is no one location farther than 1 mile from some type of crop or pastureland.

Still, the turkeys in northeastern Iowa appear to live in harmony with the rather intensive farming activities of the region. In the spring and summer, turkeys are often seen in pastures, feeding on grasses and insects. Furthermore, cattle that graze in some privately owned forest land, do not appear to compete seriously with the turkeys.

Besides farming, the only other land-use practice in northeastern Iowa that may affect the welfare of turkeys is logging. It is not an important industry in the region and is confined mostly to selective cutting of certain species. As such, logging in northeastern Iowa probably favors turkeys. Mast production is actually increased by thinning stands of timber, as are the number and variety of understory plants that are valuable as food for turkeys (Holbrook and Lewis 1967).

In spite of the apparent continuing spread of Rio Grande turkeys in northeastern Iowa at the end of the study in September 1967, the population did not appear to have increased substantially in the 7 years since the introduction occurred. There are no valid data to indicate that the population has exceeded 100 at any time since the turkeys were released. It is also unlikely that the population has dropped below the original stocking level of 39 birds.

Both eastern and Merriam's *(M. g. merriami)* turkeys are now present near the main concentration of Rio Grande turkeys. During the winter of 1967, the Wisconsin Department of Natural Resources released both eastern-derived turkeys (wild-trapped in central Wisconsin) and Merriam's turkeys, 15 and 20 miles southeast, respectively, of the Paint Creek Unit release area. In addition, during January 1969 the Iowa State Conservation Commission released 10 eastern turkeys in northern Allamakee County. If a huntable population of turkeys is to be established in northeastern Iowa, it will probably be through releases of races other than the Rio Grande.

This page has been intentionally left blank to preserve the continuity of the original document.

6

WISCONSIN'S WILD TURKEY RESTORATION EXPERIMENT

Robert E. Dreis, Clarence F. Smith, and Lewis E. Myers

ABSTRACT

A turkey stocking experiment that used hybrids developed from crossing eastern wild turkeys *(Meleagris gallopavo silvestris)* with domestic turkeys, was initiated in Wisconsin in 1954. A total of 286 adult game-farm hybrids were released in the Necedah Refuge-Meadow Valley Wildlife Area complex of 100,000 acres. This release was followed in 1957 with a release of 425 poults raised at the State Game Farm. An outbreak of disease and a severe winter all but wiped out the population. Survivors exhibited wild characteristics and apparently, Wisconsin now has a population of turkeys sufficiently wild and adapted to environmental conditions to permit it to maintain itself. The turkey population built up to an estimated peak of 2,500 birds in the 300 square miles of occupied range in the Necedah-Meadow Valley Area by the fall of 1966. Two years of successive brood failures and a severe winter reduced this population to less than 50 (estimated) birds. As of July 1969, the population had risen to an estimated 200 birds. A total of 67 birds were wild-trapped and planted in four different locations in Wisconsin during 1967 and 1968. In 3 years, these nuclei have expanded to occupy a range of 220 square miles and have grown to an estimated population of 900 birds. In 1967, a release of 15 Merriam's turkeys *(M. g. memiami)* was made in Grant County. In 1966, 1967, and 1968, Wisconsin held spring gobbler hunts in the Necedah-Meadow Valley Area. Kills of 20, 21, and 18 gobblers were recorded for the respective years. Hunter numbers were limited by IBM selection. Predation does not appear to be a limiting factor but, during winter stress conditions, kills by bald eagles *(Haliaeetus leucocephalus),* bobcats (*Lynx rufus),* and coyotes *(Canis latrans)* have been observed. One weakened turkey was killed by a red fox *(Vulpes fulva).*

Wisconsin's attempt to reestablish wild turkeys was not a research project and was not documented in a manner that lends itself to critical scrutiny by biologists. At best, it was a haphazard dumping of game-farm birds into a vacant habitat, This report is an attempt to record how Wisconsin's present turkey population originated.

STOCKING PROGRAM

To review briefly, the original stocking occurred in July 1954, with the release of 69 adult turkeys from the Allegheny Wild Turkey Farm, Julian, Pennsylvania. The release site was the complex of wild land that includes the Necedah Federal Wildlife Refuge and the state Meadow Valley Wildlife Area, totaling over 100,000 acres.

Broods seen in 1955 encouraged additional stocking from the same source, and in 1956, 217 turkeys were released in the same area. In 1957, 1,000 eggs were purchased from the Allegheny Wild Turkey Farm and were incubated at the pheasant plant in Poynette, Wisconsin; the poults were raised to 10 weeks of age. In September 1957, 425 of the 10-week-old poults were released into the same area.

Within 2 weeks of the release of the game-farm poults, field managers began to find dead turkeys. Hundreds died, both newly released poults and adult birds from the established flock. Specimens submitted to the diagnostic laboratory were found to have blackhead disease. A severe winter followed. Snow depths reached 48 inches, and there were prolonged periods of sub-zero weather. In the spring of 1958, field men established from counts at feeding stations that Wisconsin's turkey flock consisted of no more than 75 birds.

The above review covers the period described by Hartman (1959).

POPULATION CHANGES

During the 2 years after Hartman's report in 1959, no special effort was made to ascertain the turkey population. Occasionally, a brood was observed by field men in the course of other management duties. There was a decided difference between the behavior of the turkeys in 1957 and their behavior in 1960 and 1961. Formerly, flocks of turkeys would stand at close range to an automobile, but in 1960 and 1961 the birds exhibited wariness typical of turkeys of pure wild stock. The most an observer could expect was an occasional glimpse of a turkey.

The authors believe that the catastrophes experienced during 1957-58 culled the turkeys with predominantly domestic traits. Apparently, the survivors were turkeys that exhibited characteristics of true wild birds-traits that enabled them to react quickly and to survive in the wild.

In 1963, in an effort to count the number of turkeys in the state, a system of feeding stations was established. Small plywood blinds were erected at these stations when, after snows, turkeys started to use them. According to the field men involved, most of the turkeys were using these feeding stations. From the counts at these stations, plus knowledge of the gross range occupied by turkeys, it was estimated that the population increased from approximately 750 birds on 80 square miles of range in the winter of 1963-64 to about 2,500 birds on 300 square miles of range in the winter of 1966-67.

In both 1967 and 1968, the area occupied by turkeys experienced extremely heavy rainfalls during the month of June-11 inches of rain during June 1967 and almost 13 inches during June 1968. It was felt at the time that these heavy rains would seriously affect nesting success. Winter observations at feeding stations the following winter of each year showed almost no birds-of-the-year. Population estimates, again based upon counts at winter feeding stations, dropped to 1,200 birds in 1968.

On December 16, 1968, it began to snow and by December 20 a total of 35 inches of fluffy snow was on the turkey range. The snowfall was followed by 30 days of cold weather, during which time the temperature never went above 15 F. Temperatures of below zero were recorded on 25 of the 30 days.

In January 1969, teams of conservation employees traversed the major turkey range with snowmobiles and located 75 turkeys. During the critical days of December 1968, field men had observed turkeys immobilized in trees for days at a time. The birds could not travel on foot through the fluffy snow, which persisted until January 15, 1969.

Casual observations indicated good brood survival in 1969, and it is believed that the Meadow Valley flock is again increasing.

TRANSPLANTING PROGRAM

During 1967-the period of turkey abundance-40 females and 27 males were livetrapped from the Meadow Valley flock and transplanted to four other areas of the state (Table 15).

Table 15. Turkeys livetrapped from the Meadow Valley flock and transplanted in January 1967 in Wisconsin.

County Where Released	Number Released	
	Males	Females
Marinette	14	18
Crawford	5	8
Pepin	4	7
Clark	4	7

In trapping, a drop net was suspended 6 feet to 8 feet above an area baited with corn. Only during times of winter stress would the turkeys go under the net.

Records for the Clark County release are complicated because of unauthorized releases of game-farm stock by a zealous sportsmen's group. In addition, 15 wild-trapped Merriam's turkeys were secured from New Mexico, flown to Wisconsin, and released by the state in Grant County in 1967.

The areas into which the transplants were made appear to be more typically *silvestris* range than the Meadow Valley Area, which is the poorly drained bed of glacial Lake Wisconsin. The transplant areas are hilly (almost mountainous) and are heavily timbered with a mixed hardwood forest of elm *(Ulmus americana),* white ash *(Fraxinus americana),* hard maple *(Acer saccharum),* white oak *(Quercus alba),* red oak *(Q. rubra),* black oak *(Q. velutina),* and shagbark hickory *(Carya ovata).* Some extensive bottomland habitats of oak, bitter-nut hickory (*C. cordiformis),* basswood *(Tilia americana),* soft maple *(A. saccharinurn),* and river birch *(Betula nigra)* are present. Spring seeps occur, which are notably absent in the Meadow Valley Area.

The Wisconsin areas occupied at present by turkeys are listed in Table 16.

Table 16. Occupied turkey range, winter, 1969-70, in Wisconsin.

Area	Occupied Range (square miles)
Meadow Valley-Necedah	300
Clark County	Unknown
Pepin-Buffalo counties	30
Marinette County	60
Crawford County	90
Grant County	40

The gross occupied range (Table 16) was determined by signs, gobbling counts, sight observations, and reports from landowners. It is evident from these determinations that the turkeys are increasing in number and extending their range. There are no reliable data upon which a population estimate can be based.

HUNTING

Spring gobbler hunts in the Meadow Valley-Necedah Refuge area were held in 1966, 1967, and 1968. Approximately 250 square miles of range were open to hunting. Hunting was by permit only, and selections were made by an IBM machine from applications. Over 12,000 hunters applied for the 2,500 permits available each year. Hunting was limited to five 3-day periods, for 250 hunters each period. Turkey hunting in Wisconsin was popular with the public and had the enthusiastic support of sportsmen's groups.

Successful hunters were required to register their kills. The registered kill was 20, 21, and 18 gobblers for the years 1966, 1967, and 1968, respectively. While 80 percent of participating hunters heard gobbling, only 27 percent saw turkeys and less than 1 percent were successful in killing a bird.

MANAGEMENT

The only land management that may benefit the turkey is the planting of approximately 250 acres of food patches on the Meadow Valley Wildlife Area. The food patches are rotated every other year, so about 500 acres of openings are available to turkeys in the Meadow Valley Wildlife Area. Both the food patches and the fallow openings are consistently frequented by the turkeys.

The Meadow Valley Wildlife Area is not considered optimum turkey habitat. The turkey population on this area apparently erupted in 1966-1968, but it has since dwindled. The primary limiting factor appears to be winter conditions, although June rainfall patterns are important.

How successful the transplants into the hill country of western Wisconsin will be is open to question. Food is no problem in the hill country, for the south sides of the hills almost always open up soon after a snowfall. Turkeys in the hill country have been observed feeding in freshly spread manure. In this settled country, poaching is suspected, but the turkey at this time is surviving and expanding its range.

PREDATION

Under ordinary circumstances, predation does not appear to be a serious factor with Wisconsin's turkeys. Most of the possible predators are present on the turkey range. Coyotes, great horned owls *(Bubo virginianus)*, and bald eagles are common. Golden eagles *(Aquila chrysaëtos)* and bobcats are rare. During the winter of 1968-69, when turkeys were immobilized by the prolonged snow conditions, one flock of seven birds under observation was reduced to two birds by bald eagles. A game manager observed a hen turkey successfully defend her brood against a red fox. Field signs, read by experienced game managers, indicated turkey kills by bobcats, coyotes, and possibly by a red fox on a weakened individual.

7

STATUS OF WILD TURKEYS IN MICHIGAN

F. J. Ignatoski

ABSTRACT

In the fall of 1969, Michigan had an estimated turkey population of 4,000, descendants of more than 800 game-farm turkeys stocked between 1954 and 1958. Successful annual hunting seasons had been held each year since 1965; by the close of the spring 1970 season, 701 turkeys had been taken, Mortality due to weather and disease was minimal. Turkeys were most abundant in the oak-forest habitat.

Native wild turkeys *(Meleagris gallopavo silvestris)* disappeared from Michigan around 1900 (Barrows 1912:236-237). Several unsuccessful attempts were made between 1919 and 1942 to reestablish them (Ruhl 1954). The first successful plantings were made by the Michigan Department of Conservation in 1954.

The wild turkey stock from which we obtained our birds was developed by the Woodmont Rod and Gun Club of Hancock, Maryland, and originated from hens that were three-fourths wild serviced by wild gobblers. The 50 turkeys and 400 eggs forming Michigan's original imported turkey stock came from the Allegheny Wild Turkey Farm of Julian, Pennsylvania.

The 50 turkeys were released on March 23 and 24, 1954, at six sites in the Allegan State Game Area. The 400 eggs were incubated at the state game farm near Mason, Michigan, and 152 poults were subsequently released on September 8 and 10, 1954, also in the Allegan State Game Area (Wilson and Lewis 1959).

The Allegan State Game Area, consisting of approximately 40,000 acres, is located within about 100,000 acres of hardwood-pine *(Pinus* spp.) forest. This area provides the only suitable habitat remaining in the original Michigan turkey range, which was the southern half of the Lower Peninsula (Figure 9). About 60 percent of the area is oak (*Quercus* spp.), 15 percent evergreens, 15 percent mixed hardwoods, and 10 percent grassy or brushy openings.

Between 1954 and 1963-the year when Department game-farm stocking terminated-the Department of Natural Resources released 882 game-farm turkeys at various locations throughout the state (Figure 10). In addition, 84 turkeys were captured between 1961 and February 1970 from established flocks within Michigan. Figure 10 also shows the recorded private stockings in the state. Additional unknown numbers of turkeys were released by private sources during this period.

Turkeys in 1969 were found in 25 Michigan counties, mostly in the northern half of the Lower Peninsula (Figure 9). The estimated statewide population in the fall of 1969 was 4,000 turkeys, although census-taking is difficult. Most of the population data came from a statewide survey in which all Department of Natural Resources and U.S. Forest Service field personnel in turkey

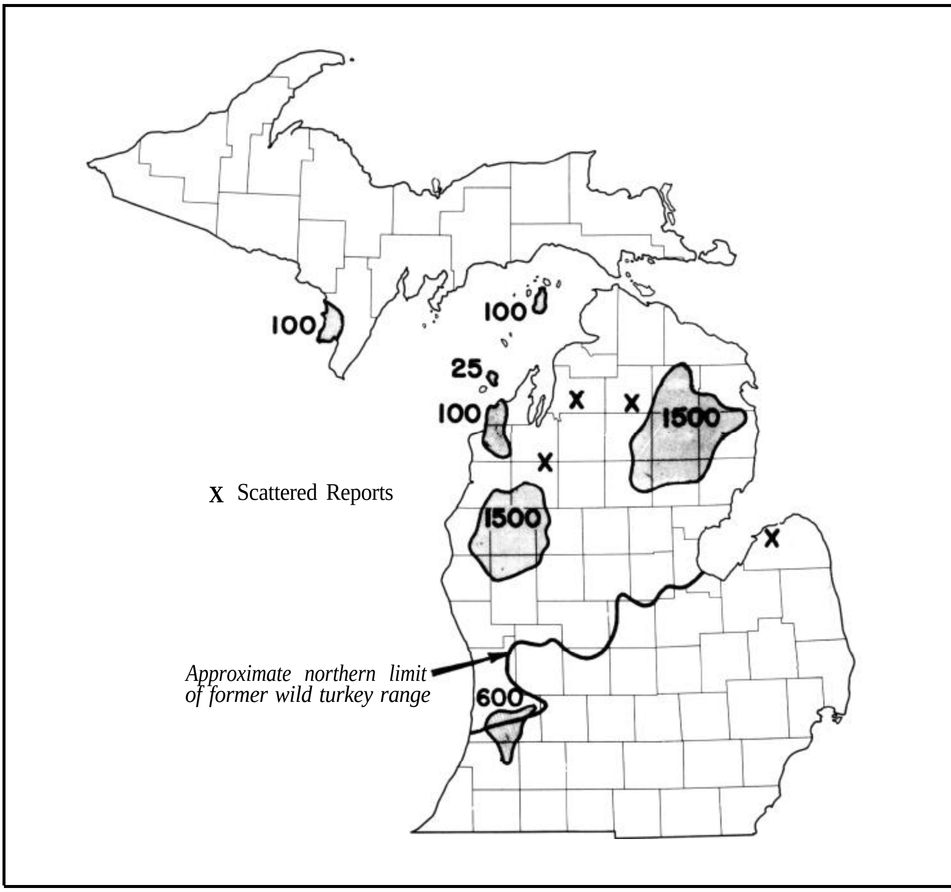


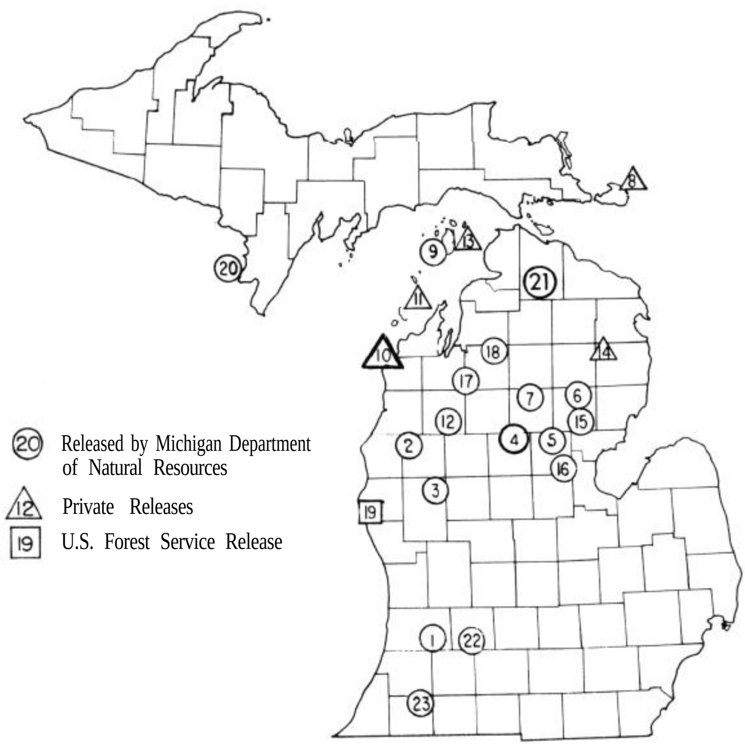
Figure 9. Turkey population estimates, fall, 1969.

areas reported the number, age, sex, and location of all wild turkeys observed. Winter counts, made in prime turkey areas, were occasionally used in this survey.

Turkeys appear to have adapted exceptionally well to the northern Michigan environment. Winter losses have been light, even with 60 to 110 inches of snowfall per year. After two seasons of personal observations in areas where 80 to 100 inches of snow were recorded, the known winter turkey losses were less than 5 percent.

Blackhead disease, caused by the protozoan *Histomonas meleagridis,* has occasionally caused mortality in Michigan's turkey flocks. Among 54 wild turkeys examined by our pathologist during the period 1954-1969, 12 cases of blackhead were diagnosed. The importance of blackhead disease as a limiting factor in population growth in Michigan turkey flocks is not known. In an effort to reduce this potential hazard, Michigan has prohibited the importation of wild turkeys into the state, has greatly restricted turkey stocking by the public, and has discouraged winter feeding, a possible source of blackhead contamination.

With the advent of established turkey populations in limited areas, hunting seasons by permit were begun in the fall of 1965 (Janson and Zorb 1966).



No.	Year	No. of Releases
1	1954	204
2	1955-57	159
3	1955-57	123
4	1956-57	132
5	1956	16
6	1956-57	112
7	1956-57	36
8	1956-58	39
*9	1961	6
10	1961	76
11	1961	8
12	1961-62	82
13	1962	32
14	1963	100
15	1963	25
16	1963	25
17	1963	25
18	1963	25
*19	1964	19
*20	1965	21
*21	1966	11
*22	1966 - 70	11
*23	1970	6

Figure 10. Game-farm turkey releases in Michigan. *Livetrapped turkeys from established Michigan flocks.

A total of 701 turkeys have been harvested through the spring of 1970 (Table 17).

The data presented in Table 17 do not necessarily indicate turkey populations. The population level is only one of many variables that influence the hunting success. These include a varying number of hunting areas and area size, number of permits issued, length of season, and weather conditions.

Weights of turkeys shot by hunters were relatively stable from year to year, even though the availability of mast crops and other foods varied considerably

Table 17. Summary of wild turkey hunting seasons, 1965-1970, in Michigan.

Season	Dates	Permits Issued	Total Kill	Males (percent)	Juveniles (percent)	Average Weights (lb-oz) Adult Male	Adult Female	Juvenile Male	Juvenile Female
Fall									
1965	Nov. 6-14	400	82	52	49	16-12	8-11	10-3	7-3
1966	Nov. 2-10	900	164	54	55	17-8	8-12	9-10	5-15
1967	Nov. 3-12	1,400	125	60	64	16-15	8-15	8-13	5-11
1968	Nov. 1-10	1,500	135	50	55	16-8	8-6	9-3	6-0
1969	Oct. 31-Nov. 3, Nov. 7-10	1,000	29	55	44	16-9	9-2	10-7	6-4
Spring									
1968	May 6-12	800	25	100	20	18-3	-	13-3	-
1969	May 9-12, May 16-19	3,200	50	100	6	18-9	-	-	-
1970	May 6-20	4,294	91	100	20	18-0	-	13-8	-

during these years. Excellent mast production was observed in 1965 and in 1966, in contrast with poor crops in 1968 and 1969, yet there was no significant change in body weight. Since acorn crop failures occur 3 out of 5 years in northern Michigan (Duvendeck 1964), I conclude that survival of wild turkeys in northern Michigan does not seem dependent on the acorn crop.

Weather conditions appear to have had a greater effect on the number of turkeys killed during the hunting seasons than has the number of permits issued. Snow cover existed for 3 or 4 days in 1966 and in 1967; there was heavy rain in 1969, and no snow and little rain in 1968.

Gobbler hunting was first permitted in the spring of 1968 and hunter satisfaction was high. Spring turkey hunting is still new to Michigan sportsmen, but their success and enjoyment are expected to increase as they become more adept at turkey calling. Shotguns and bows and arrows are the only legal weapons during the spring season, and hunting is terminated at noon.

To achieve some management guidelines, a range analysis was conducted to determine the forest cover types and size-class distribution on two, 20-square-mile areas containing relatively high populations of turkeys. Data were collected from cover-type maps made from surveys conducted by the Michigan Department of Natural Resources, Forestry Division and the U.S. Department of Agriculture. Aerial interpretation was followed by ground surveys to obtain the basal-area and size-class data used in Table 18. The results show a predominately oak *(Quercus rubra, Q. alba, Q. velutina)* area with 55 to 63 percent in the pole or larger size-classes, mixed with scattered clumps of jack pine *(Pinus banksiana),* aspen *(Populus tremuloides),* red maple *(Acer rubrum),* and white cedar *(Thuja occidentalis).* Water was available in streams, lakes, ponds, and small marshes. Grassy openings occupied 5 to 18 percent of each area. The information derived from this habitat analysis is similar to that pertaining to wild turkey range as discussed by Mosby and Handley (1943) and Kozicky and Metz (1948).

Since white-tailed deer *(Odocoileus virginianus)* and ruffed grouse *(Bonasa umbellus)* are also important game species in the areas with turkey populations, the Department will try to manage the forest to maintain a maximum of 10 to 15 percent in the sapling (0 to 4 inches dbh) size age-class.

Table 18. Percentage composition of trees (dbh in inches) on two 12,800-acre areas with relatively high populations of turkeys in Michigan.

Tree Size	Oak	Jack Pine	Aspen	Cedar	Maple	Grass	Water
Area 1 -Nirvana Trails							
0–4	5	2	2	–	–	18	1
5–10	40	5	7	1	3	–	–
11+	15	–	–	–	1	–	–
Area 2 -Wolf Lake Hills							
0–4	11	4	1	–	–	5	1
5–10	48	10	3	1	1	–	–
11+	15	–	–	–	–	–	–

This, it is hoped, will provide a proper rotation to sustain turkeys, grouse, and deer for the Michigan hunter.

Turkeys in Michigan are also found in other mixed-forest types, including areas where jack pine and northern hardwoods are the dominant species. Oak, however, is currently the single most important group.

This page has been intentionally left blank to preserve the continuity of the original document.

8

CALIFORNIA'S TURKEY STOCKING PROGRAM*

Harold T. Harper and Walton A. Smith

ABSTRACT

Wild turkeys *(Meleagris gallopavo)* have been stocked in California since 1877. From 1938 to 1951, 3,350 game-farm turkeys were stocked on 71 sites in 23 counties. Turkeys were successfully established in three areas from these introductions of game-farm stock. One release of 23 wild-trapped birds, obtained from Arizona in 1949-50, became established in the Brush Creek area of Kernville. The turkey stocking program was temporarily terminated in 1951. In 1958, 62 wild-trapped turkeys from Texas were flown to San Diego for release. These birds were established near Pine Valley, San Diego County. From 1959 to 1969, wild-trapped turkeys have been released in 35 areas of the state. These birds were obtained from established flocks in San Luis Obispo and San Diego counties, three western states, and Texas. Excellent reproduction has been reported for most of the areas stocked. Potential turkey habitat is mainly found on private lands, with more than 9 million acres of hardwoods, woodland-grass, woodland, chaparral, pine forests, and mixed conifers holding promise for wild turkey stocking. Some Forest Service lands located mainly in the northern part of the state are also suitable for stocking.

The wild turkey was not a part of the fauna when the first settlers arrived in California. Fossil remains of a turkey-like bird *(Parapavo californicus)* have been preserved from the asphalt pits at Rancho La Brea in Los Angeles County (Schorger 1966: 64). Skeletal remains of a turkey *(M. richmondi),* similar to our present type, have also been found near Mission San Jose in Alameda County (Schorger 1966: 65). These birds lived during the Pleistocene or Ice Age and disappeared during more recent times for unknown reasons.

There may have been many reasons for the absence of the present-day wild turkey from California as well as other western states. It is our belief that ecological or geographic barriers, in the form of the deserts of the southwestern United States and the high north-south mountain ranges, prevented the spread of wild turkeys to the westernmost states. These western states, formerly devoid of wild turkeys, evidently possessed the prerequisites for good turkey habitat, as evidenced by the recent successful introduction (Burger 1954).

EARLY INTRODUCTIONS

On the premise that California's habitats were suitable for wild turkeys, the first known introduction of Mexican turkeys *(M. g. gallopavo)* was made in 1877 on Santa Cruz Island by private ranchers (Phillips 1928). The Department of Fish and Game reared about 1,240 Mexican turkeys from stock ob-

* A contribution of Federal Aid in Wildlife Restoration Project W-47-R, Upland Game Investigations.

tained in western Mexico-specifically from Sonora and Sinaloa-between 1888 and 1918. Of these, 22 were released in the San Bernardino Mountains of San Bernardino County in June 1908. In October 1908, 26 turkeys were received from Mexico and retained on the game farm for breeding stock (Phillips 1928).

Burger (1954: 124) stated: "Due to the extreme difficulty of raising birds of pure wild ancestry in captivity, the game farm stocks of turkeys were of hybrid origin, resulting from crosses between the domestic turkey and one or more of the wild subspecies. Apparently the latter were mainly the Mexican turkey *(Meleagris gallopavo gallopavo)* and the Merriam's turkey *(M. g. merriami)* of the Southwest." About 1928, the Department began a series of extensive releases of these hybrid turkeys from state game farms. This program continued until 1951, with a total of 3,350 turkeys stocked in 71 different sites in 23 counties (Figure 11).

Three areas in California were successfully established with hybrid game-farm turkeys-one near Cloverdale in Sonoma County, one in Santa Clara County southeast of Gilroy, and the most successful in San Luis Obispo County.

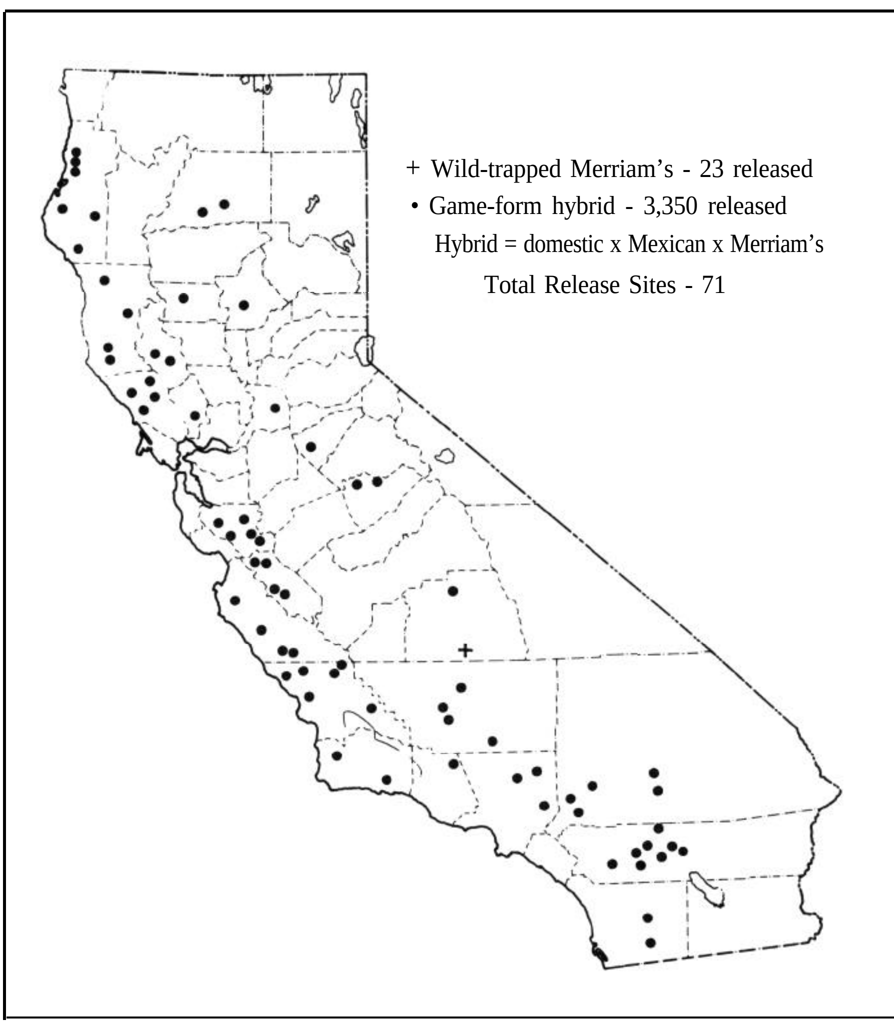


Figure 11. Release sites of game-farm turkeys in California, 1928-1951.

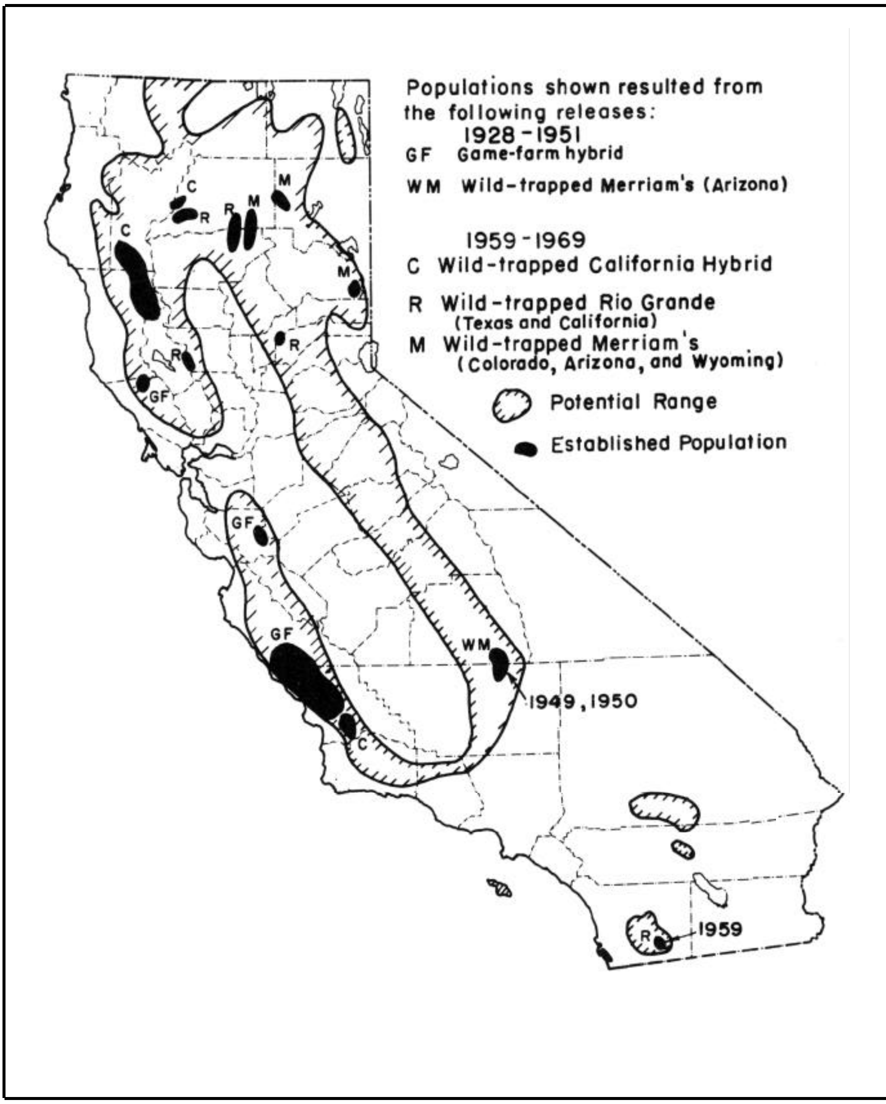


Figure 12. Established game-farm turkey populations in California, 1969.

These areas were considered established by 1954 (Burger 1954) and are shown in Figure 12.

In 1949 and 1950, 23 wild-trapped Merriam's turkeys were obtained from Arizona and released in the Brush Creek area near Kernville on the west slopes of the Sierra Nevada Mountains (Burger 1954). This planting was an almost immediate success, and by 1955 about 200 to 300 birds were present in the area.

After the apparent failure of game-farm stock in most areas planted, interest in the program was lost, and turkey stocking was temporarily terminated in 1951.

RECENT INTRODUCTIONS

In the late 1950's, renewed interest was generated by the San Diego sportsmen's groups, and their county fish and game commission requested in May

1958 that the Department cooperate in a program of introducing wild turkeys into San Diego County.

The San Diego County Commission and the Department began negotiations with the King Ranch and the Texas Game Department for Rio Grande turkeys *(M. g. intermedia).* Also, the Arizona Game and Fish Department was contacted for wild-trapped Merriam's turkeys. The request to Texas was fulfilled when 23 toms and 34 hens were trapped near Kingsville, Texas. These were picked up and flown in the Department's airplane to San Diego for release near Pine Valley, San Diego County, on November 13, 1959. Only six birds died in transit. One year after liberation, biologists of the Department of Fish and Game reported up to 100 birds in the release area. In 1960, 10 toms and 16 hens were sent from Arizona and released on Volcan Mountain northeast of Wynola, San Diego County, between February 16 and 19, 1960. These birds apparently were placed in undesirable habitat since no reproduction was reported and the birds have disappeared.

The Department again in 1960 became interested in stocking turkeys but using only wild-trapped birds either transplanted from established flocks in

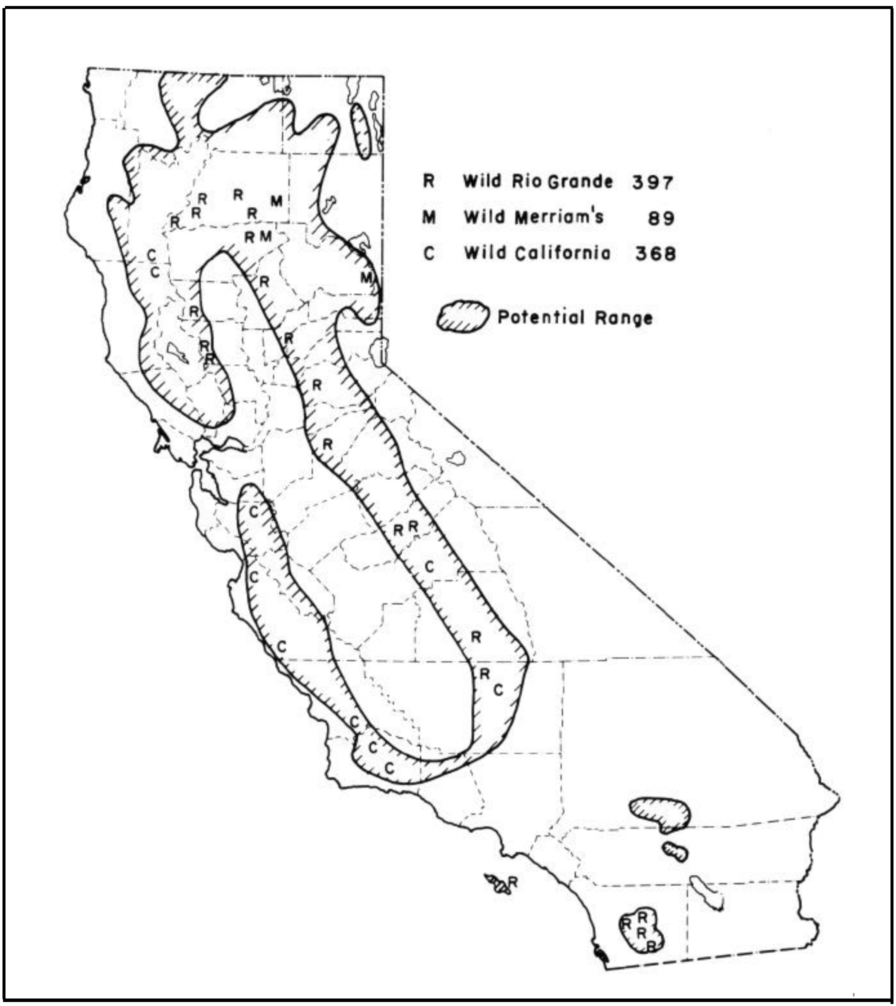


Figure 13. Releases of wild-trapped turkeys in California, 1959-1969.

California or obtained from other states. Studies by Leopold (1944) and Knoder (1959) have shown that game farm-reared turkeys released into the wild have little chance of surviving and becoming established.

From 1959 to the fall of 1969, wild-trapped turkeys have been released in 35 areas of the state (Figure 13). Of these, 368 were descendants of game-farm turkeys trapped in San Luis Obispo County, 89 were Merriam's turkeys obtained from Colorado, Wyoming, and Arizona, 348 were Rio Grande turkeys from Texas, and 49 were trapped from flocks in San Diego County. Table 19 shows the source and stocking sites since 1959. Releases have been more numerous in the northern half of California, where the largest blocks of turkey habitat are located. Most of the releases are too recent to determine ultimate success. However, excellent reproduction occurred the first year after release on most of the areas stocked. The release in March 1969 of 7 hens and 7 toms (wild-trapped California hybrids) on the Mt. Hamilton range resulted in an actual count, by biologists, of 28 birds after the first breeding season. The 1961 release of wild-trapped hybrids in the Huasna district of San Luis Obispo County increased from 36 birds to about 100 after the first breeding season, and the population was estimated to be 250 to 300 birds after the breeding season of 1965.

POTENTIAL HABITAT

By far, most of the better habitat in California for wild turkeys is found on privately owned ranches and farms. U.S. Forest Service lands, primarily in the northern counties, hold promise for stocking wild-trapped birds from established populations and out-of-state birds. Forest Service lands along the western slopes of the Sierras may be suitable, but private lands with light human activity have the greatest potential. Habitat along the foothills of the Sierras in many areas is too densely populated with people to have much value for wild turkeys. It has been estimated that California's potential acreage for wild turkeys amounts to 14,697,239 acres of habitat, of which 369,540 are in hardwoods; 4,602,241 woodland-grass; 758,094 pine *(Pinus* spp.) forest; 2,822,443 mixed conifers; 2,150,432 Douglas fir *(Pseudotsuga menziesii)* when associated with pine forests; 341,764 pinion pine-juniper *(P. cembroides-Juniperus* spp.); 1,977,929 woodland-chaparral; 632,410 grassland-meadow; and 1,042,386 less valuable habitat (Harper 1970).

Wild turkey release sites have been selected within the boundaries of the potential habitat delineated by Figure 13 on the basis of remoteness from human habitation, abundance of water-natural lakes, streams, rivers, springs, or man-made reservoirs and stock ponds-degree of landowner cooperation, and vegetative composition. The habitat generally conforms to the vegetative types described by Jensen (1947). Before the state stocks privately owned lands, the landowner must agree to a trapping and transplanting program when biologists of the Department determine that the turkey population is sufficient to allow the removal of surplus birds. The population is judged to be sufficient for live-trapping when the population has tripled the original numbers stocked, which usually occurs in 3 to 5 years.

Hunting season recommendations, based on population counts by field biologists, are submitted to the Fish and Game Commission for approval. Future hunting season recommendations have been set forth by Harper (1970).

FOOD HABITS

The Department's knowledge of turkey requirements was enhanced through the collection of 59 wild turkeys for food-habit studies in San Luis

Table 19. Wild turkey stocking program, 1959-1969, in California.

Stock Area Stocked	County	Date of Release	Number Toms	Number Hens	Source of Stock
Wild-trapped California *hybrid*					
Huasna	San Luis Obispo	March 1961	15	21	San Luis Obispo County
Black Butte River	Mendocino	March 1962, 1964,1965	16	40	"
Indian Dick Guard Station	Trinity	January 1963, 1965	18	33	"
Foxen Canyon	Santa Barbara	October 1965	18	24	"
Lake Cachuma	Santa Barbara	October 1965	19	18	"
French Gulch	Shasta	October 1965	14	12	"
Tularcitos Canyon	Monterey	October 1965, 1966	10	7	"
Watts Valley	Fresno	October 1967	5	20	"
Greenhorn Mt.	Kern	October 1968	4	16	"
Raymond (5 mi SE)	Madera	March 1969	2		"[a]
Raymond (7 mi NE)	Madera	March 1969	2	-	"[a]
Mt. Hamilton	Santa Clam	March 1969	7	7	"
Plaskett Ridge	Monterey	September 1969	18	22	"
		Subtotal	148	220	
Wild-trapped Merriam's					
Volcan Mountain	San Diego	February 1960	10	16	Arizona
Cinder Cone	Shasta	December 1966	4	10	Colorado
Doyle	Lassen	January 1967	10	24	Wyoming
Middle Ridge	Tehama	February 1967	4	11	Arizona
		Subtotal	28	61	
Wild-trapped Rio Grande					
Corte Madera	San Diego	November 1959	23	34	Texas
Snobel Valley	San Diego	November 1965	11	2	San Diego County
Spenceville W.A.	Yuba-Nevada	February 1967, 1969	7	16	Texas
Bear Valley	Colusa	February 1967, 1968.1969	7	27	"
Duncan Creek (Ono)	Shasta	February 1968, 1969	6	23	"
Millville	Shasta	January 1969	4	12	"
Bear Mountain	Calaveras	January 1969	2	12	"
Frenchtown	El Dorado	January 1969	-	15	"
Frenchtown	El Dorado	January 1969	2	-	San Diego County[b]
Williams	Colusa	January 1969	4	8	Texas
Williams	Colusa	February 1969		9	"
Stonyford	Glenn	February 1969	-	12	"
Stonyford	Glenn	February 1969	3	-	San Diego County[b]
Bangor	Butte	February 1969	-	12	Texas
Bangor	Butte	February 1969	3	-	San Diego County[b]
Manton	Tehama	January 1969	-	12	Texas
Manton	Tehama	January 1969	2		San Diego County[b]
Platina	Shasta	January 1969		11	Texas
Platina	Shasta	January 1969	2	-	San Diego County[b]
Glennville	Kern	January 1969	4	12	Texas
Elderwood	Tulare	January 1969	1	14	"
Elderwood	Tulare	January 1969	2	-	San Diego County[b]
Raymond(5miSE)	Madera	January 1969	-	11	Texas
Raymond(5miSE)	Madera.	January 1969	2	-	San Diego County[b]
Raymond(7miNE)	Madera	January 1969	-	12	Texas
Raymond(7miNE)	Madera	January 1969	2		San Diego County[b]
Paynes Creek	Tehama	January 1969	-	15	Texas
Paynes Creek	Tehama	January 1969	2	-	San Diego County[b]
Cuyamaca	San Diego	January 1969	3	13	San Diego County
Catalina Island	Los Angeles	February 1969	4	19	Texas
		Subtotal	96	301	
		Total	272	582	

[a]California hybrid males used to balance sex ratios in Rio Grande plants.

[b]Rio Grande males from San Diego County used to balance sex ratios.

Obispo County in 1966. The collection included 15 birds taken in February, 16 in May, 14 in August, and 14 in November. Of these, 44 were adult males, 9 adult females, 3 immature males, and 3 immature females (Smith and Browning 1967). It was determined that wild oats *(Avena fatua* and *A. barbata)* were the single most important food item taken on a year-round basis. In all, 53 plant and 12 animal items were found to be eaten by the turkeys collected. Through the knowledge of the distribution of wild oats and oak forests, the Department calculated that approximately 9 million acres hold promise as habitat for wild turkeys. This acreage does not include the ponderosa pine-oak *(Pinus ponderosu-Quercus* spp.) belt in the northernmost counties.

MANAGEMENT POSSIBILITIES AND IMPLICATION

Turkey management is not basically different from the management of other species of wild birds, but habitat needs of turkeys are often more demanding than those of other species, and greater attention must be given to disease prevention and maintenance of pure strains.

Some populations of turkeys have undoubtedly made adjustments to their environments that have permitted them to survive under what seem to be new circumstances for turkeys. The adjustment to their environment and their ability to survive, may have contributed to the success of a cross between wild and game-farm birds in the San Luis Obispo area. Lindzey (1967b:549) stated: "Experience suggests that subtle behavioral changes which appear to have taken place in some populations of birds may be successful adaptations to assure adjustment to new environments. We now find these birds surviving even in farm woodlots and other habitats considered foreign to those occupied by the original wild turkey." Now, after many generations, a wild California hybrid turkey may have developed (Figure 14). This is not to say that another stocking program using game-farm birds should be initiated, but we should recognize that we have three established flocks in California from releases of wild strain, game-farm birds. These stocks should be perpetuated and maintained in the wild to ensure that these populations remain as virile and wild as possible.

Within two or three successful breeding seasons-the exact times to be determined by biologists in those areas where releases have been made-the Department will embark on a trapping and transplanting program to hasten the spread of turkeys within selected habitats. Within three to five breeding seasons after a release, a hunting season should be considered if successful reproduction occurred during the previous years. Eight counties are being considered by the Fish and Game Commission for the 1970-71 turkey season; these are in addition to San Luis Obispo County, which was open in 1968 and 1969.

The eastern wild turkey *(M. g. silvestris)* may fit into California's north coastal belt where rainfall and vegetation compare more closely with that on the eastern seaboard, and thus may establish populations in areas that the Merriam's and Rio Grande turkeys will not tolerate.

Future stocking plans depend upon availability of wild-trapped birds, both from within the state and out of state. Trapping will continue on flocks already established in California, not only from those in San Luis Obispo County but from other areas as well. The California hybrid turkey established in San Luis Obispo County has been successfully established in northern California and has proven to be a hearty, wily bird. Also, some birds from plantings made within the past 2 years should be trapped and transplanted to adjacent areas, if production during 1970 equals or exceeds that of 1969. Utah has offered wild-trapped Merriam's turkeys to aid us in our program (personal communications),

Figure 14. Wild California hybrid turkeys on the Eagle Ranch, San Luis Obispo County, October 15, 1969. Oak woodland interspersed with grassland is preferred habitat for both Rio Grande and California hybrid wild turkeys in California.

and Texas has consented to another stock of wild-trapped birds from the Aransas National Wildlife Refuge and also from other flocks on private lands (personal communications).

HUNTING SEASONS

Two turkey-hunting seasons have been held in California-one for 1 day on November 23, 1968, and the other for 2 days on November 22 and 23, 1969. Hunting was allowed in San Luis Obispo County both years, with one turkey of either sex as legal game. Legal weapons were shotguns and bows and arrows; shooting hours were from one-half hour before sunrise to one-half hour after sunset. There were no restrictions on hunter numbers, and a special license or tag was not required.

During the 1968 season, Department personnel at six check stations contacted 213 hunters who bagged 29 turkeys for a 13.6 percent success. In 1969, field checks by Department personnel resulted in contacting 124 hunters who bagged 32 turkeys for a 25.8 percent success. Holbrook and Lewis (1967:364) gave statewide hunter success as about 5 percent in Tennessee and Kentucky. The results from the first hunt held in Oregon indicated a 14 percent hunter success (personal communication), and Idaho indicated a 16.3 percent hunter success (personal communication).

Less than 1 percent of the estimated turkey population in San Luis Obispo County was killed during each of the first two seasons. Mosby (1967:127) summarized the estimated percentage of the population taken in hunting in four states as 12.8 percent for Florida, 24.5 percent for West Virginia, 29.3 percent for Virginia, and 10 to 50 percent for Pennsylvania.

The kill of 29 turkeys in 1968 consisted of 20 adults, 8 immatures, and 1 unclassified. In 1969, the kill of 32 turkeys consisted of 10 adults, 17 immatures, and 5 unclassified. Adult birds accounted for 66 percent of the bag in 1968 and 30 percent in 1969.

Both seasons were enthusiastically endorsed by the hunters and the Department. Consequently, it is anticipated that the season will continue, with more areas opened as turkey populations increase in other areas throughout the state.

9

RESTORATION OF THE WILD TURKEY IN INDIANA

Gerald D. Wise

ABSTRACT

Eastern wild turkeys *(Meleagris gallopavo silvestris)* were extirpated from Indiana by 1900, and the major portion of their former range is under cultivation. Attempts to restore wild turkeys, using wild-trapped birds, began in 1956, and, at present, 10 areas have been stocked. Releases made from 1963 through 1966 in Indiana have been providing turkeys for additional transplants within the state. Present management efforts have primarily consisted of trapping and transplanting turkeys, and Indiana's first modern turkey hunt is scheduled for the spring of 1970.

Restoration of the eastern wild turkey to much of its former range has generally followed the same steps: protective legislation, establishment of refuges, stocking of wild-trapped turkeys, and habitat management (Lindzey 1967a). Depending upon available habitat, the degree of restoration has varied among the many states throughout the traditional range.

EXTENT OF TURKEY HABITAT

Original range of the wild turkey in Indiana included most forested areas of the state (Figure 15). However, by 1900 (Leopold 1929), as a result of overharvest and habitat destruction by fire, grazing, and timber cutting, they had been extirpated. Their present range is but a fragment of the original, and the potential range is limited (Figure 15). As of 1967, only 17 percent of the state's land area supported forest cover (Essex 1968).

Acquisition of cut-over forest lands by both state and federal agencies began by 1930 and totaled 250,000 acres by the mid-1960's. Reforestation of these areas stimulated thoughts concerning woodland game species and eventually resulted in reintroduction of the wild turkey.

TURKEY INTRODUCTIONS

The first introduction of wild turkeys was a private venture. Through the efforts of U.S. Navy personnel, five eastern wild turkeys (four hens and one tom, Table 20) were trapped in 1956 from Schumaker Naval Depot, Arkansas, and released on Crane Naval Ammunition Depot in Martin County, Indiana (Hamilton 1962). Scattered old fields and oak-hickory *(Quercus-Carya)* forests provide potential turkey habitat over most of this 60,000-acre installation of unglaciated topography. A network of storage bunkers and roads is present throughout, but none of the area is farmed or grazed. Initially, the restocking was successful, and during the winter of 1961-62 the population was estimated

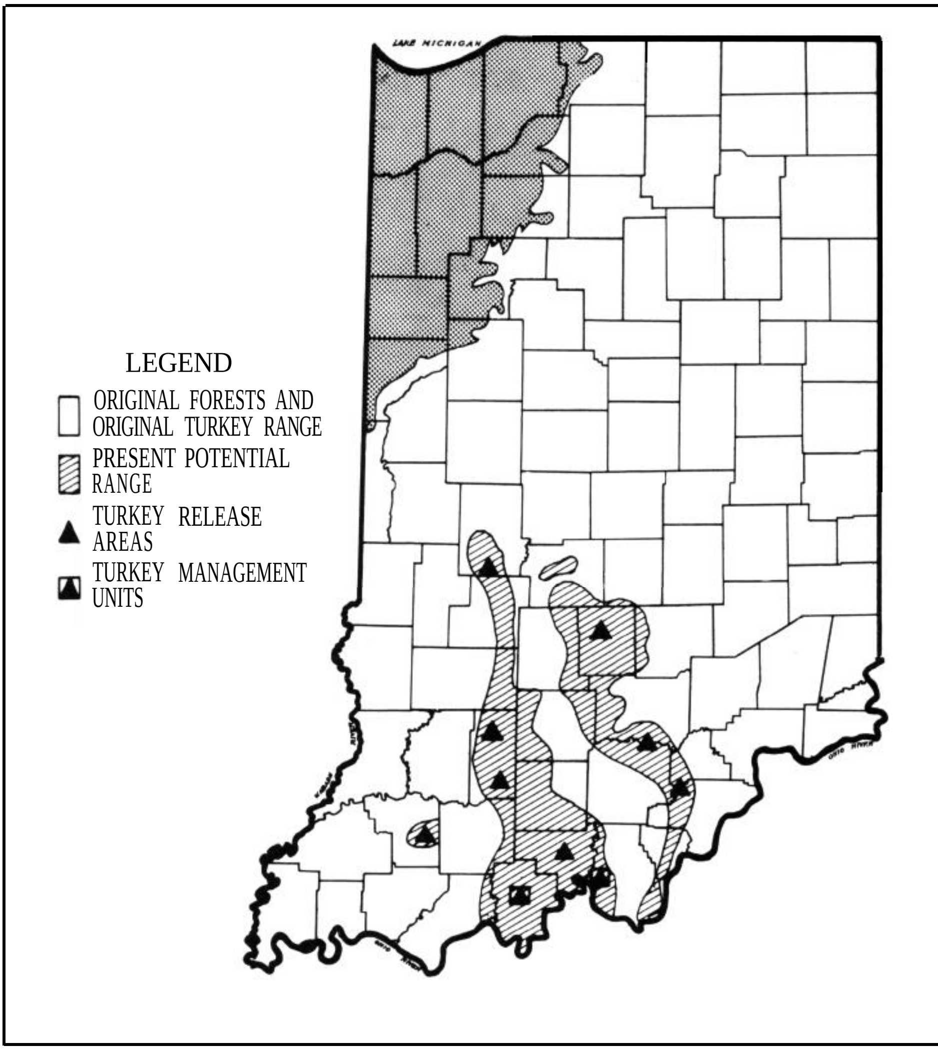


Figure 15. Range and distribution of the wild turkey in Indiana, 1970.

to be between 100 and 200 birds (Hamilton 1962). During the winter of 1961-62, seven turkeys (five hens and two toms) were trapped from the Depot by personnel of the Indiana Department of Natural Resources and moved to Brown County State Park, a 15,000-acre tract (Figure 15). For unknown reasons, turkey populations on the Naval Depot began to decline in 1963, and by 1966, only a remnant of the original population remained.

Turkey introductions were continued from March 1962 through January 1966, when Department personnel released 56 wild-trapped turkeys obtained from the Missouri Department of Conservation. These birds were released on four areas in the southern third of the state (Figure 15 and Table 20). Five were released in Brown County State Park in 1962-63, 21 in Perry County in 1963, 15 in Harrison County during 1964-65, and 15 in Clark County in 1965-66. All releases were successful, and each area, except Brown County State Park, is furnishing stock for transplanting.

Table 20. Releases of wild-trapped turkeys, 1956-1970, in Indiana.

Release Area	Approximate[a] Size (acres)	Date of Release	Number Released: Adults Toms	Adults Hens	Juveniles Toms	Juveniles Hens	Source	Status and Estimated Spring Density, 1970
Crane NAD, Martin County	60,000	Feb. 1956	1	4	(age unknown)		Arkansas	Declined from high of 100-200 in 1962 to less than 1 per sq mile
Brown County State Park, Brown County	15,000	Jan. 1961 to Mar. 1963	2 2	3 -	– –	2 3	Crane NAD and Missouri	Immediate dispersion followed by low population levels of less than 2 per sq mile
Perry County	6,000	Oct.-Dec. 1963	6	6	3	6	Missouri	8-10 per sq mile Good dispersion
Harrison County	20,000	Jan. 1964 to Feb. 1965	6	4	–	5	Missouri	6-8 per sq mile
Clark County	20,000	Nov. 1965 to Jan. 1966	5	4	–	6	Missouri	8-10 per sq mile Fair dispersion
Orange and Martin counties	5,000	Dec. 1968 to Mar. 1969	5	–	2	6	Perry and Harrison counties	Good reproduction Good dispersion
Pike County	3,000	Oct. 1969	4	3	5	8	Perry County	Too recent to evaluate
Jackson and Washington counties	14,000	Oct. 1969	2	1	3	4	Perry and Harrison counties	Too recent to evaluate
Owen County	6,000	Mar. 1970	–	2	2	6	Harrison and Clark counties	Too recent to evaluate
Crawford County	3,000	Mar. 1970	2	3	–	6	Clark County	Too recent to evaluate

[a]Size of areas delineated by continuous or semi-continuous public ownership and does not include the potential range, which is composed of various ratios of public to private ownership.

TURKEY MANAGEMENT

Next in the restoration program was the establishment of two 6,000-acre turkey management areas-one on national forest lands in Perry County and one in Harrison County on state forest land (Figure 15). The main basis for selection of these two areas was that they were contiguous tracts of publicly owned land. Almost all other government-owned forest lands are interspersed among small private holdings, and control of hunting and harvest of timber is difficult or impossible. The perimeter of each area was marked by a single No. 9 wire and numerous signs, Trails and roads were closed with gates to restrict vehicular access and all hunting was terminated. Timber sales were prohibited during turkey nesting seasons and portable sawmills were not allowed in the areas.

In an attempt to benefit both wild turkeys and white-tailed deer *(Odocoileus virginianus),* a program of woodland habitat improvement was begun in 1953. Approximately two ponds per Section were built during 1954-55 on both management units. Wildlife openings, averaging 1 acre in size and numbering five per Section, were also constructed on each area. Less than half of these were completed before the turkey releases and were left unseeded; the remaining openings were built from 1966 through 1968 and were seeded to a clover-lespedeza *(Trifolium-Lespedeza)* mixture.

Currently, management efforts for turkeys are trapping and transplanting. Trapping is done in the fall during October and November and in the spring during March. Although there has been greater success per effort in the fall, spring releases still seem preferable; they reduce the chances of wide dispersion and can be made with fewer birds, since winter mortality is not a factor. Defeathering of birds in the trapping process is less severe in spring than in fall, and damaged feathers will be replaced sooner.

Several combinations of bait have been used, but shelled corn *(Zea mays)* and/or wheat *(Triticum aestivum)* is preferred by the turkeys. Two weeks prior to trapping, bait lines are established along trails and usually extend for 1 mile on each of two sides of the trap site. When a flock begins using a line, the bait is gradually restricted to the vicinity of the cannon net (Dill and Thornsberry 1950), which is placed along a widened portion of the trail.

Several modifications have been made in the equipment. Most significant of these is the use of recoilless cannons manufactured by Central Technology, Inc., Herrin, Illinois. These models have more thrust and velocity and are much easier to set up than the old projectile-firing cannons. Three of the new cannons were loaded and left out over winter. All fired perfectly the following spring. We have also used the recoilless cannons during periods of high fire danger, without any mishap. Good results have also been obtained on modified models that do not have tails and have the attachment rings welded to the front caps. Trap-site preparation, which is done in early summer, includes construction of a bank approximately 2 feet high by 3 feet wide by 60 feet long with a front-to-back slope of 20 degrees. Banks along old roads or ditches are often used. Such a bank enables placement of the net and cannons so that they are not visible from the turkeys' eye level, and it also provides a valuable height advantage for the net and projectiles.

CENSUS TECHNIQUES

It has, for some time, been obvious to woodland-game managers that reliable census techniques for turkeys are lacking (Powell 1967). Snow-track counts were unsatisfactory in Indiana, for a large percentage of turkeys do not appear to move appreciably during periods of temporary snow cover. On one occasion, during February of 1968, eight workers covered 25 miles of census routes throughout the 6,000-acre Perry County management area (Figure 15). Tracks of 12 turkeys were found, but during the following spring 25 different gobblers were heard on one morning in the same area.

Spring gobbler counts and personal interviews (Mosby and Handley 1943) provided our most reliable population indices. Gobbler counts were satisfactory when conducted over limited areas so that listeners were no more than 0.5 to 1 mile apart. Workers recorded the time and direction of each gobbler heard from their stationary posts for a 2-hour period following daylight. By plotting the data on maps, duplicates were eliminated and a minimum count derived. Disadvantages of this technique included the daily variability in gobbling intensity and the large number of personnel required. Personal interviews were valuable for providing insight into initial success of transplants, egress from management areas, general limits of dispersion, and attitudes of local residents to the turkey restoration program.

CURRENT STATUS

The current status of the turkey in Indiana's potential range is encouraging. The two management units and the Clark County area have been supporting prebreeding densities of approximately 6 to 8 birds per Section. From 1968 to March 1970 they have also furnished 64 birds for restocking. Several additional areas have established populations of lesser densities, and five new areas (Figure 15) were stocked during that time. An experimental spring gobbler hunt was scheduled for both management units in 1970, and within a few years an open area of several counties should be possible.

Reintroduction of wild turkeys in Indiana has been successful, but the degree of success throughout the available habitat will depend upon the limits of multiple use to which the forests will be subjected. Problems are many in a populous state that is only 17 percent forested and has less than 300,000 of these forested acres in public ownership. Demands of a growing number of special-use groups upon these areas is alarming, especially in view of the fact that turkey populations in high-use areas are remaining at low levels. In light of these challenges, the next most important step in turkey management, after trapping and transplanting, is the initiation of access management. This should consist of closed trails with walk-in types of recreation.

10

THE CHANGED STATUS OF THE WILD TURKEY OVER THE PAST THREE DECADES*

Henry S. Mosby

ABSTRACT

The four races of the wild turkey *(Meleagris gallopavo* spp.) in the continental United States have increased remarkably during the last 30 years, both in numbers and in occupied habitat. Within the last 2 decades, the annual harvest has increased about 2.8-fold. In addition, the wild turkey has been established beyond its ancestral range in seven western states and has been reestablished in two additional states west of the Mississippi, from which it had been extirpated. In the east, the turkey has been reintroduced successfully in six states. This expansion in numbers and in range has been due largely to the use of wild-trapped stock and to habitat improvement. The present population of wild turkeys in the United States is estimated to be about 1,250,000 birds.

Almost 3 decades ago, serious doubt was expressed that the wild turkey in the United States would remain as a game species, for it seemed on the decline throughout most of its range (Blakey 1941). Events since that time have proven this to be a gloomy prediction, for, in fact, the wild turkey has become a prized game trophy in many states in which it was unknown less than 30 years ago. In addition, the numbers of America's largest upland game bird have increased in most, but not all, states in which it has traditionally been an important game animal.

The increasing importance of the wild turkey as a game animal was indicated by the fact that it has been included in the kill statistics collected annually by the U.S. Fish and Wildlife Service (1953, 1969) in its yearly Big-Game Inventory, beginning in 1951. The turkey is the only bird included as a high-trophy species on this inventory. It is recognized that the statistics incorporated in these annual inventories may not be of high precision, but most workers agree that, over a period of years, these kill and population figures do give an acceptable index of the fluctuations in the several big-game populations. For the continental United States, the kill increased from about 47,000 turkeys in 1952 to about 128,000 in 1968-a 2.8-fold increase (Table 21).

The eastern *(M. g. silvestris)* and Florida *(M. g. osceola)* wild turkeys traditionally have supplied a majority of the continental harvest; the kill of these two subspecies was 86 percent of the total kill in 1958 and 75 percent in 1968. Crude estimates of the population of these two subspecies suggest a total population of about 97,000 in 1948 (Mosby 1949) and 531,000 in 1968 (Table 22). The figure of 531,000 for 1968 does not include 16,500 additional turkeys re-

*** Release No. 70-1 of the Virginia Cooperative Wildlife Research Unit, Virginia Commission of Game and Inland Fisheries, Virginia Polytechnic Institute, Wildlife Management Institute, and U.S. Fish and Wildlife Service, cooperating.**

Table 21. Annual harvest and estimated wild turkey populations in 1952 and 1968 reported in the Big-Game Inventories.

State	1952 Kill	1952 Population[a]	1968 Kill	1968 Population[a]
Alabama	5,364	37,500	39,978	225,000
Arizona	783		1,600	35,000
Arkansas	363	11,000	1,129	30,000
California	NOS[b]	500	50	8,000
Colorado	138	12,200	325	15,000[c]
Florida	18,000	38,000	20,000	60,000
Georgia	3,000	22,500	3,000	21,000
Idaho			9	
Indiana			NOS	
Iowa			NOS	
Kansas			NOS	750
Kentucky	NOS	750	17	1,930
Louisiana	NOS	5,200	350	6,500
Maryland	300	1,000	360	1,000[c]
Massachusetts			NOS	150
Michigan			160	3,700
Minnesota				15
Mississippi	600	12,500	3,768	53,000
Missouri	NOS	2,379	1,270	12,700
Montana			400	
Nebraska			663	4,000
Nevada			NOS	
New Mexico	2,000	25,000	2,192	25,000
New Jersey			NOS	
New York			1,050[d]	10,000[c]
North Carolina	1,000	10,000	220	4,000
North Dakota	NOS	120		
Ohio			20	2,100
Oklahoma	NOS	1,500		
Oregon			45	2,000
Pennsylvania	9,227	35,000	17,300	45,000
South Carolina	1,000	12,000	3,000	20,000
South Dakota	NOS	850	1,000	7,000
Tennessee	48	6,000	214	5,000
Texas	3,500	75,000	24,412	575,000
Utah	NOS	16	214	
Virginia	1,608	5,000	4,707	29,000
Washington			100	2,000
West Virginia	436	8,000	1,700	15,000
Wisconsin			22	600
Wyoming	NOS	865		
Total	47,367	321,880	128,167	1,219,445

[a] From Big-Game Inventories, 1952 and 1968, U.S. Fish and Wildlife Service.
[b] No open season.
[c] Crude estimate by HSM.
[d] Interpolated from Proud (1969).

ported in six states (Massachusetts, Michigan, Minnesota, New York, Ohio, and Wisconsin) that had few, if any, wild turkeys in 1948.

In 17 western states, which support the Rio Grande *(M. g. intermedia)* and Merriam's *(M. g. merriami)* turkeys primarily, the annual harvest increased from about 6,500 in 1952 to 31,000 in 1968 (Table 23). Of these 17 states, 12 (California, Idaho, Kansas, Montana, Nebraska, Nevada, North Da-

Table 22. Estimated annual harvest of eastern and Florida wild turkeys in 1948 and 1968.

State	1948[a]	1968[b]
Alabama	3,200	39,978
Arkansas	NOS[c]	1,129
Florida	3,800	20,000
Georgia	1,000	3,000
Kentucky	NOS	17
Louisiana	400	350
Maryland	25	300
Mississippi	NOS	3,764
Missouri	NOS	1,270
North Carolina	3,000	220
Oklahoma	NOS	
Pennsylvania	3,772	17,300
South Carolina	2,500	3,100
Tennessee	NOS	214
Texas	NOS	
Virginia	6,067	4,707
West Virginia	430	1,700
Subtotal	24,194[d]	97,049[e]
States in which the wild turkey has been established largely during the period 1948-1968.		
Massachusetts		NOS
Michigan		135
Minnesota		NOS
New York		1,050[f]
Ohio		13
Wisconsin		18
Subtotal		1,216[g]

[a]Mosby (1949).
[b]U.S. Fish and Wildlife Service (1969).
[c]No open season.
[d]The estimated population was 129,373.
[e]The estimated population was 531,130.
[f]Proud (1969).
[g]The estimated population was 16,575.

kota, Oregon, South Dakota, Utah, Washington, and Wyoming) established, or reestablished, the wild turkey as a resident and, in most of these states, as a *huntable* species during the last 3 decades.

Perhaps the most spectacular recent development has been the establishment of huntable populations of the wild turkey in Montana, Wyoming, and North Dakota-beyond the ancestral distributional limits of the wild turkey in the United States. This extension of range was made possible by the development and perfection of the cannon-net and drop-net trapping procedures that made feasible the trapping of the Merriam's wild turkey, primarily, for purposes of transplanting. Less spectacular, but of equal importance, has been the trapping-transplanting of the eastern, Florida, and Rio Grande subspecies. The transplanting of wild-trapped stock has resulted in reestablishing the wild turkey in sizable areas, within its ancestral range (southwestern Virginia, southwestern West Virginia, Ohio, the Panhandle region of Texas, and other regions). In New York, a huntable population has been established by the

Table 23. Estimated annual harvest of Merriam's and Rio Grande wild turkeys in 1952 and 1968.

State	1952[a]	1968[b]
Arizona	783	1,600
California	NOS[c]	50
Colorado	138	325
Idaho		9
Kansas		NOS
Montana	NOS	400
Nebraska		663
Nevada		
New Mexico	2,000	2,192
North Dakota	NOS	
Oklahoma	NOS	
Oregon		45
South Dakota	NOS	1,000
Texas	3,500	24,412
Utah	NOS	214
Washington		100
Wyoming	NOS	
Total	6,421[d]	31,010[e]

[a]U.S. Fish and Wildlife Service (1953).
[b]U.S. Fish and Wildlife Service (1969).
[c]No open season.
[d]Population estimate 116,051, excluding Arizona, Idaho, Kansas, Montana, Nebraska, Nevada, Oregon, and Washington.
[e]Population estimate 633,750 excluding Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oklahoma, Utah, and Wyoming.
Source: U.S. Fish and Wildlife Service (1953, 1969).

spread of turkeys from northern Pennsylvania and by the release of game-farm turkeys (Proud 1969). However, most states have found the use of game-farm turkeys for establishing or reestablishing the turkey in suitable habitat to be unproductive of practical results (Mosby 1959:5, Donohoe and McKibben 1970: 10-11, Wunz 1973). For example, Virginia released some 22,000 game-farm turkeys over a period of about 25 years; the results of this program were most disappointing, although it is possible that one population was established in one section of a single southwest Virginia county. Missouri experienced similar results (Dickneite 1973). It is noteworthy, therefore, that the use of game-farm birds in Michigan has resulted in an established population of about 4,000 turkeys (Ignatoski 1973) in areas primarily beyond the recorded ancestral range. Likewise, there is an established population in southeastern New York as a result of game-farm stocking, although this population is not thriving as is the population resulting from the spread of native wild birds into south-central New York (Proud 1969).

Figure 16 presents an approximation of some of the major areas in which the wild turkey has been established or reestablished within the last 3 decades. Aldrich (1967: 18) presented more complete information on the current distribution of the wild turkey throughout continental United States and Hawaii.

There is other evidence of the increased recognition of the importance of the wild turkey as a sporting species during the last 30 years. During this period five books have appeared (Mosby and Handley 1943, Davis 1949, Latham 1956, Schorger 1966, and Hewitt 1967) and a number of state bulletins (Dalke et al. 1946, Ligon 1946, Wheeler 1948, Bailey et al. 1951, Burget 1957a, Hoff-

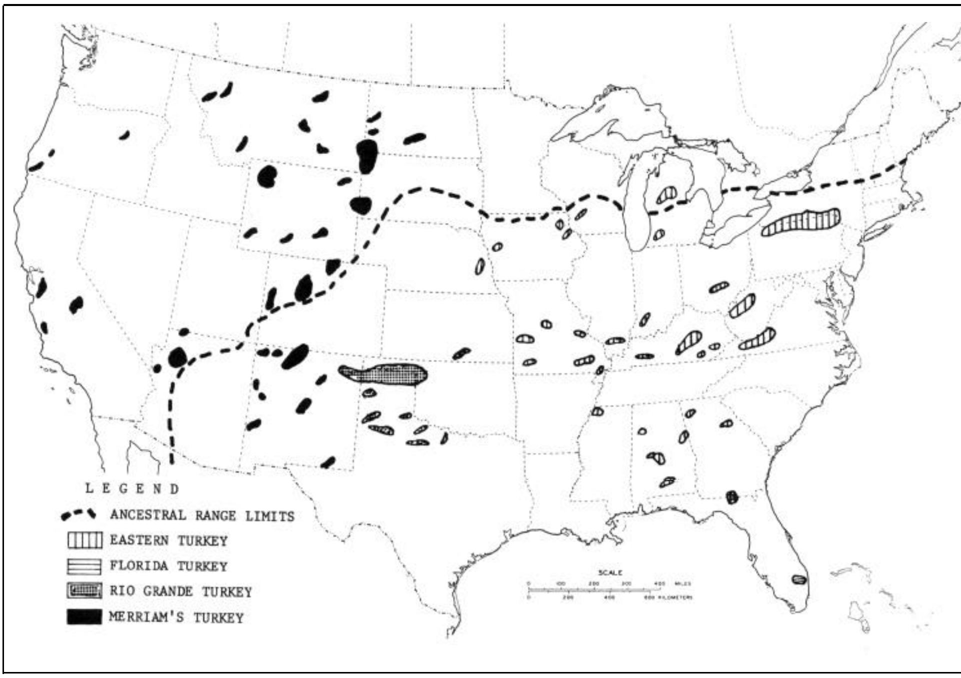


Figure 16. Schematic presentation of some of the major areas of reestablishment and range extension of wild turkey populations in the United States during the period 1938-1968 (taken from various sources, especially Mosby 1949, 1959, and Hewitt 1967).

man 1962, and Powell 1965). The return of the turkey in many areas, as well as its establishment in extra-limital regions, has made turkey hunting possible for many inexperienced hunters. Thus, several booklets on hunting methods for the wild turkey have become popular; these instructional publications normally are prepared by nontechnical devotees of wild-turkey hunting (Turpin 1966). In 1941, The Wildlife Society appointed a committee to prepare a monograph on the wild turkey; this committee's activities were interrupted by World War II. The committee was reactivated in the mid-1950's, and the long-awaited monograph on the wild turkey appeared in 1967 (Hewitt 1967). The First National Wild Turkey Symposium, sponsored principally by the Southeastern Section of The Wildlife Society, was held in 1958, and the Second National Wild Turkey Symposium, sponsored by the North Central Section, gives further evidence of the sustained interest among wildlife biologists and sportsmen in the management of America's most sporting game bird.

Experience over the past 30 years may permit some generalizations regarding the wild turkey and its management: (1) The wild turkey is much more adaptive, ecologically speaking, than was assumed 30 years ago, for it has done well in habitats and in cover types to which it did not seem adapted in the early 1940's; (2) the Merriam's turkey and the mountain-inhabiting members of the eastern turkey appear to adapt with greater ease to new habitats into which they are introduced than do the Florida and Rio Grande subspecies (Menzel and Hurt 1973); (3) the Rio Grande bird appears to be limited, for practical purposes, to areas having less than 30 inches of rainfall (Wigal and Haugen 1968); (4) additional evidence is accumulating that the release of game-farm stock in areas occupied by a population of wild turkeys may, and often does, introduce disease into the wild flocks (Wunz 1973); (5) the release of wild-trapped stock into new and suitable habitats has produced almost spectacular results, and in many instances, which are documented by papers presented at the First Symposium and at the Second Symposium has resulted in establishing a huntable population within as short a time as 5 years.

All management problems have not been answered. It appears that some of the most pressing but unanswered problems facing the manager of wild turkeys include: (1) the influence of the current practices in even-age forest management upon the wild turkey (Thomas et al. 1973b); (2) the reason or reasons for the decline of established high-density wild turkey populations in such regions as southern Florida, the Francis Marion National Forest in South Carolina, and the Piedmont of Virginia; (3) a factual resolution of the perennial problem of the proper mix, if any, between gobbler-only and any-sex hunting harvest; (4) the contribution, if any, by first-year hens to the annual productivity of wild turkey populations; (5) the requirements, if any, that land-management programs must fulfill in order to develop or maintain food, cover, water, and clearings that meet the basic requirements of the wild turkey; and, finally, (6) the measured influence of extensive land-management programs currently being carried out on present or on potential wild-turkey habitats (Capel 1973).

In summary, during the last 30 years the prospects have brightened considerably for the wild turkey and its management in the United States, where, in 1970, there may be as many as 1,250,000 birds. There is every indication that the contributions made by the wild turkey to the removable game harvest will increase during the decades ahead, and it is entirely possible that a huntable population may be established in every state of the Union, except Alaska. If history bears out this conclusion, we may look forward to a Wild Turkey Symposium, such as the preceding and current ones, each decade henceforth.

II

MOVEMENTS
NESTING ECOLOGY
AND BROOD STUDIES

Lovett E. Williams, Jr.

The next five papers have one topic in common-they all say something about the movement behavior of the turkey. Of the questions that are usually asked about the wild turkey, “How far does a turkey range?” is the hands-down favorite. This section answers that question (as a number of earlier studies have attempted to do) for people who are curious and should lay to rest the need for other studies to measure turkey movement only in terms of yards and miles. The papers in this section share another characteristic-they do not treat turkey movement data as an exercise in plane geometry. Three of them deal more with behavioral, ecological, and biological observations related to movement than they do with movement *per se.*

The writers do not stress the practical value of studies on turkey movement, but there are practical applications. Movement behavior determines the minimum size for turkey management areas. It also dictates whether a shooting club shoots its own or somebody else’s turkeys, and it directs the spatial distribution of management effort. It governs the rate of expansion of newly introduced flocks and determines how fast the species becomes established in the local areas where it was overhunted or where its populations were decimated by epizootics or other causes. Since turkeys usually go where they want to go, their movement tells the manager in no uncertain terms what turkeys like (and probably need).

Movement is the way turkeys get from a place to nest to a place to roost and a place to feed. We know a great deal about the material needs of wild turkeys but far too little about their behavior in obtaining them, just as we know so much more about a turkey’s feet and legs than we do about its inclination to use them. A turkey without its behavior is not a whole turkey, and a would-be turkey manager without a sound knowledge of turkey behavior can only guess how to manage wild turkeys. If these papers serve only to focus attention on the serious lack of knowledge of movement-related behavior of turkeys, they will certainly be useful. And, even if they fail in that, they at least tell “how far a turkey goes.”

This page has been intentionally left blank to preserve the continuity of the original document.

11

OBSERVATIONS ON MOVEMENT, BEHAVIOR, AND DEVELOPMENT OF TURKEY BROODS*

Lovett E. Williams, Jr., David H. Austin, Tommie E. Peoples, and Robert W. Phillips

ABSTRACT

Twelve broods of wild turkeys *(Meleagris gallopavo osceola)* were studied in southern Florida with radio-tracking techniques. Hens used an ecotone between grassy pasturelike areas and denser scrub for nesting. After the broods hatched, they went directly into cypress *(Taxodium distichum)* woods and remained there for at least the first 4 weeks of life. The loss of some very young poults coincided with the time that the broods crossed streams or other surface water, but no loss was known to have resulted from falling rain. Some flightless poults could swim well. Each newly hatched brood left its nest at a different time of day, but none departed within 2 hours of sunrise or sunset. Broods roosted in different places on the ground each night for the first 12 or 13 nights. Afterwards they roosted in trees. Poults could fly well at least 1 or 2 days before they began roosting in trees. Brood hens covered ground-roosting poults with their bodies, outspread wings, and partly spread tail feathers. For at least 4 weeks after they began roosting in trees, some of the poults were sheltered by the hen's outspread wings. Turkey hens often revealed by their behavior that they were aware of the exact moment that they were spotted by observers. Data on movement and on habitat utilization of young broods, behavior of broods and brood hens when disturbed, and other observations on the life history of turkeys through about 8 weeks of age are presented.

This is the second report on a long-term study begun in 1967. Williams et al. (1969) reported on the nesting of the turkey in southern Florida. The present paper deals with turkey broods during the period between hatching and late summer.

Radio-tracking techniques make these observations especially useful, because broods could be identified individually and observed at will. This permitted their activities and development to be traced chronologically and correlated with age and other factors.

It is not clear from the literature whether some behavioral concepts and early life history of the turkey were based on wild populations, domestic and semi-domestic stock, or even on captive birds. Our observations are on native turkeys living under natural, wild conditions. Few early life-history data have been reported before for the wild turkey in Florida.

We thank Charles P. Lykes, of Tampa, and his company, Lykes Brothers, Inc., for making their Fisheating Creek Wildlife Management Area and Refuge available for this study and for their cooperation in many other ways.

***This is a contribution of Federal Aid to Wildlife Restoration Program, Florida Pittman-Roberston Project W-41.**

Herschell W. Haywood and Glynn H. Ivey, game managers; Neal F. Eichholz and William B. Frankenberger, student assistants; and Harvey L. Hill and Jerry H. Peoples, former game managers, assisted with the field work. Lonnie M. Bell, James H. Carter, and Phillip W. Phillips, aircraft pilots, assisted generously. We also acknowledge the support and assistance of James A. Powell, chief of the Game Division, and the critical reviews of E. B. Chamberlain and R. Wayne Bailey.

METHODS

STUDY AREA

The study area is located on Lykes Fisheating Creek Wildlife Management Area and Refuge in Glades County, Florida, 12 miles west of Lake Okeechobee. The terrain is flat, ranging between 30 and 55 feet above mean sea level. Rainfall is usually well distributed throughout the year and averages approximately 50 inches annually. Subfreezing temperatures are rare and brief.

Flat topography as well as minimal fluctuation of seasonal temperature and rainfall simplify the nature of the study area. Seven plant associations with narrow ecotones between them can be identified. Figure 17 shows these cover types and their characteristic juxtaposition. Together they comprise nearly all of the vegetative features of the area.

Cypress woods.-The woods along the creek (Figure 18) are dominated by fairly homogenous stands (Figure 18) of cypress trees, with small islands of other trees (mainly live oaks, *Quercus viginiana;* laurel oaks, *Q. laurifolia;* and cabbage palm, *Saba1 palmetto)* where the elevation is higher than 33 feet. The surface soil is mostly sandy but is overlain with humus sediments and litter wherever high-water stream flow has been conducive to the accumulation of these materials. The creek swamp is subject to frequent shallow flooding.

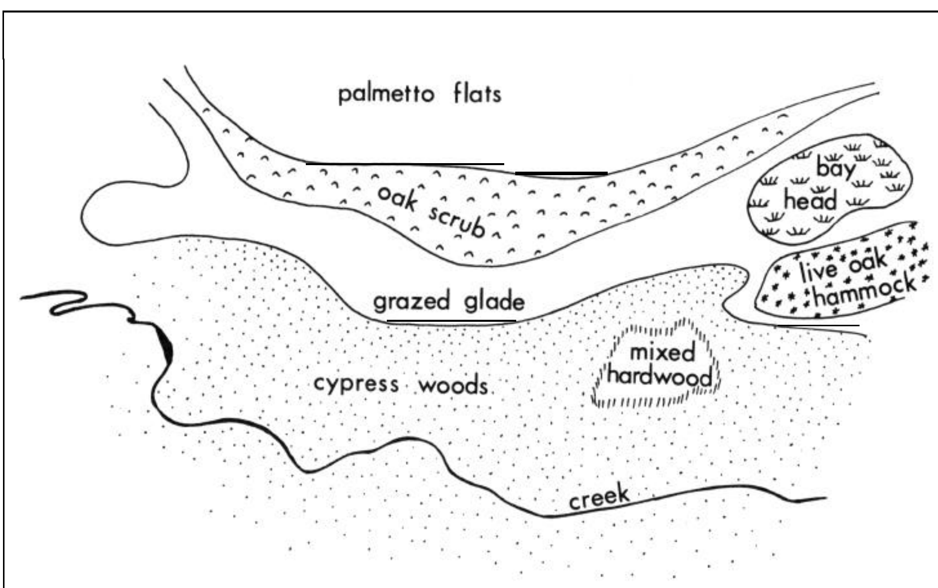


Figure 17. Distribution of principal plant associations on the study area in Florida. Bayheads, live oak hammocks, and mixed hardwood hammocks, shown here as islands, may occur contiguously to each other and any other association.

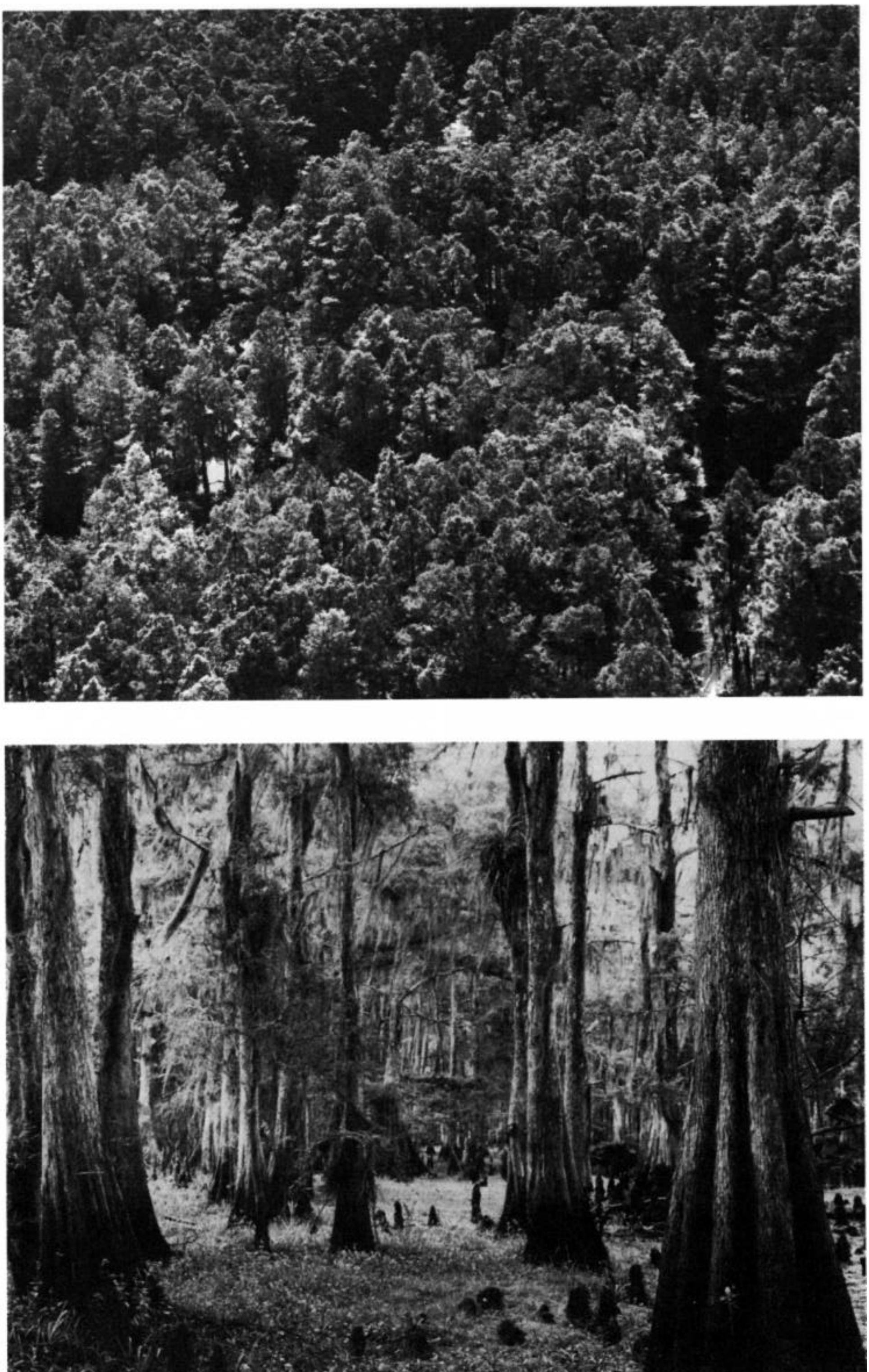


Figure 18. A Cypress woods and creek from the air on the study area in Florida. B. Cypress woods near the creek on an early spring morning on the study area in Florida.

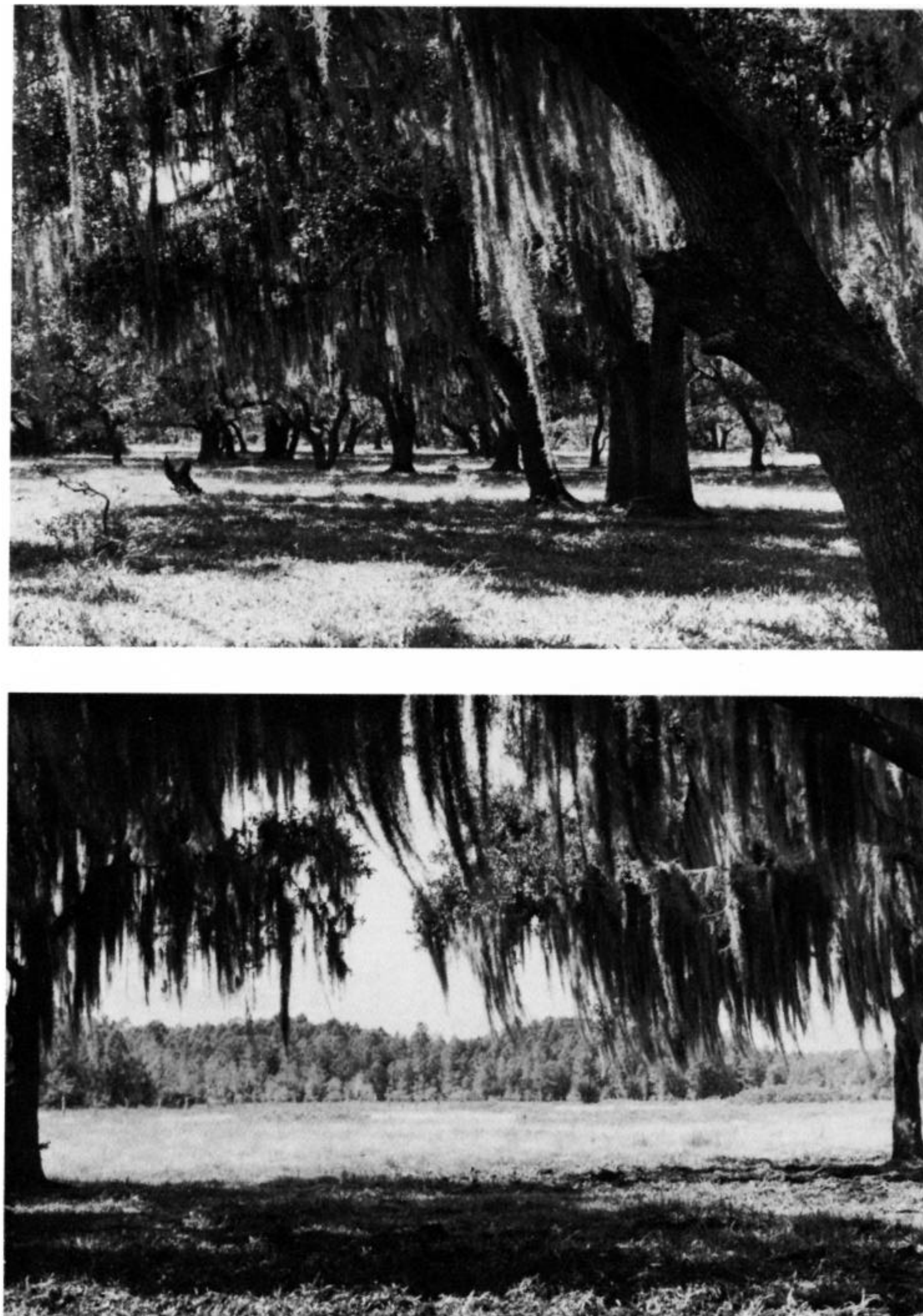


Figure 19. A. An open live oak hammock with understory of grasses and sedges. B. View from the edge of a hammock across the grazed glade association toward cypress along creek (in background).

Understory shrubbery is sparse in the cypress woods, but grasses, sedges, and annual and perennial herbs are vigorous and green throughout the year.

Live oak hammocks.-Live oaks occur in nearly pure stands ranging in extent from groups of a few trees to stands of several acres (Figure 19). These *hammocks* are unlike some other hammocks on the study area that contain mixed species of hardwoods in addition to live oak (see description of mixed hardwood hammocks below), Visibility at eye level is occasionally interrupted by small clumps of saw palmetto *(Serenoa repens).* Cabbage palm occurs in some of the older hammocks of this type, eventually assuming dominance. In most years the live oak hammocks produce prodigious crops of acorns.

Grazed glades. -Parallel to the creek, outward from the cypress woods, is an elongate, nearly treeless zone dominated by short grasses (mainly *Axonopus compressus),* sedges, and herbs (Figure 19). This plant association is similar in appearance to a cattle pasture (Figure 20), partly because of moderate year-round cattle grazing. Water covers this area (Figure 21) several times each year outward to the edge of the saw palmetto flats, live oak hammock, or scrub, as the case may be. It is apparent that frequent flooding prevents these latter associations from invading the grazed-glade zone.

Bayheads and swamps.-The dominant overstory vegetation in the few bays and swamps are broadleaf evergreen shrubs *(Myrica cerifera* and others), evergreen trees *(Gordonia lasianthus, Magnolia virginiana,* and *Persea* spp.), and a few vines *(Vitis* sp. and *Smilax* spp.). These places usually contain surface water and sometimes dense vegetation. The dark soils contain a high proportion of humus and litter.

Oak scrub.- An association of *scrub* oaks *(Q. chapmanii, Q. myrtifolia, Q. geminata,* and *Q. inopina)* and other short, woody vegetation *(Lyonia ferruginea, Befaria racemosa, Ilex opaca var. arenicola)* occurs on the deep, white sands of prehistoric beach dunes, which lie above 43 feet in elevation. The scrub vegetation rarely exceeds 15 feet in height. The ground is nearly bare over large areas except in the ecotone where the scrub joins the grazed glades (Figure 20). There, dominance is shared by saw palmetto, wire grass *(Aristida stricta),* and runner oak *(Q. minima).* The turkey prefers this ecotone for nesting.

Saw palmetto flats.--Saw palmetto and wire grass associations (Figure 20) with widely spaced pine trees *(Pinus palustris* and *P. elliottii)* comprise a small part of the study area.

Mixed hardwood hammocks.-Many of the hardwood species have similar ecological requirements and occur together in islands or hammocks where suitable conditions exist. Higher elevations within the cypress woods usually contain mixed hardwood hammocks. The principal tree species are live oaks, laurel oaks, and cabbage palms. Dense, elongate clones of saw palmetto are often associated with hammocks, especially in the higher places. The trees are usually covered with heavy growths of Spanish moss *(Tillandsia usneoides)* and other epiphytes.

Ecotones and miscellaneous.-The narrow ecotones between the major plant associations comprise less than 10 percent of the surface area. A few trails, wood roads, old tram roads, and the creek with wide expanses of water (called lakes) along it are not in this vegetation description.

Cattle and feral hogs occur, and people have free access to the study area most of the year. In recent years, hunting of hens and gobblers has been permitted on half the area during the fall, and the annual kill has probably exceeded 50 percent of the population by our estimate. Trappers and poachers have removed approximately 30 percent of the turkeys on the refuge portion

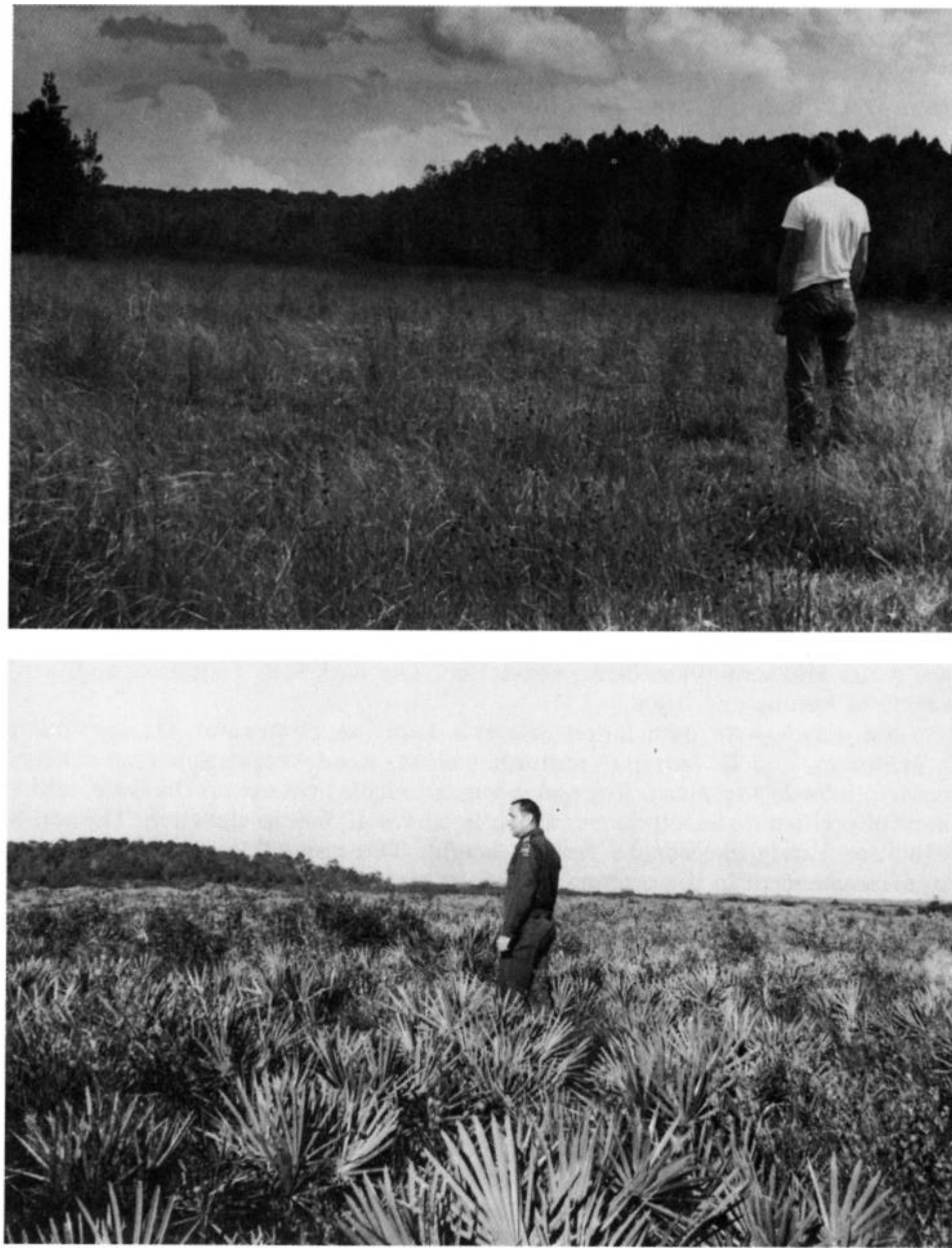


Figure 20. A. Open, pasturelike grazed-glade zone of grasses and sedges that parallels the creek cypress on both sides. B. Nest cover in left foreground intergrades into extensive palmetto flat in right background.

Figure 21. Grassy grazed glade during high water.

annually. The prenesting spring turkey population throughout the inhabited range of the study area is estimated to be about one turkey per 35 acres. The sex ratio has been about even.

The turkeys are typical *M.* g. osceola. No pen-raised turkeys have been released on the area, to our knowledge. No land management for turkeys has been practiced on the area, but an extensive baiting operation in connection with this and other studies provides turkeys with several tons of whole shelled corn (Zea mays) each year. An intensive poisoning program to eliminate nest predators was carried out in about 4 square miles of the area during the turkey nesting season of 1969 as part of another study.

The general character of the study area is portrayed in Figures 18 through 21.

RADIO-TRACKING TECHNIQUE

A radio transmitter weighing 50 grams and equipped with one battery, was strapped onto each of 59 hens by under-wing loops of latex surgical tubing (Figure 22). Each transmitter was identified by its unique frequency between 150.815 MHz and 151.210 MHz, or by its particular pulse rate. Two crystal-controlled and two continuous-tuning 24-channel portable receivers with sensitivity better than 0.10 microvolt were used. Several antennas were used, including two types of hand-held, two-element yagis and three types of multi-element, high-gain antennas installed on trucks for remote fixes. A more detailed description of this equipment was given by Williams et al. (1969). One of the brood hens carried an experimental transmitter with a rechargeable nickel-cadmium battery and a small solar cell.

During the two spring study periods, 12 hens that were carrying tracking transmitters produced broods on which several location fixes were made on each of 132 consecutive tracking days in 1968 and 112 tracking days in 1969.

Figure 22. Method of attaching transmitter to hen. A. One-foot-long lengths of surgical tubing are taped to the anterior and posterior ends of the transmitting package. B. A loose-fitting loop is tied with a square knot under each wing. C. After a correct fitting is obtained, the excess tubing is cut off and the knot is tightened. D. The turkey is ready to be released. The whip antenna curls upward from the posterior end of the transmitting package.

Fixes were obtained by plotting two or more bearings. From a distance of 1,000 feet the accuracy of distant fixes was found to be within 100 feet under good circumstances, but at times signal reflections and weak signals produced greater errors. When great accuracy was desired, as during hourly fixes of broods during the first days after leaving their nests, the transmitting hens were approached more closely and care was taken to detect misleading reflections. Skill was important in the field technique. Minor inaccuracies undoubtedly occur in the data, but whenever great accuracy was thought to be important, it was obtained by taking more bearings and approaching closer to the location of the turkey so that landmarks could be noted.

Performance of the telemetry equipment varied with the terrain, weather conditions, posture and position of the turkey, time of day or night, cover conditions, skill of the operator, and differences among the devices themselves.

Signal range was greatly influenced by the height of antennas. Ranges of reception exceeding 10 miles were obtained with receivers in airplanes. Ranges of at least 1 mile were obtained when the turkeys were in trees. Daytime ground-to-ground range did not usually exceed 0.75 mile. Dense, intervening vegetation sometimes reduced the range of reception to less than 0.25 mile.

Average reception life of transmitting units was 2 months for the transmitters that lasted more than a week. A few units were heard after 5 months. The solar cell unit lasted 8 months. Termination of reception was caused by broken antennas, expended batteries, and damaged or lost units.

Three broods were tracked constantly during daylight of the first full day after leaving their nests, and their roost sites were determined. Position fixes were made bi-hourly during daylight of the second full day, and during the third through 12th or 13th day, positions were plotted at least once each morning, noon, midafternoon, and night, with a few exceptions because of rain. After broods began to roost in trees, their locations were plotted each night and noon, and they were occasionally approached at other times for observation. Another brood was tracked frequently, but not systematically, during the period between leaving the nest and the first night it roosted in trees.

Tracking data from 12 broods (including the 4 mentioned above) form the basis for this paper. Many of the observations, however, pertain to more than these 12 broods, because most telemetered broods were in frequent association with untelemetered broods.

DATA-KEEPING

Tracking data were recorded by manual plotting on photo-reproduced sections of quadrangle and other maps drawn to the same scale. Notes were recorded in field notebooks and transcribed each day to bound record books kept for each telemetered hen. Some data were recorded in the field on printed forms and with tape recorders.

This report contains some observational information that cannot be tabulated and is difficult to present in a systematic fashion. Elements of subjectivity are unavoidable, but the authors concur on all statements in the paper that rely heavily upon memory or that involve subjective interpretation.

CAPTURE METHODS

Most of the hens were captured with alpha-chloralose (Williams 1966, Williams et al. 1967) or tribromoethanol (Williams et al. 1973) on whole shelled or cracked yellow corn. A few were captured with a cannon net (Austin 1966).

LITERATURE REVIEW

It is customary to compare research findings with the findings of earlier writers. This is made difficult in the present case, because so few who have written about the early life history of the turkey have described their methods. It is not clear whether some accounts about young turkeys pertained to domestic or to wild stock. Few reports explain how the age of poults was determined, although most writers have ascribed age to the broods they observed. Some writers have admitted using the opinions of laymen to explain phenomena. Finally, we find a tendency for writers to repeat data that can be traced to a single earlier writer. This gives the impression that the idea is widely held or that the observation has been repeated, when it is merely the only available published statement on the subject. Because our observations are original and are not intended to be definitive nor to support or refute previous work, literature citations are minimal in this report.

DEFINITION OF THE HATCHING PROCESS

Little published data can be found concerning the period of time required for whole clutches of wild turkey eggs to hatch. Most writers, such as Mosby and Handley (1943:118), state that the process requires about 24 hours, but this is probably not meant to be taken precisely. Bailey and Rinell (1967a:79-81) cited many authors who have written that hatching takes place in less than 24 hours, but precise data have not been given.

Donohoe et al. (1968) reported a period of 22 hours and 45 minutes between the time they saw the first poult (already hatched and dry) and the time they saw the hen leaving the nest with four poults. Wheeler (1948) found a nest at 9:00 AM with two poults, one pipped egg, and five other eggs. When the nest was visited 24 hours later, the hen and brood of eight were 100 feet from the nest site. In the present study, 46 hours elapsed between the time one nest was first seen with three eggs pipping and the time the hen left the nest with 10 poults. All the eggs had hatched.

Much more data will be needed to determine a meaningful average length of time required for hatching, but the data now available suggest that the process requires a day or longer. In this report, poult age will be given in terms of days after leaving the nest. We know that some of the poults in a given clutch are about 1 day old at this time.

Until poult-age data can be treated uniformly, there will be discrepancies among writers in age-correlated developmental data. These discrepancies will be especially significant in the very early stages. If age definitions are presented by writers, adjustments can be made when more conclusive information is available.

RESULTS AND DISCUSSION

NESTING

The 12 telemetered broods hatched from nests in the ecotone between the oak scrub and saw palmetto flats (Figure 20). The nesting of these turkeys was discussed in another report (Williams et al. 1969).

Hazards of Rain and Water

Heavy rains fell while several broods were hatching and all 12 broods experienced one or more moderate to heavy rains before they were 2 weeks old, but no brood was known to have been adversely affected. Some broods lost poults about the time they were known to have crossed water-filled ditches or streams within a few hours after leaving their nests. One hen hatched a full clutch of nine during a heavy downpour and crossed a swollen creek within the next 2 days. Five of the poults were missing when the brood was found later on the other side of the creek. Another brood was believed to have lost five poults when it crossed a 6-foot-wide ditch of water the same day it left the nest.

None of the 30 nests was destroyed by water, but 2 would have been had they not been destroyed by predators before the creek rose, after heavy late-spring rains.

It is widely believed by biologists and laymen that heavy rains during spring and summer are detrimental to turkey reproduction. Powell (1965) found such rains to be an important limiting factor in Florida and showed that heavy spring rains are followed by poor fall turkey harvests on the Fisheating Creek Wildlife Management Area. We do not understand the means by which fall populations are limited by summer rains, but we believe that falling rain is probably not as serious as the flooding it causes.

Adult turkeys and poults can swim (Martin and Atkeson 1954, Taber 1955), and our data suggest that flightless broods in Florida may find it necessary to swim frequently and readily take to water. We have not been able to establish whether hens swim, wade, or fly when crossing water with flightless broods, but, in one case, the fact that the water was several feet deep suggested that they flew or swam.

One 5-week-old poult was seen gliding gracefully from its roost tree into about 3 feet of water. It was able to flop its way to shore. Four other poults of about the same age were seen as they glided to deliberate landings in a hyacinth-choked lake along the creek. The observer was not certain that they escaped.

Hour of Leaving Nests and Roosts

Ten closely observed broods revealed no pattern in the time of nest departure, except that none departed within 2 hours of sunrise or sunset.

Two broods left their nests about 2.5 hours after sunrise; two others left later during the morning; five hens moved away from their nests during the afternoon. Two that left during the afternoon did so about 2 hours before sunset. One other brood departed its nest at an unknown time before 3:00 PM. Time of departure from the nest was not determined for 2 of the 12 broods. Therefore, progress of hatching appears to be the greatest factor determining time of nest departure rather than environmental factors such as light intensity, moisture conditions, or others correlated with time of day.

Nest departures by two broods at nearly the same time in the morning (about 8:30) probably occurred because the broods had finished hatching during the late afternoon or night and delayed leaving the nests until about 2 hours after sunrise. Stoddard (1931:38) believed that bobwhite *(Colinus virginianus)* broods also remained in their nests overnight if hatched late in the day.

Preflight broods remained stationary on the roost spot throughout the night and early morning. Broods about 1 or 2 days old remained on the roost

2 hours after sunrise, and some broods stayed longer before moving in the morning. Preflight broods that were 8 to 12 days old remained on the ground-roost spot only a few minutes after sunrise or occasionally began moving even before sunrise. Beginning with the first night spent in trees, flying broods left their roosts slightly before sunrise.

MOVEMENT FROM NEST TO BROOD RANGE

The average distance from nests to first-night roosting places was 212 yards (extremes of 7 yards and about 600 yards) for 10 broods (Table 24).

Table 24. Nesting and movement data for 12 broods of turkeys on Lykes Fisheating Creek Wildlife Area, Florida.

Band Number	Age-Class of Hen	Number of Eggs	Number of Poults	Time of Leaving Nest	Distance to First Roost (yards)	Distance Moved First Day[a] (yards)
237 R	Juvenile	9	9	7:45 PM	7	7
222 R	Adult	5	5	Unknown	100	Unknown
233 R	Adult	10	10	After 12:11 PM	250	"
2831 R	Adult	12	10	After 3:00 PM	300	"
213 R	Adult	11	10	After 10:00 AM	200	"
215 R	Adult	11	10	After 10:45 AM	200	"
229 R	Adult	10	9	After 1:30 PM	70	"
006 R	Adult (4 years)	7	6	Before 8:45 AM	600	675
289 R	Adult	11	10	About 8:30 AM	475	925
265 R	Juvenile	11	9	About 6:30 PM	100	100
288 R	Juvenile	10	10	After 1:30 PM	Unknown	Unknown

[a]Calculated by distances between successive fixes throughout the first day or portion thereof, after leaving the nest. This calculation is a distinct underestimate of the distance actually traveled.

Typical movements between the nests, the range of the broods, and their movement during the first day after leaving the nest, are shown in Figures 23 and 24.

Young broods moved more slowly than older broods. The rate of movement for three broods can be roughly calculated by the time-lapse and distance between successive, hourly fixes. One brood moved 528 yards per hour for 40 minutes between 8:20 AM and 9:00 AM after being disturbed by an observer. An undisturbed brood moved as fast as 151 yards per hour during parts of its first day. Broods were also virtually stationary for long periods (Figure 24).

EARLY BROOD RANGE

Most of the broods went directly from the nesting cover, across the open grazed-glade zone (Figure 19), and into the forest. Broods remained in the cypress woods for several weeks (Figures 25 and 26).

The ground cover in the cypress woods during the brooding period (May through July) was dominated by short grasses, iris (*Iris* sp.), cypress knees, and fast-growing herbs (*Polygonum* sp., *Hydrocotyle* sp., and *Saururus cernuus*). A few grassy openings occur within the cypress woods where the broods ranged, but frequent observations suggested that for the first 2 or 3 weeks the broods did not venture more than a few yards from concealing ground vegetation and overstory cover (Figure 18).

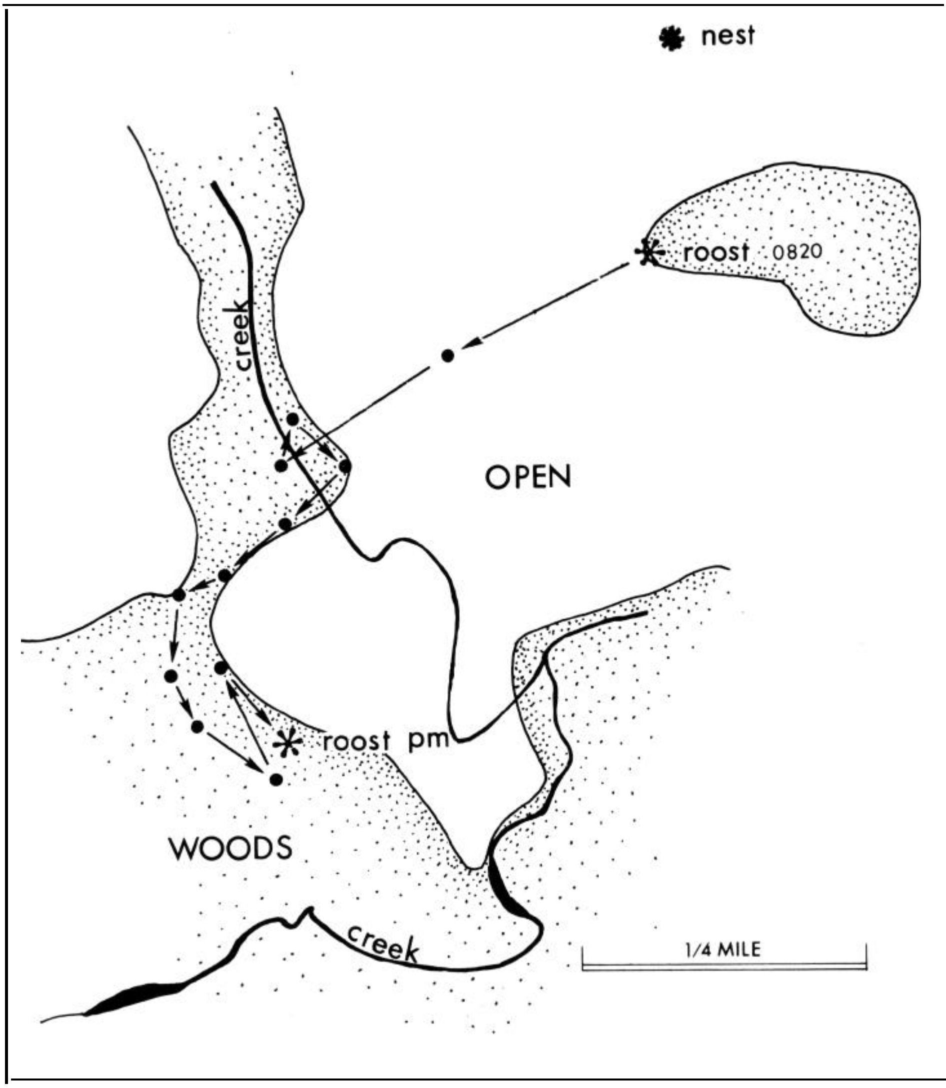


Figure 23. Movement of a brood the first full day after leaving the nest on the study area in Florida. The brood departed its nest at 6: 30 PM and roosted 100 yards south of the nest (upper right of figure) on the edge of a bayhead. It departed the roost at 8:20 the next morning. Black dots represent position fixes every hour on the hour beginning at 9:00 AM. The brood reached its roost position by 8:00 PM.

After about 12 days the poults could fly well and were more frequently seen feeding in the glades and uncanopied openings farther from escape cover.

RATE OF MOVEMENT AND SIZE OF AREA UTILIZED

Broods appeared to be exploring their range during the first few days after leaving their nests. When they were not impeded by openings or other obstacles, they moved greater distances without turning and were found more frequently in places to which they did not return.

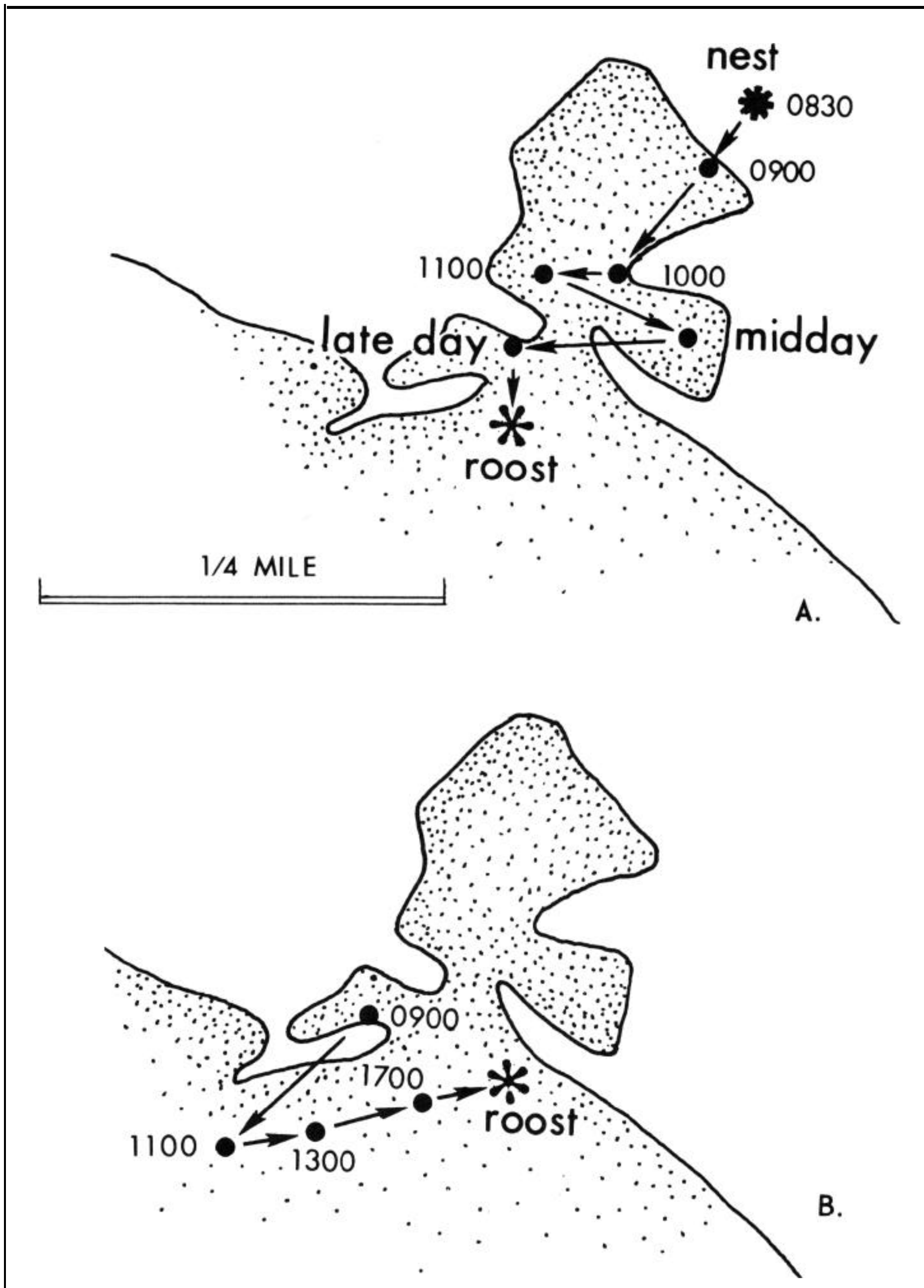


Figure 24. A. Movement of brood from nest in early morning to roost late in the same day on the study area in Florida. B. Movement of the same brood as in 24A during second day after leaving the nest.

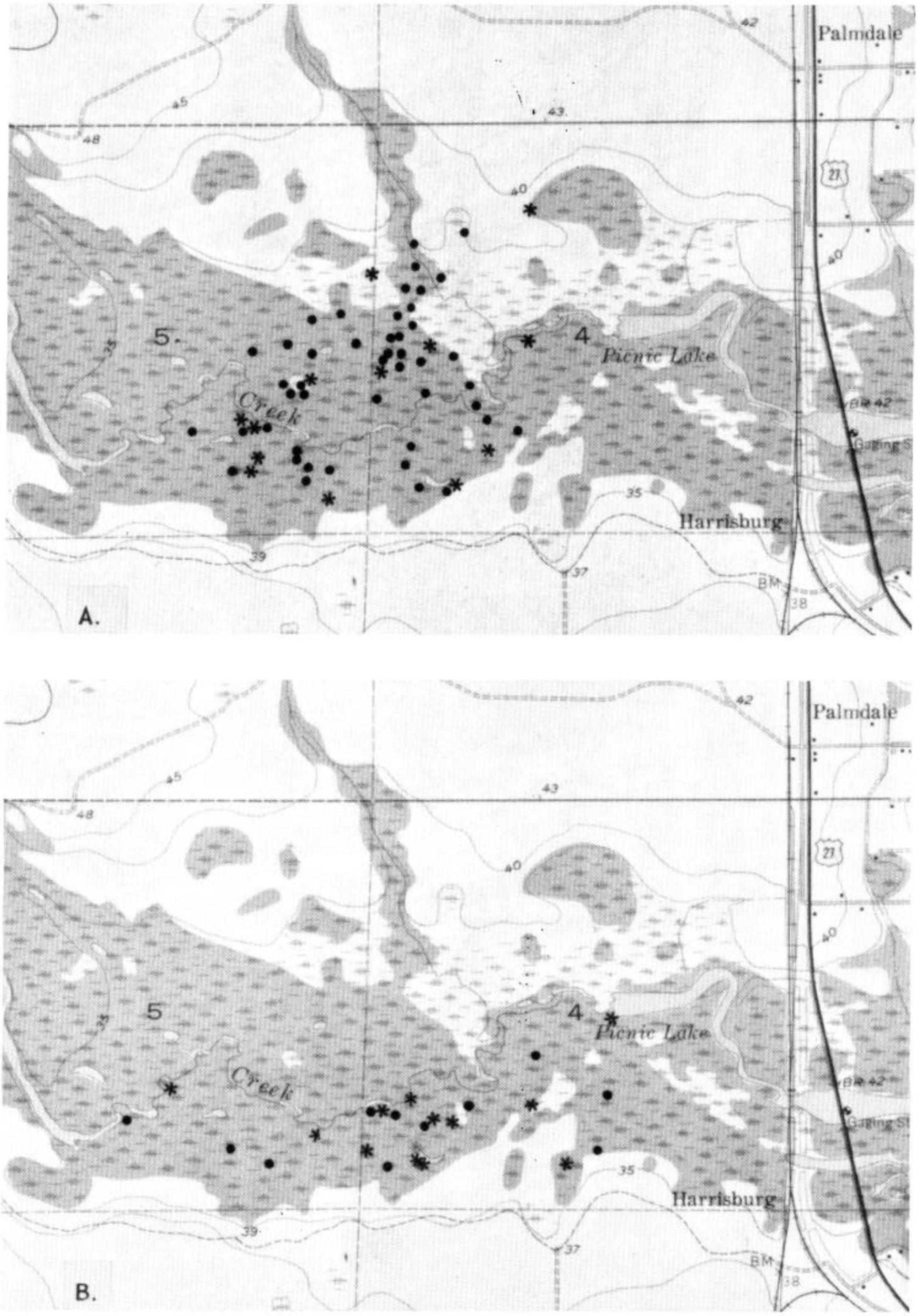


Figure 25. Position fixes plotted on quadrangle maps for same brood as shown in Figure 24. Dots are daytime positions, asterisks represent roost sites. A. Fixes obtained first day through 13th night. B. Fixes obtained 14th day through 24th day.

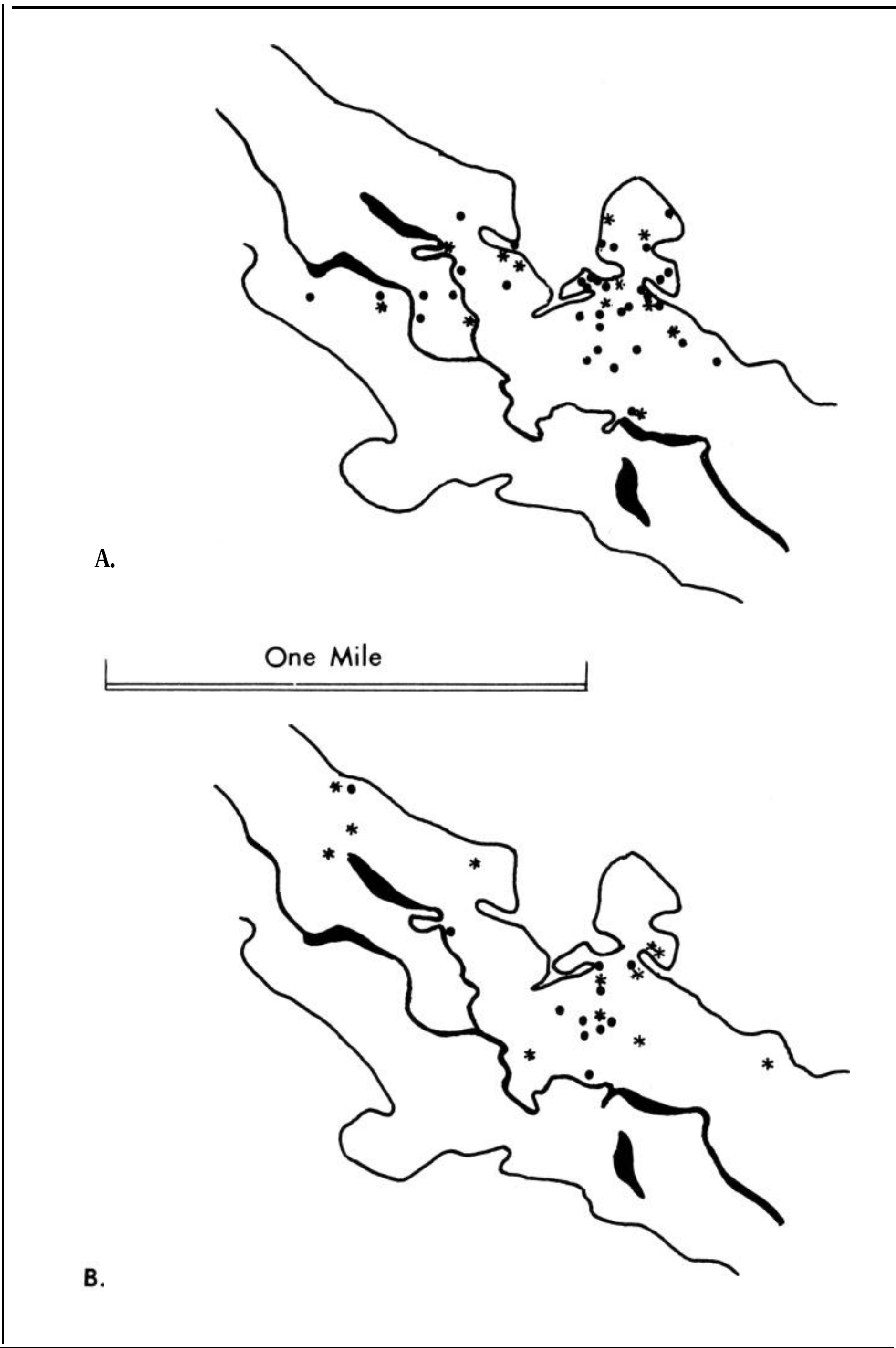


Figure 26. Position fixes on brood shown in Figure 24 plotted on same scale as in Figure 25. Dots are daytime positions, asterisks represent roost sites. A. Fixes obtained first day through 12th night. B. Fixes obtained 13th day through 24th night.

Roosting on the Ground

Three of the four Sightless broods that were closely tracked roosted on the ground for the first 12 nights after leaving their nests and roosted in trees for the first time on their 13th night. The other brood roosted in a tree for the first time on the 12th night. No brood was known to roost on the ground again after once roosting in trees.

Approximately 100 position fixes were made on ground roosts of preflight broods. During dry conditions, nearly all of the spots chosen for roosting were under or very near the cypress canopy. Broods roosted in the cypress woods during periods of high water whenever they could find dry ground, but during periods of flooding they often roosted in the saw palmetto of the dry ecotone between the grazed glade and the oak scrub. There was no evidence that hens with broods ever roosted in shallow water.

At least 25 roost spots on the ground in the cypress woods were examined closely. They were detected by the body depressions of the hens and the small droppings of the poults. The ground cover in these places varied from zero, leaf litter only, to complete lateral concealment of the brood by herbaceous vegetation, but a preference was shown for roosting in cover between these two extremes. Broods often roosted at the base of a tree, stump, or cypress knee. Preflight broods did not roost in thickets or in dense shrubbery although this type of cover was usually available to them. Some occasionally roosted in dense clumps of smartweed or other herbaceous vegetation, but they were not concealed from above in these situations.

Six preflight broods were watched as they awoke. The distribution of poult droppings revealed that the young had spent the night under the body, outstretched wings, and tail of the hen. The hens had not defecated on the roost spots. A large fresh dropping was found at least 6 feet away in each of four cases.

Roosts Used by Young Flying Broods

Broods spent their first nights off the ground on the lower limbs of cypress trees, occasionally other species, between 6 and 20 feet high. Broods roosted higher in trees as they grew older and were observed to be roosting as high as adult turkeys (30 to 40 feet) by the age of 5 weeks.

Those we observed did not use concealing vegetation nor crouch close against the trunks of trees. Some of the poults slept beside the brood hen under her outstretched wings until they were about 4 weeks old, but a few poults older than 2 weeks were seen asleep a few feet away from the hen, on the same limb. One 5-week-old brood and two 6- to 7-week-old broods roosted on several different limbs near the hens. The wings of the brood hens were not outstretched.

Early Morning Behavior on the Roost

Three 5- to 7-week-old broods were observed as they awoke on June 17, 1969. The broods were roosting together, accompanied by two hens without broods. The instrumented brood was 5 weeks old. The other poults were estimated by their size to be 6 and 7 weeks old.

The observer approached the roosting turkeys in the darkness. Several of the poults and one hen heard or saw the observer as he neared them, but after he was hidden and still, the turkeys showed no further evidence of being aware of his presence. The hens with their broods were spaced 30 to 80 feet apart on the lower limbs of cypress trees, approximately 30 feet above the rising water of a slough near the creek. The water under the turkeys was about 1 foot deep. No two of the five adult hens were in the same tree.

At 6:16 AM the only hen in clear view was still squatted on a limb in the sleeping posture, but her poults were hopping from limb to limb in the same and in one nearby tree. At 6:30 one poult spotted the observer and putted the alarm call but soon resumed its restless motion and paid no further attention to the observer. At 6:32 one hen silently glided to the ground in the cypress woods about 400 feet from her roost and was followed at about 5-second intervals by four poults from the same tree. At 6:40 a second hen flew down in the same general direction and distance, followed immediately by eight poults. The poults flew approximately as far as the hens. Neither hen was heard to yelp. The radio-instrumented hen flew down at 6:42, followed immediately by three poults.

At 6:45 a hen on the ground began calling and several more poults flew in her direction from the trees. One of these glided to a landing in the calm water of the slough, which it evidently mistook for land, and flopped its way to the bank to join some of the other turkeys. At 7:00 the five hens and their poults were seen moving while they fed along the edge of a small opening in the cypress woods.

Response of Incubating Hens to Disturbance

Five of eight hens did not resume incubation after being flushed from their nests a single time, but one hen continued to incubate her clutch after being flushed at least five times. In the 30 nests observed, none was known to have been deserted except as a result of predation or human disturbance, and no desertion was caused by the investigators except by flushing a hen from her nest. On at least six occasions, hens leaving or returning to their nests were frightened by observers within 100 yards, but no hen deserted.

One hen abandoned a briefly incubated nest when a foraging armadillo *(Dasypus novemcinctus)* rolled a few unbroken eggs from it. Another hen deserted her nest when fewer than half of the eggs were partly eaten by a spotted skunk *(Spilogale putorius)*.

The two smallest clutches (five and seven eggs) were hatched by adult hens. These two were the only hens that roosted in trees after incubation behavior had begun. We suspect that this behavior was due to disturbance by a predator, during which part of the clutch was taken; afterward, the hens resumed incubation of the remaining eggs.

Our data suggest that incubating hens are able to recognize predation on their clutches when disarranged or broken eggs remain at the nest, but the mysterious disappearance of some eggs may be tolerated. Obviously, the number of eggs being incubated is not an infallible indicator of the number of eggs laid.

Response of Brood Hens and Preflight Poults to Disturbance

Broods were never deliberately disturbed, but when this happened accidentally, we sometimes remained nearby and tested certain responses of the poults and hens when it appeared that it would produce no ill effects on the broods.

For the first 3 or 4 days after leaving their nests, broods did not seem to attempt to elude observers by moving out of their paths or by running. When an observer approached within 100 feet in view of the hen, she normally squatted over her brood and remained motionless with her head drawn closely in on her back. If an observer approached no closer than 30 feet, a hen usually remained silent and motionless, but if the hen was stared at intently at this range, she would usually stand erect, begin putting loudly at l- to 2-second intervals, and take a few steps away from her brood. It was evident that hens often knew when they had been spotted.

When a hen stood and began putting, some of the poults dispersed from directly under her and spread over an area of about 3 or 4 square yards. The dispersal reaction was minimal during the first few days but became progressively more pronounced. When the brood was 8 or 9 days old most of the poults moved a few feet when frightened and attempted to hide under forest litter or herbaceous vegetation.

In dispersing, poults crept on the ground for a few inches and usually remained motionless after first stopping. Sometimes poults moved a second time before finally becoming motionless. While poults were still, we did not detect any sound from them, but the hens continued to cluck and putt loudly at a rate of about one putt per 2 or 3 seconds.

Some hens ran away with little hesitation when approached closely after the brood was hidden. When they left the vicinity of their broods during disturbance, they could be faintly heard clucking at a distance, but the presence of an observer for longer than 10 minutes often caused a brood hen to go too far from the immediate vicinity to be heard putting. When the hen remained absent, one or more poults usually began calling within a half-hour. All poults heard calling had discontinued their motionless behavior and had run away when approached by an observer.

Poults less than 4 days old nearly always remained motionless, even when touched lightly by an observer, and could sometimes be handled and returned to the ground. Preflight poults tolerated less handling as they grew older. When more than 6 days old they ran, peeped, and screeched wildly if touched by an investigator.

Disturbed brood hens became especially alarmed at the imitated sound of poults calling; one hen showed even greater excitement when an observer imitated the yelping of an adult turkey while in the vicinity of the hidden 7-day-old poults.

Deceptive Behavior of Brood Hens

Hens with preflight poults older than 4 days usually crept a few feet away from their hidden poults before deliberately standing in full view and putting. When we had not seen the hen creeping, this behavior often resulted in our searching in the wrong spot for poults. The hens sometimes compounded the deception by exhibiting greater excitement when an observer stood at the wrong spot than when he stood where the poults actually were. We tested this thoroughly on one occasion by moving in all directions from the spot where the hen first began to stand and putt, and found that her attention was focused on a certain spot about 20 feet away from the poults.

During the first few nights after the broods began roosting in trees, hens often flew down and behaved as though the broods were on the ground when an observer approached them closely at night or in early morning.

In more than 50 times that we disturbed preflight broods, we were never actually attacked by a brood hen, but they sometimes threatened convincingly, especially at the sound of a distress call by a poult. Excited hens approached within 15 feet of observers on many occasions, and one hen came within 8 feet when a poult was screeching in distress.

Brood hens exhibited frantic behavior and assumed peculiar postures when one of their poults was being made to screech in panic. The term *crippled act,* however, is not a good description of what we observed.

Age at First Flight

Nine days, 21 hours, and 10 minutes after leaving the nest, one roosting brood flushed into the forest canopy when approached within 5 feet by an observer in the early morning. All six poults flew well and alighted in cypress trees, 10 to 25 feet overhead. They roosted on the ground again that night. The age of the poults since hatching probably ranged from 10 to over 11 days. These were the youngest poults we observed to fly, but their ability to fly at that time suggested that they could have flown at an earlier age if they had been sufficiently stimulated.

Another poult in a different brood was unintentionally flushed and seen to fly weakly for about 3 feet during the 10th day after it left the nest. The brood also roosted on the ground again that night. Poults about 10 days old were observed to fly over logs, puddles, and other obstacles as they followed the hen while feeding. The ability to fly well enough to roost in trees may be acquired gradually in this way.

Disturbance of Flying Broods

When broods capable of strong flight were approached and frightened, they tended to flush into nearby trees. If the ground cover was especially concealing, they sometimes assumed a motionless crouch unless approached within a few feet by an observer. Young poults were more likely to hide in any convenient ground cover and less apt to flush when the distance to trees was more than 100 feet.

After a brood was able to fly well, the hen did not permit an observer to approach her closely, and if pressed, she did not remain in the immediate vicinity as long as she would have remained before the poults could fly. She normally ran away, rather than fly with the poults, and could not be heard clucking in the distance.

When broods more than 3 weeks old saw observers more than 300 feet away, they stood alert for a few seconds, and if good ground cover was not nearby, the poults flew into trees, almost directly overhead. After the disturbance subsided, the poults immediately responded to the quick, two-, three-, or four-syllable assembly yelp of the brood hen. Poults in trees or on the ground flew or ran to the brood hen when she called and the brood was normally out of view in less than 1 minute, often in half that time.

When broods were about 2 or 3 weeks old, the hens reassembled them as soon as an intruder was out of their immediate vicinity, sometimes while he was still in distant view. In one case, only 2 minutes elapsed between the flushing of a 14-day-old brood from the roost tree, their reassembly at the call of the hen, and their departure. This interval was much shorter than was ever observed for older broods.

While a brood less than 4 weeks old was being disturbed by an observer, the hen usually remained close by and putted constantly. After the hen returned nearer to the site of disturbance and assembled the brood, she was not heard to putt again unless the intrusion was renewed.

Behavior of Broods Disturbed on the Roost

At 6 o'clock one morning, three broods, 4 to 5 weeks old, roosting together, were approached too closely and became alarmed. The broods were in different cypress trees 20 to 50 feet apart. The hens putted several times, flew about 300 feet across a slough to more cypress trees, and continued to putt loudly. They were followed immediately by about half of the poults, and within 5 minutes all the poults had flown in their general direction. At this time the hens, while they were still in the trees, began yelping assembly calls and some sounds unfamiliar to the observer. About 10 minutes after the hens flew, the poults began calling and moving around in the trees near the hens. Then the hens flew about 150 yards from the poults back across the slough and about 200 yards from their original roost trees. One hen flew back to the roost trees and alighted on the ground and clucked, but her poults were about 300 feet away. After about 2 minutes this hen flew to join the others.

About 3 minutes later the poults began to follow by flying to the hens about 150 yards away. Four poults, from at least two of the broods, alighted on water hyacinths *(Eichomia crassipes),* which covered the surface of the slough.

Ten minutes later two of the hens, in a very alert posture, were seen with a group of poults as they leisurely fed out of sight along the edge of the grazed-glade zone adjoining the cypress woods. One hen, not accompanied by poults, remained anxiously near the slough where some of the poults had alighted in the hyacinths. The hen finally left, alone, in the direction of the other hens, which were then out of her sight.

Summary of Behavior During Times of Danger

For at least the first week after hatching, the broods assumed *freezing* behavior when danger threatened. Hale and Schein (1962) consider this to be in response to the behavior of the hen, in the case of the domestic turkey. This seems to account for similar behavior in wild poults, since the poults themselves could hardly be expected to recognize all dangerous situations instinctively, and it would be disastrous for them to flee from every moving object in their environment. The freezing posture and behavior was so highly developed that during the first 2 or 3 days of life, the poults could be handled and replaced on the ground without being stimulated to run.

During the second week of life, poults began to respond to danger directly without relying entirely upon behavior of the hen. At this age they exhibited a mixed creeping-dispersal, hiding, and running reaction to human disturbance, and they attempted to run if handled. Two-week-old poults could fly well and readily flew when frightened.

CONCLUSION

Behavior of the turkey is stimulated by elements in the environment, and the places it lives provide the media in which it behaves. We mention this to caution the reader against thinking that variances in observations reported in this paper indicate innate peculiarities in *M. g. osceola.* Many of the supposed differences between *M. g. osceola* and *M. g. silvestris* probably do not exist.

Until much more is learned about turkey behavior in various environmental situations, no activity, movement tendencies, or behavioral patterns should be treated as racial attributes.

This page has been intentionally left blank to preserve the continuity of the original document.

12

MOVEMENT OF MERRIAM'S TURKEY IN THE PINE RIDGE OF NEBRASKA

James J. Hurt, Ross A. Lock, and Karl Menzel

ABSTRACT

During the winter of 1968-69 and the late summer of 1969, 93 Merriam's turkeys *(Meleagris gallopavo merriami)* were trapped and individually marked with leg bands and colored streamers attached to button wing tags. Cannon nets, a walk-in net trap, a chicken pen trap, and a cattle shed trap were employed and evaluated in captures of turkeys at five trap sites. According to band-recovery data collected during a 10-month period, 9 adult birds moved an average of 2.4 miles from the trap sites, and 16 juveniles moved an average of 2.3 miles. Movements of 14 hens from the trap sites averaged 2.5 miles, only slightly farther than the average of 2.0 miles by 11 toms. Sightings of individually marked birds indicated an average movement of 1.1 miles from the trap sites by 16 adults as compared with an average movement of 3.6 miles by 15 juveniles. Fifteen toms moved an average of 2.2 miles from the trap sites; 16 hens moved an average of 2.5 miles.

Merriam's turkeys were first released in the Pine Ridge of Nebraska in 1959. It had been increasingly evident that for improved management of the species, additional information was needed on its (1) habits and behavior patterns, (2) ecological relationships, and (3) movements and distribution. Consequently, a trapping and banding program was initiated in the winter of 1968-69 in an attempt to collect this information.

DESCRIPTION AND LOCATION OF THE PINE RIDGE

The Pine Ridge is located in the northwestern corner of Nebraska. It is a narrow, eroded escarpment approximately 90 miles long with a maximum width of 20 miles. There are 630 square miles or 403,000 acres of available turkey habitat. Approximately 83 percent of the Ridge is privately owned. The remaining 17 percent is controlled by the U.S. Forest Service and the Nebraska Game and Parks Commission (50,000 acres).

The highest elevation (5,280 feet) occurs at the western end of the Ridge. Mean annual temperature is 47.2 F with extremes of 110 F and -35 F. The average frost-free period is 130 days. Average annual rainfall is approximately 17 inches, most of which occurs in the spring.

The area is comprised of a system of rugged canyons and buttes interrupted by a number of small streams and numerous plateaus. The Ridge has a mountainous topography similar to that of the Black Hills of South Dakota. Soils are mostly fine, sandy loams.

A good network of primary and secondary roads parallels most of the major drainages. This arrangement facilitates survey work and the harvest of birds.

Major land use in the Ridge is cattle ranching, but cropland is interspersed throughout most of the area. Crops include winter wheat *(Triticum aestivum),* oats *(Avena sativa),* barley *(Hordeum vulgare),* rye *(Secale cereale),* and alfalfa *(Medicago sativa).* A limited lumber industry exists primarily for commercial pulpwood. Some clearing of timber is done in attempts to increase grass production,

Approximately 350 human dwellings, averaging less than one per square mile, are located within the turkey range; however, two dwellings per square mile are common in certain areas. Many of the ranch buildings are close to watercourses.

The dominant vegetation consists of open stands of ponderosa pine *(Pinus ponderosa)* interspersed with representatives of the mixed-grass prairie. The more common grasses include big bluestem *(Andropogon gerardi),* little bluestem *(A. scoparius),* needle-and-thread *(Stipa comata),* prairie sandreed *(Calamovilfa Zongifolia),* and bluegrass *(Poa* sp.). Dominant forbs are soapweed *(Yucca glauca),* western ragweed *(Ambrosia psilostachya),* poison ivy *(Rhus radicans),* cudweed sagewort *(Artemisia ludoviciana),* and goldenrod *(Solidago* spp.). Common understory shrubs include snowberry *(Symphoricarpos occidentalis),* chokecherry *(Prunus virginiana),* skunkbush sumac *(Rhus trilobata),* and wild rose *(Rosa acicularis).* Deciduous *trees* such as green ash *(Fraxinus pennsylvanica),* American elm *(Ulmus americana),* box elder *(Acer negundo),* and plains cottonwood *(Populus sargentii)* are found along the stream bottomlands.

RECENT HISTORY OF MERRIAM'S TURKEY IN THE PINE RIDGE

The recent history of the wild turkey in the Pine Ridge is one of successful transplanting, resulting in a dense turkey population, From the stocking of 28 wild-trapped birds obtained from South Dakota and Wyoming in 1959, the population grew to an estimated 3,000 after four nesting seasons. The birds dispersed rapidly throughout the area and now are found in all suitable habitat in the Pine Ridge. Population density has varied in the drainages from year to year, but the annual survey of winter flocks shows an average population of approximately 3,000 birds. A population high of between 5,000 and 6,000 birds was reached in the fall of 1964. The population has leveled off and remains fairly constant, except during the years when wet, cold weather in the spring results in a poor hatch.

This success story is evident when results of hunting seasons are reviewed. Eight either-sex fall seasons have resulted in 9,263 hunters taking 4,622 birds for 49.9 percent success. In six spring gobbler seasons, 3,620 hunters have bagged 843 gobblers for 23.3 percent success.

Propagation of the wild turkey in the Pine Ridge has been a tremendous success and a bonus to the area and to the sportsman.

METHODS

TRAPPING

When the turkey population is high in the Pine Ridge and sufficient snow cover is present, trapping is simple. Because of their habitat, the birds have become accustomed to eating grain where and when it is available. When snow covers the grain in stubble fields, the birds frequently move into or near a farm or ranch yard and pick up grain distributed for livestock. Flocks of 50 to 100 birds are common. The birds are wary of strangers but usually become accustomed to the rancher and his daily activities. Some of the ranchers feed the birds grain, considering it a reward for their consumption of grasshoppers during the summer. Under such conditions it is easy to bait and catch the birds.

Four trap sites were used during the winter of 1968-69 and late summer of 1969 for the primary purpose of trapping and tagging birds necessary for the study of their movements. One other trap site was used to capture birds for transplanting, Two sites were in ranch yards, two were on food plots of oats on state-owned wildlife management areas, and one was at the edge of the timber adjacent to a field of winter wheat.

Trapping methods and techniques varied at nearly every trap site. The trappers took advantage of the birds' habits and of their presence in the vicinity of ranch buildings.

Walk-in traps.-Birds that fed in a rancher's yard occasionally entered a fenced-in pen adjacent to a chicken coop. A net was placed on top of the fence to enclose the pen. The birds were baited into the enclosed area through an open gate. After several days of allowing the birds to become accustomed to the net covering the pen, the rancher closed the gate and captured 32 birds. The turkeys were easily removed with little feather loss or injury.

Another unusual trapping method was a drop net attached to the open portion of a shed in a ranch yard. The birds were baited into the open-front shed, and the net was dropped by cutting a twine that suspended it. This method resulted in a capture of 24 turkeys. These birds were easy to handle and little defeathering or injury resulted.

A more conventional walk-in trap was used at one of the trap sites. The trap measured approximately 22 by 18 by 5 feet. It was of wooden frame construction with surplus fish-netting forming the top and sides. The ends were open to allow the birds to enter the trap. After the turkeys were baited into the trap the suspended nets at the ends were dropped manually. In two attempts, 13 birds were captured in this trap. One bird was caught at the same site in a box-type, walk-in deer trap set close to the walk-in turkey trap.

Propelled nets. -Modified cannons (Dill and Thornsberry 1950) were used with a net of 30 by 60 feet with 2.5-inch mesh. Four shots with this net resulted in the capture of 33 turkeys.

Another net used was propelled by rocket-type cannons and was 30 by 70 feet in size with 1.25-inch mesh and a 12-inch skirt around its perimeter. Two shots with this net resulted in the capture of 50 turkeys.

The rocket-type cannons are an asset to trapping because of the speed with which the net is thrown and the ease of setting up the projectiles. The 1.25-inch-mesh net with a skirt is also desirable, because it reduces defeathering and injury to the birds and hinders their escape from under the net.

The walk-in trap results in less defeathering and fewer injuries than does the cannon net, but the cannon net is more mobile and usually catches more turkeys per attempt.

Sightings of marked birds released at the trap sites were recorded for each of the four trap sites. The only sightings used were those made or confirmed by Commission personnel. No special efforts were made to locate marked birds.

BANDING AND COLOR-MARKING

During 1968-69, 93 birds were color-marked and banded. All of the birds were released at the trap sites. Butt-end aluminum leg bands, placed on one leg of each bird, were slightly overlapped on hens and butted-up on gobblers. Colored streamers of plasticized nylon fabric (DAY-GLO SAFLAG, Safety Flag

Company of America, P. O. Box 1005, Pawtucket, Rhode Island) were attached to the dorsal surface of the wing with a button tag (Burch's Best Ear Button, available through Nasco Farm and Ranch Supply, Fort Atkinson, Wisconsin). The patagial tagging procedure described by Knowlton et al. (1964) was used. Tags were attached to one wing on each bird. Streamers were cut in strips of 1.5 by 6 inches. One end of each streamer, to which the button tag was attached, was folded over approximately 1 inch and glued for reinforcement. In order to identify individual birds, most of the streamers were marked with numbers, letters, or other symbols, using printer's ink or MARKS-A-LOT cartridge ink. Streamers of different colors were used at each of the trap sites to aid future observations and identification of marked turkeys,

The 93 color-marked turkeys released at the trap sites provide the basis for the present report.

Apparently, retention of the leg bands and color markers has been excellent. According to information collected at compulsory check stations on 25 marked birds, one bird had lost a leg band and another a wing button and streamer. Streamers on most of the birds were examined and found to be in excellent condition, showing no appreciable wear. Twelve streamers and bands had been in the field for approximately 10 months.

RESULTS

TRAPPING

During the 1968-69 winter, 132 turkeys were trapped at four trap sites. Fifty-two were leg-banded and transplanted to five locations within the state. Seventy-two were color-marked and banded and were released at the trap sites. Twenty-one additional birds were trapped, banded, color-marked, and released at the trap sites during the late summer of 1969. Trapping data pertaining to the 93 color-marked birds released at the trap sites are presented in Table 25.

BAND RECOVERIES

Twenty-three bands from 71 turkeys (32 percent) released at three of the trap sites were recovered during the following spring and fall hunting seasons.

Table 25. Trapping results for Merriam's turkey, 1968-69, northwestern Nebraska.

Site	Dates Trapped	Number of Birds Trapped	Number of Birds Marked[a]	Adults M	Adults F	Juveniles M	Juveniles F	Sex Unknown
Ponderosa State Wildlife Management Area	12-18-68, 12-19-68, 1-17-69	14	14	8	2	1	3	0
Wohlers Ranch (private land)	1-28-69, 1-30-69	50	42	2	12	12	16	0
Ball Ranch (private land)	1-8-69, 2-11-69	37	16	0	4	4	8	0
Gilbert-Baker State Wildlife Management Area	9-16-69, 9-17-69	21	21	6	3	0	0	12
Total		122[b]	93	16	21	17	27	12

[a]Released at trap sites.
[b]Twenty-nine birds transplanted.

Table 26. Band-recovery data by hunters, from 93 color-marked turkeys released at the trap sites in 1968 and 1969 in northwestern Nebraska.

Trap Site	Date Trapped	Date Recovered	Movement (miles)	Age When Banded	Sex	Hunting Season
Ponderosa	12-31-68	4-19-69	0.5	Ad	M	Spring
Ponderosa	12-18-68	4-20-69	2.0	Ad	M	Spring
Ponderosa	12-31-68	4-20-69	4.0	Ad	M	Spring
Ponderosa	12-18-68	4-22-69	2.0	Ad	M	Spring
Ponderosa	12-31-68	4-26-69	0.5	Juv	F	Spring[a]
Ponderosa	12-18-68	4-28-69	0.1	Ad	M	Spring
Ponderosa	12-18-68	10-25-69	3.0	Ad	F	Fall
Wohlers	1-30-69	4-20-69	0.5	Juv	M	Spring
Wohlers	1-30-69	4-20-69	1.0	Juv	M	Spring
Wohlers	1-28-69	4-20-69	3.0	Juv	M	Spring
Wohlers	1-28-69	4-20-69	3.0	Juv	M	Spring
Wohlers	1-28-69	4-20-69	4.0	Ad	M	Spring[a]
Wohlers	1-28-69	10-25-69	4.5	Ad	F	Fall
Wohlers	1-28-69	10-25-69	2.0	Ad	F	Fall
Wohlers	1-30-69	10-25-69	2.0	Juv	F	Fall
Wohlers	1-30-69	10-25-69	1.5	Juv	F	Fall
Wohlers	1-28-69	10-25-69	1.0	Juv	F	Fall
Wohlers	1-28-69	10-26-69	0.7	Juv	F	Fall
Wohlers	1-28-69	10-28-69	1.5	Juv	F	Fall
Wohlers	1-28-69	11-02-69	8.0	Juv	F	Fall
Ball	1-8-69	10-26-69	2.0	Juv	M	Fall
Ball	1-8-69	10-26-69	2.0	Juv	F	Fall
Ball	1-8-69	10-26-69	8.0	Juv	F	Fall
Gilbert-Baker	9-17-69	10-25-69	0.5	Juv	F	Fall[a]
Gilbert-Baker	9-17-69	10-26-69	1.0	Juv	F	Fall

[a]Bird found dead by a hunter.

Two bands from 21 turkeys (9 percent) released at the Gilbert-Baker trap site were recovered during the following fall hunting season (Table 26). All band recoveries have been made by hunters who have shot the birds or found them already dead.

According to band-recovery data, movements from trap sites by adults and by birds banded as juveniles were similar. Nine adult birds moved an average of 2.4 miles from the trap sites as compared with 16 juveniles that moved an average of 2.3 miles. Movement by adults. ranged from 0.1 to 4.5 miles; the range for juveniles was from 0.5 to 8.0 miles. Movements from the trap sites by 14 hens averaged 2.5 miles, only slightly farther than the average of 2.0 miles by 11 toms.

MOVEMENTS OF COLOR-MARKED BIRDS

A total of 55 sightings was recorded involving 189 marked birds. The number of marked birds per sighting ranged from 1 to 28.

Sightings of birds identified by original trapping station.- A total of 28 sightings of 45 birds from the Ball trap site was recorded (Table 27). The distance moved ranged from 0 to 14.5 miles; the latter record is the longest movement registered in this study.

Table 27. Sightings of wing-marked turkeys released at the trap sites in northwestern Nebraska.

Trap Site	Observation Period	Number of Sightings	Number of Marked Birds Observed[a]	Average Distance (miles)	Range of Movement (miles)
Ponderosa	1-14-69 to 10-27-69	3	9	0.2	0.0 to 0.5
Wohlers	2-6-69 to 10-18-69	16	93	2.7	0.2 to 5.9
Ball	1-13-69 to 11-1-69	28	45	5.0	0.0 to 14.5
Gilbert-Baker	9-17-69 to 10-22-69	8	42	0.5	0.0 to 1.8
Total		55	189		

[a]Includes repeat observations.

Table 28. Sightings of individually marked birds released at the sites of capture in northwestern Nebraska.

Site	Date Trapped	Date Observed	Marked Birds[a]	Individually Recognized Birds[a]	Movement (miles)
Ponderosa	12-18, 31-69	1-14-69	7	7	0.0
Ponderosa	12-18-68	10-14-69	1	1	0.2
Wohlers	1-28-69	3-26-69	4	2	0.5
Wohlers	1-28-69	6-20-69	1	1	4.0
Wohlers	1-28-69	9-9-69	1	1	4.5
Wohlers	1-28-69	9-20-69	1	1	4.6
Wohlers	1-28-69	10-7-69	1	1	4.8
Ball	1-8-69	1-13-69	2	2	0.0
Ball	1-8-69	1-14-69	4	4	0.0
Ball	2-11-69	4-15-69	1	1	14.5
Ball	2-11-69	8-4-69	2	1	2.5
Ball	2-11-69	8-24-69	1	1	1.7
Ball	2-11-69	8-24-69	1	1	2.4
Ball	2-11-69	10-9-69	2	2	10.5
Ball	2-11-69	11-1-69	2	2	14.5
Gilbert-Baker	9-16, 17-69	9-17-69	6	6	0.0
Gilbert-Baker	9-16-69	9-30-69	4	2	0.0
Gilbert-Baker	9-16-69	10-7-69	8	2	0.0
Gilbert-Baker	9-16, 17-69	10-22-69	3	3	1.8

[a]Includes repeat observations.

Sixteen observations involving 93 birds from the Wohlers trap site were recorded (Table 27). Movement ranged from 0.2 to 5.9 miles.

Eight observations involving 42 birds from the Gilbert-Baker trap site were recorded (Table 27). Movement ranged from 0 to 1.8 miles; all observations were made on this 2,457-acre state area.

Three observations involving nine birds from the Ponderosa trap site were recorded (Table 27). All birds were observed at or near the trap site. The lack of other sightings is probably due to the small number of birds marked and to the high percentage of birds killed during the spring hunting season that occurred 4 months after the trapping.

Birds recognized individually. -Fifty-two observations of color-marked birds and 41 observations of individually recognized turkeys were made on 19 of the 55 total sightings (Table 28). From the total of 93 birds that were color-marked, 31 have been observed at least one time since they were trapped.

Sightings of color-marked birds, during a 10-month period, show that distances moved from trap sites by adults compared with birds banded as juveniles varied considerably. Nineteen sightings of 15 different color-marked adults indicated an average movement of 1.9 miles from the trap sites, compared with 22 sightings of 16 different color-marked juveniles with an average movement of 4.2 miles. Distances of movements from the trap sites by color-marked toms and hens were similar. Fourteen sightings of 12 different toms indicated an average movement of 0.9 mile from the trap sites, compared with 21 sightings of 15 different hens with an average movement of 3.6 miles.

Probably the most important information that can be obtained from the color-marked birds concerns seasonal movements to and from trap sites. At this time, not enough sightings have been recorded to draw definite conclusions from data on movement. It was often difficult to recognize individual birds unless the marked birds were nearby and stationary. If the birds were marked on both wings, the chances of observing the markers would be increased.

This page has been intentionally left blank to preserve the continuity of the original document.

13

MOVEMENTS, BEHAVIOR, AND NESTING ECOLOGY OF THE WILD TURKEY IN EASTERN ALABAMA*

Hilburn O. Hillestad †

ABSTRACT

An ecological study of the eastern wild turkey *(Meleagris gallopavo silvestris)* was conducted in the Alabama Piedmont during the spring and summer of 1968 and 1969. Fifteen hens were captured, patagium-tagged, instrumented with 27 MHz radio transmitters, and released at the capture sites. Twelve hens provided significant data on movements, behavior, and nesting. Spring and summer ranges of four nonnesting hens averaged 194 acres; spring and summer ranges of eight nesting hens averaged 370 acres. Movements to nest sites from capture sites averaged 0.8 mile; maximum straight-line movement for eight nesting hens averaged 1.7 miles. Predators caused five nest failures; three nests were successful. There was no renesting. Seven hens selected similar nesting habitat but were separated by distances up to 5 miles. Their selected nest sites were in open, recently cut-over upland pine habitat. Both sociological and ecological factors were believed to have influenced five hens that nested in close proximity. Adult hens were believed to initiate the dispersal of juvenile gobblers from the family flock. Juvenile gobblers dominated juvenile hens, but were subordinate to adult hens in family flocks. Survival of poults is possibly aided by this hierarchic arrangement. Additional behavior of nonnesting hens and of nesting hens is reported.

A radiotelemetry study of the basic ecological attributes of the eastern wild turkey was begun in March 1968. This study was concerned with the movement and reproductive activities of hens in a recently established, expanding population. The project sought to determine: (1) the preferred nesting habitat and the nesting success of the wild turkey, (2) the size, shape, and stability of the minimum range of hens and poults during the rearing season, (3) the extent and time of poult mortality, and (4) the behavior associated with mating, nesting, and poult rearing.

This research was part of a larger study investigating the dynamics of a population that: (1) was established by the release of 26 turkeys in 1965-66, (2) was not influenced by immigration from surrounding areas, and (3) was mostly composed of individually marked turkeys from which population estimates could be derived by direct count (Speake et al. 1969).

I wish to thank the following for special help in turkey capture, field observation, and for helpful suggestions: D. W. Speake, L. H. Barwick, A. K. Burttram, M. K. Causey, E. P. Hill, A. S. Johnson, and R. L. Marchinton. J. E. Har-

* A contribution of the Alabama Cooperative Wildlife Research Unit: Auburn University Agricultural Experiment Station, Game and Fish Division of the Alabama Department of Conservation, the U.S. Fish and Wildlife Service, and the Wildlife Management Institute, cooperating.

† Present address: Institute of Natural Resources, University of Georgia, Athens.

rison furnished the photograph for Figure 30. L. E. Williams, Jr. and D. H. Austin, Florida Game and Fresh Water Fish Commission, provided helpful suggestions in the use of alpha-chloralose for capturing turkeys. E. J. Baker, conservation officer, assisted in patrolling the research area for poachers.

Appreciation is expressed to the landowners of the Saugahatchee Wildlife Research Area for permission to work on their land and to the Alabama Cooperative Wildlife Research Unit, Auburn University, for financial support. Appreciation is also expressed to the National Wildlife Federation for a Conservation Fellowship awarded in 1968, and to the American Museum of Natural History, Frank M. Chapman Fund, for a grant for research equipment in 1967.

STUDY AREA

The study area, located near Auburn, Alabama (Figure 27), is a 9,000-acre tract used by the Alabama Cooperative Wildlife Research Unit for wildlife studies by agreement with landowners. Agricultural land use is primarily cattle grazing, with associated permanent pastures (Figure 27). Roughly a third of the area is grazed by cattle and is composed of improved and woodland pastures. The dominant vegetation on improved pastureland is coastal Bermuda grass *(Cynodon dactylon).*

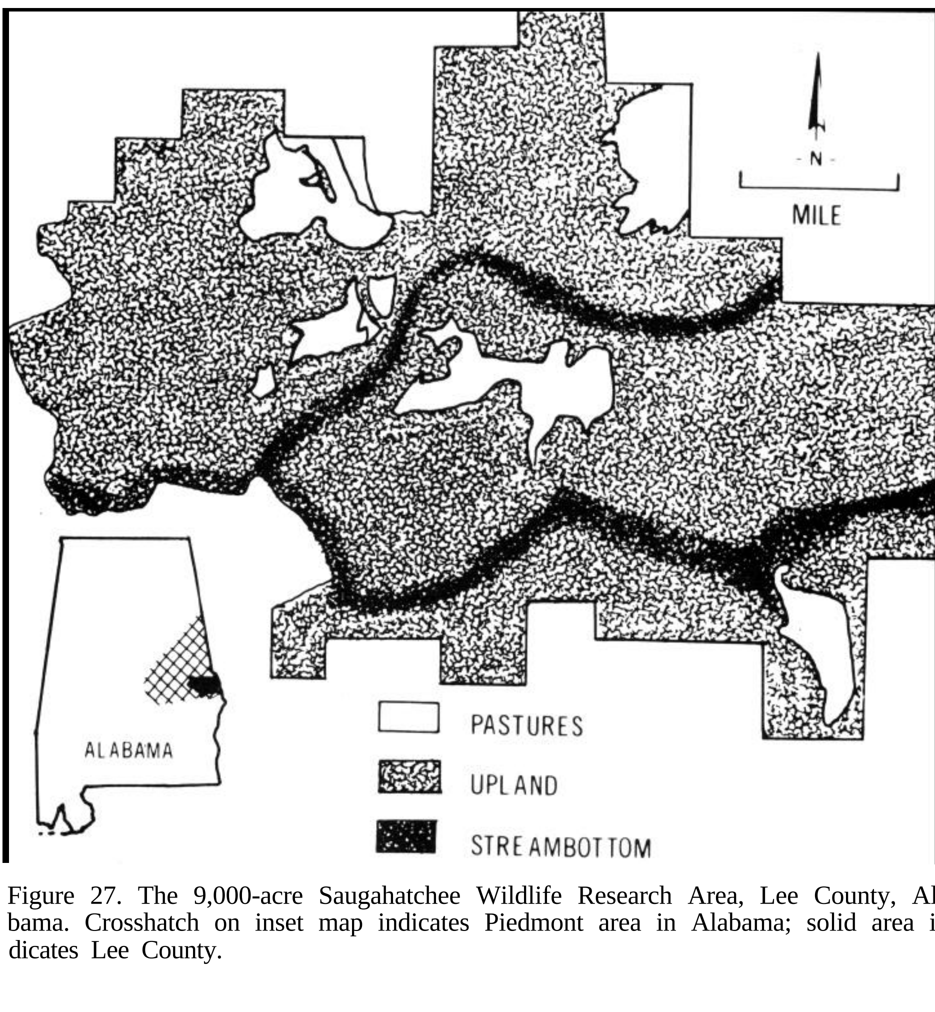


Figure 27. The 9,000-acre Saugahatchee Wildlife Research Area, Lee County, Alabama. Crosshatch on inset map indicates Piedmont area in Alabama; solid area indicates Lee County.

Forest cover consists of bottomland hardwoods, upland hardwoods, and extensive upland hardwood-pine associations. The entire area has been cut over, most of it recently. Forest land is managed primarily for short-rotation pulp production.

Turkeys were extirpated from this area many years ago; other portions of the county contained a few turkeys in 1941 (Barkalow 1949). Twenty-six birds were introduced into the study area in 1965-66, and, based on a direct count, Speake et al. (1970) estimated a population of 118 in October 1968.

There has been no turkey hunting on the research area except for occasional poaching.

METHODS

Fifteen hens were captured in 1968-69 with the oral anesthetic alpha-chloralose (Williams 1966). Hens were aged by wing characters (Williams 1961), and they were banded with aluminum leg bands and patagium tags (Knowlton et al. 1964:167). In this paper, *subadult* indicates a hen less than 1 year old.

Small, portable, 4-pound 27 MHz receivers were used (Figure 28). The

Figure 28. Portable 27 MHz radio receiver and radio transmitter used for instrumentation.

pulsed-signal transmitters weighed 4 ounces, including harness (Figures 28, 29). They were mounted on the backs of the birds, with the loop transmitting-antennas positioned over the necks and under the breast feathers, and were secured with 0.25inch rubber tubing that passed beneath the wings (Figure 29). Predicted battery life was 90 days; actual battery life was 65 to 154 days.

Figure 29. Instrumented hen ready for release. Note patagium tag used for individual identification.

Instrumentation did not appear to interfere with normal feeding, mating, or flying. Instrumented turkeys were monitored by triangulation (Cochran and Lord 1963:16), and locations were plotted on maps prepared from aerial photographs. Reception range varied according to topography but averaged 0.5 mile; maximum range was 1.0 mile.

Observations were usually made by locating the instrumented hen by telemetry, then moving to an advantageous position from which the birds could be observed with binoculars. Other observations were made from blinds at bait sites during capture operations.

Locations determined by telemetry were transferred to a composite map for each turkey. To determine the minimum range (Ellis and Lewis 1967: 576) during the reproductive season, the outermost locations were connected. Reference to *range* in this study implies minimum range during spring and summer. Diagrammatic minimum range maps were prepared (Figures 30-35) from composite maps of telemetry locations. Because plotting more than 100 individual telemetric *fixes* for each hen would obscure the generalized habitat features of the ranges, only diagrammatic range maps were prepared.

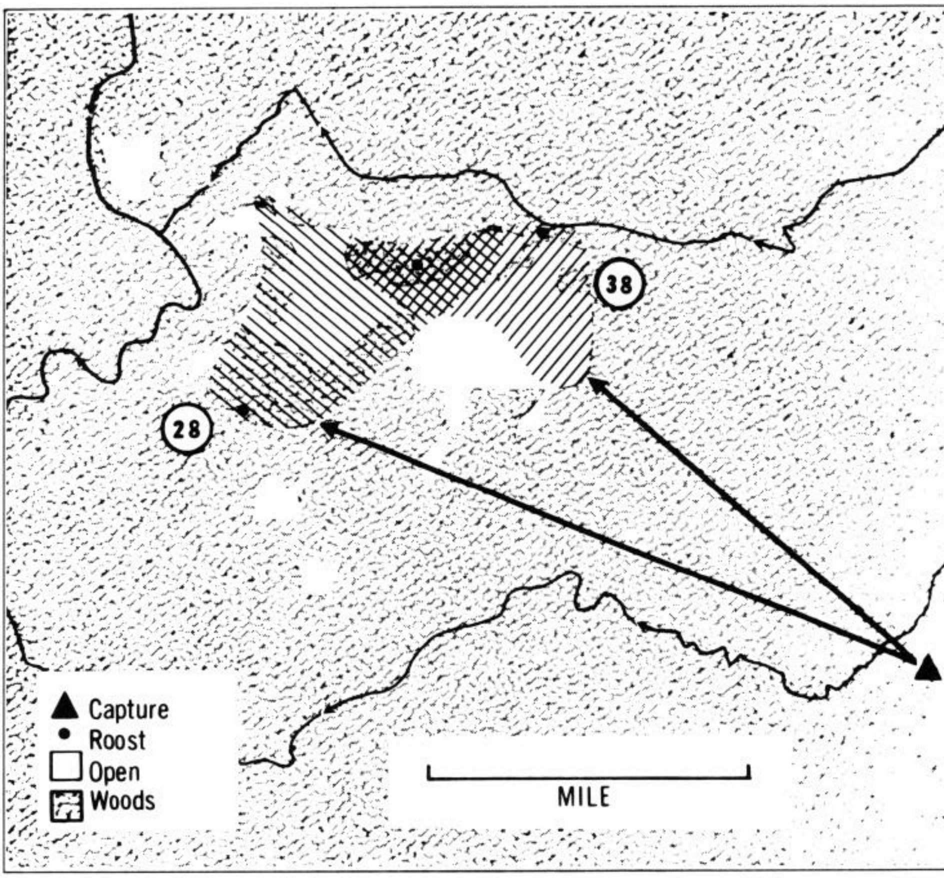


Figure 30. Ranges of subadult Hens 28 and 38 during spring and summer, 1968. Ranges were 210 and 144 acres, respectively. Streams are shown as solid lines with arrows indicating direction of flow.

Generalized roost sites are included in each turkey's range. Roost sites indicate the approximate 2- to 3-acre area hens used for roosting and do not necessarily indicate the exact roosts.

Movements from capture sites to nest sites were measured as straight-line distances between those points. Minimum distances between extreme locations were also recorded for each hen.

RESULTS AND DISCUSSION

MOVEMENT AND RANGE

Nonnesting hens. -Four subadult, nonnesting hens were instrumented in 1968. These four birds furnished adequate data to allow determinations of their ranges and movements (Table 29). Three of the hens dispersed an average of 1.4 miles from their capture sites to the minimum range area; the fourth hen did not disperse from her capture site.

The maximum distance determined between extreme locations recorded for the four hens studied was the 2.75 miles of Hen 28. Shortly after release on April 4, she moved 1.9 miles, straight-line distance, from the trap site to a

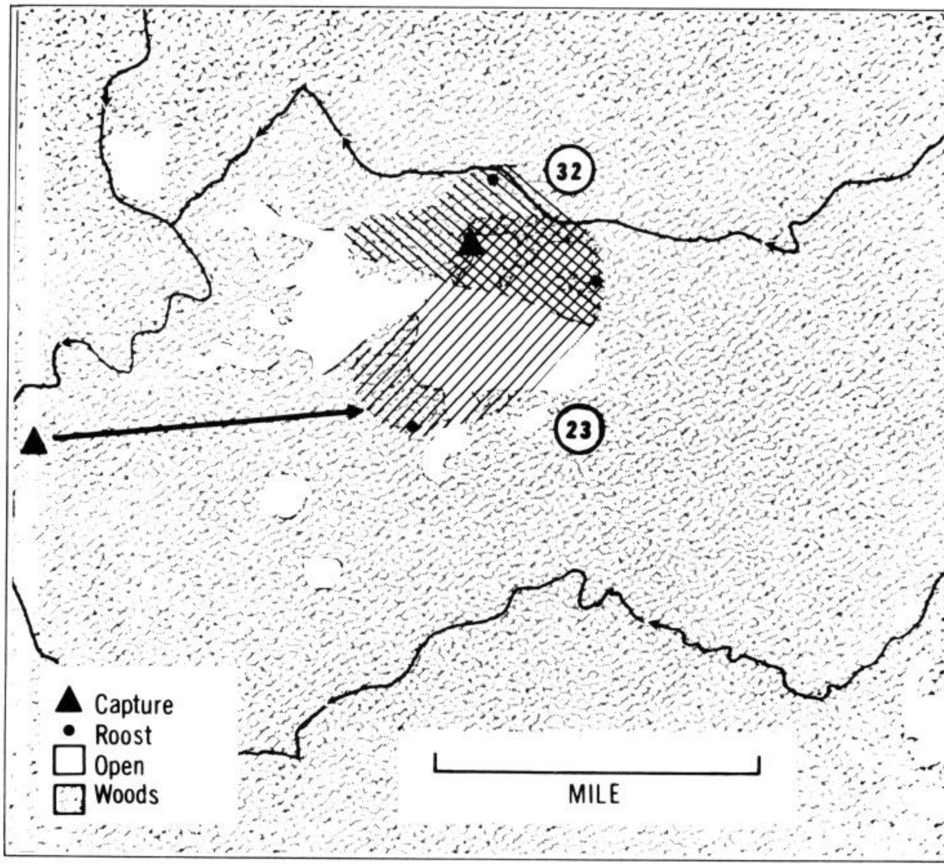


Figure 31. Ranges of subadult Hens 23 and 32 during spring and summer, 1968. Ranges were 228 and 134 acres, respectively.

location where she occupied a range of 210 acres until May 18 (Figure 30). She then moved 2.3 miles to the vicinity of the original capture site and occupied an undetermined range. The area to which this hen dispersed contained more hens than the area she left. The reason for this movement was unknown -she did not nest.

Hen 38 (Figure 30), captured at the same site as Hen 28, moved 1.4 miles to an area close to that of Hen 28 and remained there until tracking ceased.

Hen 32 had the smallest and most stable range of any hen studied; she remained on 134 acres near her capture site (Figure 3 1). Ellis and Lewis (1967: 573) observed that of 17 young hens banded, only 3 were found on the study area after the spring breakup.

Nesting hens. -Although the average life of a transmitter was 65 days and probably spanned the peak nesting period, only one of the five hens instrumented in 1968 was known to nest. Hen 22 raised two poults, which were observed in late August and September 1968, but radio contact was insufficient to determine her range and movements.

In 1969, five adult and five subadult hens were instrumented. Two subadults were tracked less than a month, with insufficient data to determine their ranges. Eight hens were tracked to provide information on movements related to nesting and brood rearing (Table 30).

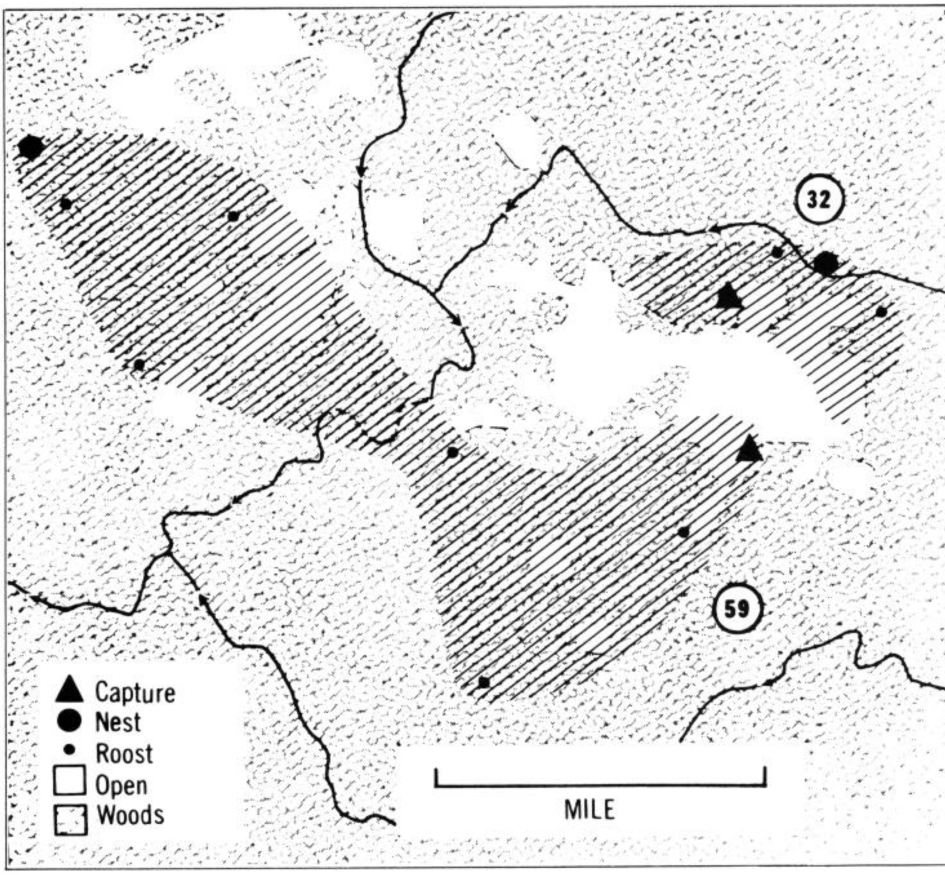


Figure 32. Ranges of adult Hen 32 and subadult Hen 59 during spring and summer, 1969. The 160-acre range of Hen 32 was the smallest range of any nesting hen; the 884-acre range of Hen 59 was the largest. Both hens were unsuccessful in nesting.

Previous studies of turkeys, based on sightings, reported spring movements of 2 to 5 miles (Mosby and Handley 1943:171) to mating and nesting areas, 2 miles for adult gobblers (Dalke et al. 1946:42), and 0.9 mile for adult hens (Ellis and Lewis 1967:573). Hens in the present study moved an average of 0.8 mile from the capture sites to the nest areas. This average figure may not represent their dispersal, since the hens were all captured about April 1. However, most of the hens had been near the capture sites for some time prior to capture.

Hen 32 was recaptured April 10, 1969, at the site of her original capture as a subadult in 1968. Her range of 160 acres in 1969 during 129 days was almost identical to her range of 134 acres in 1968 during 67 days (Figures 31 and 32). This is the only hen that did not disperse after capture. She also remained within her nest range for approximately 3 months after nesting unsuccessfully in 1969.

The average spring and summer range for three hens with poults and five broodless hens was 370 acres; minimum distances between extreme locations averaged 1.7 miles. All hens, except Hen 59, used grazed pastures and associated edges to a great degree.

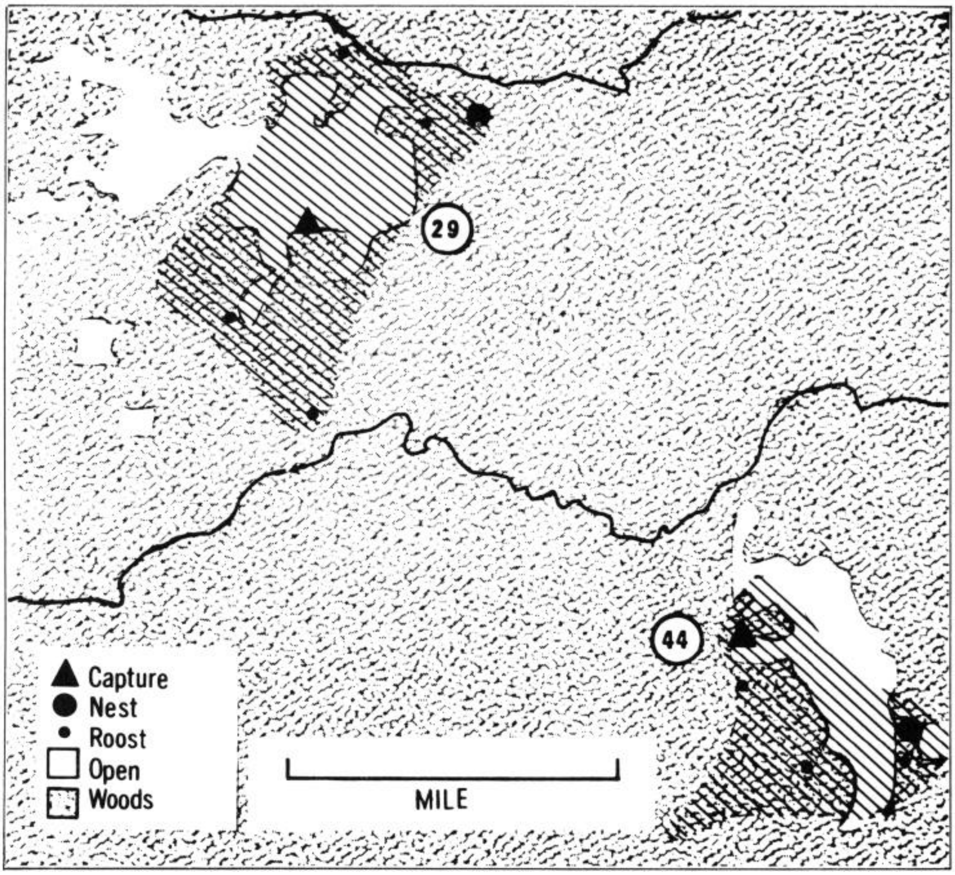


Figure 33. Ranges of adult Hen 29 and subadult Hen 44 during spring and summer, 1969. Ranges were 384 and 218 acres, respectively.

All hens in this study occupied relatively small ranges that included large amounts of improved pastureland and woodland-pasture ecotone. The locations and sizes of the ranges indicated that improved pastureland was the key item in habitat selection by the hens. This is the subject of another paper (Hillestad and Speake 1971), which presents management suggestions, based on movement and range data, for brood-rearing habitat.

NESTING

Of eight instrumented hens that nested in 1969, seven selected similar habitat; four of these seven selected almost identical habitat. The preferred habitat consisted of recently cut-over loblolly pine *(Pinus taeda)*, shortleaf pine *(P. echinata)* and sweet gum *(Liquidambar styraciflua)*. Young, thinly spaced loblolly pine, shortleaf pine, and sweet gum ranged from 10 to 30 feet in height. The understory was broomsedge *(Andropogon virginicus)*, Japanese honeysuckle *(Lonicera japonica)*, plumegrass *(Erianthus* sp.), greenbrier *(Smilax* sp.), muscadine *(Vitis rotundifolia)*, and blackberry *(Rubus* sp.). Two nests were at the bases of small sweet gums; others were in the open and slightly covered with muscadine, Japanese honeysuckle, and/or blackberry.

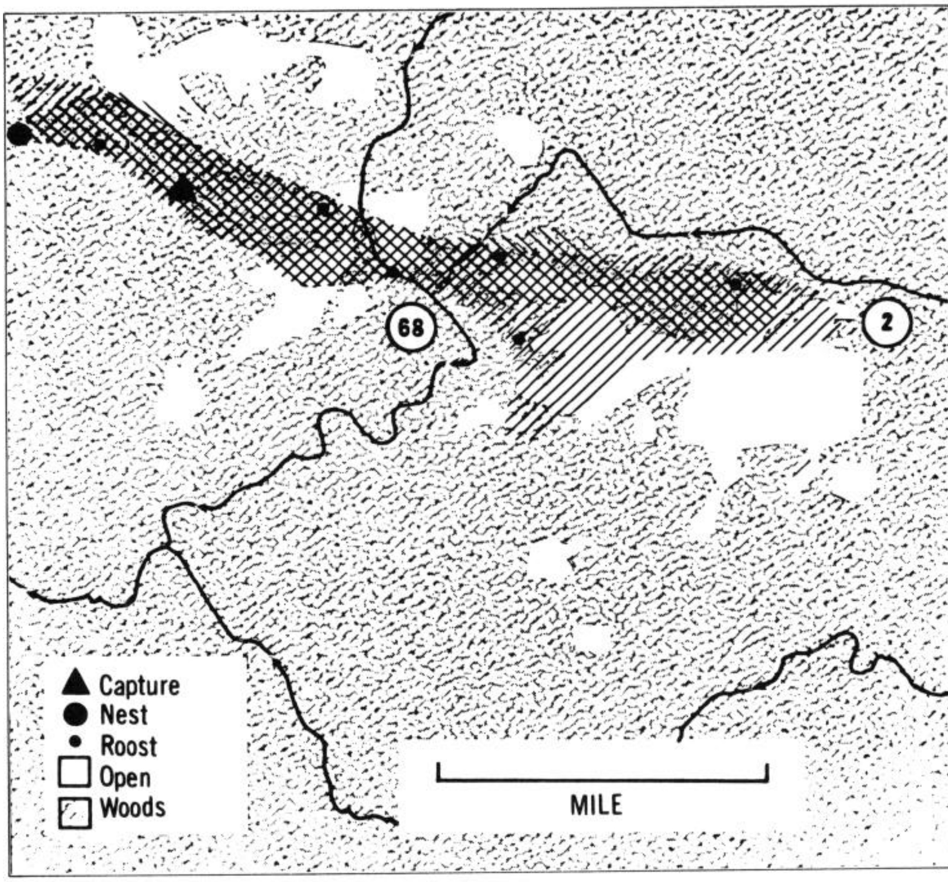


Figure 34. Ranges of adult Hens 2 and 68 during spring and summer, 1969. Range sizes were 401 and 301 acres, respectively. The nest of Hen 2 was not found, but she had a successful hatch and reared eight poults. Hen 68 was unsuccessful in nesting.

One hen nested at the base of a sweet bay *(Magnolia virginiana),* within 180 feet of a small stream. Had this nest not been destroyed by a predator, it would have been flooded before the termination of incubation. Large (20- to 24-inch dbh) bottomland hardwoods composed the overstory, mostly sweet gum, water oak *(Quercus nigra),* sweet bay, and loblolly pine. The understory consisted of elderberry *(Sambucus candensis),* Chinese privet *(Ligustrum sinense),* Japanese honeysuckle, and jack-in-the-pulpit *(Arisaema triphyllum).*

All nests were in ungrazed areas but only 100 to 400 yards from the grazed areas. Alternative nest habitat consisted mainly of bottomland hardwoods, nearly mature upland hardwoods, and extensive mixed upland hardwood and pine, all with relatively open understory.

Five hens nested in close proximity in upland cut-over habitat. Williams et al, (1969:25) reported a definite clustering of nests in southern Florida and suggested that the selection of nest sites was probably due to habitat preference rather than to sociological factors.

Sociological factors may have influenced Hens 2, 21, 45, and 68 to nest in close proximity to one another. Three of these hens were adults and one was a subadult. These four hens had been together before capture and adult Hens 2

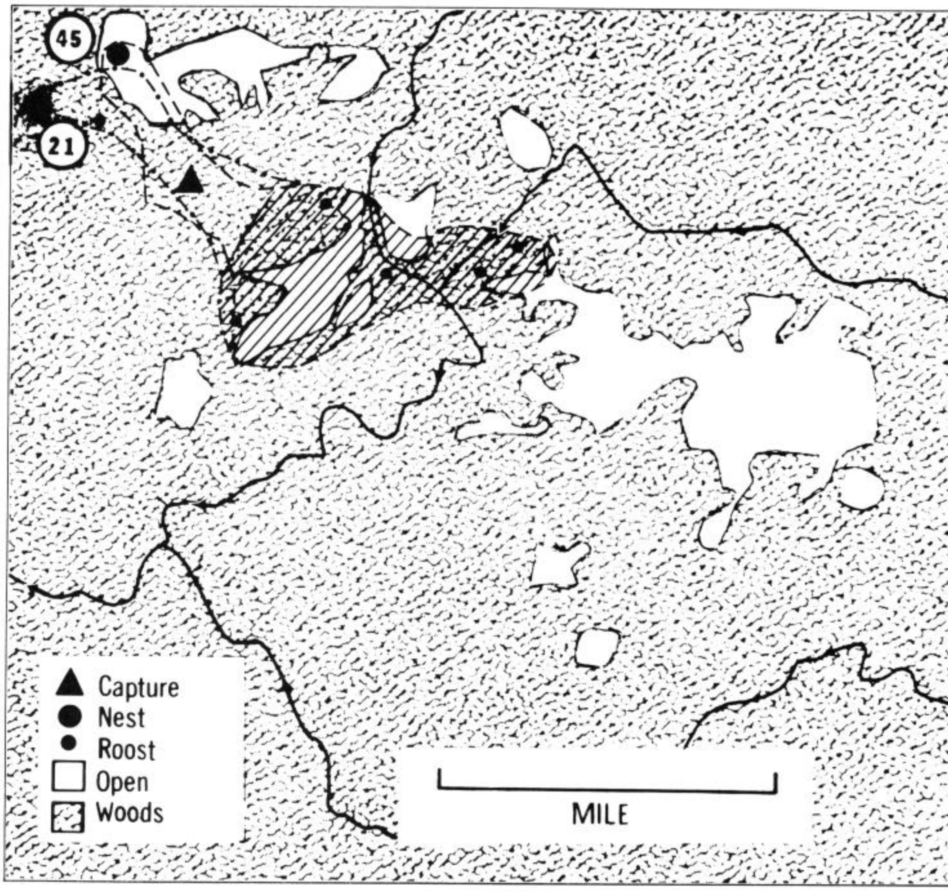


Figure 35. Ranges of adult Hen 21 and subadult Hen 45 during spring and summer, 1969. Diagonal lines indicate mutual brood-rearing range shared by Hens 21 and 45. Ranges were 326 and 282 acres, respectively.

and 21 were captured together. Throughout the nest period all four hens usually walked from a small field, where they fed, down a logging road to the vicinity of their nests. Since she had not been near the area prior to nesting, the subadult hen was probably unfamiliar with the habitat in which she nested. Neither had the adult hens been sighted frequenting the nest area in previous years. Ligon (1946:10) had "fairly dependable proof" that Merriam's turkey hens *(M. g. merriami)* returned to the same nest ground as long as they were in the prime of life and the area was not seriously disturbed. Ellis and Lewis (1967:574) had similar evidence in Missouri; in the high population they studied, adult hens chose desirable nest locations near the winter areas.

The movement and behavior of subadult Hen 59, the fifth hen nesting in this group, is difficult to explain, but her nest site suggests that she was influenced by habitat. I never saw her with other turkeys throughout her 106-day tracking period. She was never seen in fields or pastures, and she avoided these areas when they were in her travel routes. She nested, however, within 200 yards of Hen 21. The distance from capture site to nest site for Hen 59 was 2.4 miles. Ellis and Lewis (1967:574) reported that, in the high population they were studying, crowding forced juvenile hens who had not nested before to seek

Table 29. Movements and ranges of four nonnesting subadult turkey hens, as determined by radiotelemetry, from March 30 to June 6, 1968, on the Saugahatchee Wildlife Research Area, Alabama.

Turkey Number	Date of Capture	Weight (lb)	Tracking Period (days)	Dispersal from Capture Site[a] (miles)	Minimum Distance Between Extreme Locations (miles)	Range (acres)
23	April 2	7.7	65	1.05	1.88	288
28	April 2	7.5	65	1.88	2.75	210
32[b]	March 30	8.1	67	0.00	0.88	134
38	April 2	8.5	65	1.40	2.28	144
Average		7.9	65	1.44	1.95	194

[a]Direct movements to nearest point of minimum range after release.
[b]Hen 32 is not included with average dispersal, because she did not move.

Table 30. Movements and ranges of eight nesting turkey hens, as determined by radiotelemetry, April 1 to September 4, 1969, on the Saugahatchee Wildlife Research Area, in Alabama.

Turkey Number	Date of Capture	Age-Class	Weight (lb)	Tracking Period (days)	Miles from Capture Site to Nest	Distance Between Extreme Locations (miles)	Range (acres)
2	April 1	Adult	8.50	139	_[a]	2.68	401[b]
21	April 1	Adult	8.25	137	0.56	1.68	326[b]
29	April 8	Adult	9.00	99	0.65	1.25	384
32	April 10	Adult	7.00	129	0.33	0.82	160
44	April 16	Subadult	8.00	81	0.59	0.88	218
45	April 7	Subadult	7.00	156	0.50	1.50	282[b]
59	April 17	Subadult	8.00	106	2.40	2.50	884
68	April 16	Adult	8.00	98	0.56	2.35	301
Average			7.97	118	0.80	1.70	370

[a]Nest not found.
[b]Hen with brood.

nest sites far from winter concentration areas. Perhaps crowding caused the extensive movements of Hen 59.

There were no significant differences in nest location, construction, and size between adult and subadult hens. All hens made depressions into which they imported material. Nest size averaged approximately 2.5 by 8.0 by 10.2 inches, similar to the "8- x 10-inch" dimensions reported by Mosby and Handley (1943:114) and Williams et al. (1969:28). Seven nests had clutches of 4 to 10 eggs, with an average of 9.1 (Table 31).

Four of 10 subadult hens instrumented in this study were known to nest. Leopold (1944:160) stated that juvenile hens nested their first year. Wheeler (1948:37), however, believed that few hens nested their first year.

NEST PREDATION

Predators destroyed or caused abandonment of five of the eight nests (Table 31); only 16 of 64 eggs (25 percent) hatched. Three nests were destroyed or abandoned within 5 days after the nests were found. The visit by the investigator to the nest sites may have made them more susceptible to predation by establishing scent trails and/or paths to the nests. Two incubating

Table 31. Record of seven turkey nests during 1969 on the Saugahatchee Wildlife Research Area, Alabama.

					Nest Information			
Turkey Number	Date of Capture	Age-Class	Clutch Size	Nest Size[a] (inches)	Fate of Nest	Date Nest Was Found	Date Nest Was Hatched, Abandoned, or Disrupted	Number of Poults Hatched
2	April 1	Adult	—[b]					
21	April 1	Adult	9	2 x 8 x 10.5	Hatched	May 7	May 27[c]	6
29	April 8	Adult	11	3.5 x 8 x 10.5	Abandoned[d]	July 5	July 6	
32	April 10	Adult	10	2.5 x 8 x 10.5	Disrupted	May 20	May 25	
44	April 16	Subadult	4	2 x 7.5 x 10	Abandoned	June 20	July 9	
45	April 7	Subadult	10	2.5 x 7.5 x 10	Hatched	May 17	June 15[c]	10
59	April 17	Subadult	7	3 x 8.5 x 10	Disrupted	May 27	June 30	
68	April 16	Adult	13	2 x 8 x 10	Disrupted	May 8	June 3	
Average			9.1	2.5 x 7.9 x 10.2				

[a]To nearest 0.5 inch.
[b]This nest was not found, but the hen was seen with eight poults on May 26. Her activities during nesting indicated that she nested near Hens 21, 45, 59, and 68.
[c]Observed event.
[d]Caused by predation attempt.

hens were accidentally flushed from their nests by the investigator, but both returned later in the day.

During this study, three hens had violent struggles with unidentified predators, although all hens survived. Many breast feathers were around each nest, and the surrounding vegetation was trampled.

Two clutches were destroyed by the predator(s) during or after the predation attempt. One clutch remained intact in the nest 28 days after the predation attempt, before the eggs were eaten by an unknown predator. Another clutch remained intact in the nest until the 15th night after the predation attempt, when the eggs were rolled out of the nest and eaten by an unknown predator. Two days after Hen 29 abandoned her nest, after a predation attempt, the eggs were destroyed. Except for the eggs of Hen 29, all eggs destroyed by predators were crushed and eggshell fragments were scattered in and around the nests.

Predation appears to have been directed at the hens themselves in three instances, because a struggle took place between the nesting hens and predators and the eggs of two of the nests remained intact for substantial periods afterwards.

Johnson (1970:69) offered captive raccoons *(Procyon lotor)* chicken eggs on various occasions. Those raccoons obtained from an area with a well-established, dense turkey population opened the eggs almost immediately. In contrast, raccoons from areas with few or no turkeys did not open the eggs-perhaps because they were not familiar with them. Thus, there may be a lag between the time predators are first exposed to eggs and the time they learn to eat them.

Predation of turkey nests is well documented. Blakey (1937:11), Mosby and Handley (1943:126), Dalke et al. (1946: 50), Wheeler (1948:37), Walker (1949:22), McDowell (1956:12), and recently Williams et al. (1969:29) reported nest failures attributable to predators and, in some instances, identified the predators. Despite these studies, the effect of predation on a turkey population is unclear.

POULT MORTALITY

Poult mortality in this study was low; however, due to the small sample size, little can be concluded concerning poult survival. Eight poults in one brood first observed on May 26 were still alive in mid-October 1969. Two other hens lost only 2 of 16 poults during the first week. One hen lost a 6-week-old poult in mid-July from unknown causes.

Blakey (1937: 11) blamed inclement weather for high poult mortality in the Missouri Ozarks. Rainfall was slight during this study, with only light, intermittent showers. In Alabama, Wheeler (1948:40) found that half the nests hatched, and about half the poults reached maturity.

BEHAVIOR

Nonnesting hens. -Four instrumented subadult hens tracked in 1968 often associated with other hens and gobblers during the breeding season, although they were not known to nest, Specific associations were with broodless hens, hens with broods, and with subadult and adult gobblers. Hen 28 was accepted into a family group of 2 hens and 13 poults and moved, fed, and roosted with them for several weeks. Association between hens and adult gobblers during April and late May elicited mating display, but the hens remained passive. The hens remained with adult gobblers until late June, but mating behavior by the gobblers was not observed after late May.

Gobblers appeared to initiate the loose associations with these poultless hens; the hens seemed to associate as readily with gobblers as with other hens. Leopold (1944:152) reported that some "mature males always were found attached to groups of hens and young." McIlhenny (1914:123) said that gobblers seldom associated with hens and young, and Mosby and Handley (1943:171) concurred. Although during the present study some degree of association did occur, sometimes adult gobblers used the same field with hens and poults without actually associating with them.

Nesting hens. -Laying hens made more cautious approaches to their nests than did incubating hens. Their approach was almost nonchalant until approximately 30 yards from the nest, where they often stood still for several minutes; then, with a slight craning of the neck and side-to-side motion of the head, they continued to the nest. In contrast, incubating hens proceeded quickly and directly to their nests after their brief feeding periods. Audubon (1840-44:46) stated: "When depositing her eggs, the female always approaches the nest with extreme caution, scarcely ever taking the same course twice . . . ." Mosby and Handley (1943:110) reported that hens are secretive in going to and from the nest during both egg-laying and incubation periods. Hens in this study usually approached their nests from the same general direction each time.

Only one hen was observed to fly to and from her nest. All other nests were located so that flying would have caused considerable maneuvering and noise. Williams et al. (1969:28) often observed hens flying to their nests, but these instances of flight seemed to be facilitated by nearby clearings.

In some areas hens cover their eggs when leaving, but in other areas they do not. McIlhenny (1914:113) said: "There is one precaution the hen never neglects, however slovenly the nest is built; this is to completely cover her eggs with leaves or grass on leaving the nest. . . . This is done to protect them from predaceous beasts and birds, particularly from that ubiquitous thief and villain, the crow." Blakey (1937:8) said that the hen usually conceals the nest with leaves after laying. Mosby and Handley (1943:113) and Dalke et al. (1946:47) agreed and suggested that covering is for egg protection. Williams et al. (1969:27 and personal communication) made more than 50 observations of 24 nests in southern Florida and found no evidence of egg covering.

In the present study, Adult 44 and Subadult 45 were observed covering their nests on five occasions during the laying period. These same hens were not observed to cover their nests after incubation began. On four occasions incubating hens were observed leaving their nests. All four simply stood up over the eggs and walked away.

Egg concealment could possibly be dependent upon the size of population and the level of predation. Selection might exert strong pressure for hens to conceal their nests in areas with high predator populations.

Hens with broods. -Three closely observed family groups of turkeys provided insight into flock hierarchies. Several behavioral patterns occurred in all three flocks, although their size varied from 3 hens and 14 poults to 1 hen and 4 poults.

Adult hens always dominated their male poults even when the young gobblers surpassed the hens in size (not in weight) in late September and October. Adult hens increased their harassment of and belligerency toward these gobblers as they grew. By late August and September, when the juvenile gobblers were 3 to 4 months old, they were not allowed to feed close to any of the adult hens, whereas there was no corresponding harassment of the young hens. Young gobblers fed at preferred bait piles only after the adult and juvenile hens had left. By late summer, young gobblers were beginning to move and feed as a "semisegregated group" within the flock.

The annual breakup of flocks in the fall into all-hen and young-gobbler groups is a well documented but unexplained event (Audubon 1840-44:44; McIlhenny 1914:118; Mosby and Handley 1943:171; Wheeler 1948:29; and Ellis and Lewis 1967:575). However, Bailey (1967:103) stated: "Dominance factors may regulate the order in which chicks follow the hen. Males, growing faster, become dominant over the females-even over the hen at about 14 weeks of age-and form flocks of their own in early winter. The cause of this is poorly understood, but the females probably avoid the males because of the latter's dominance."

In the present study, adult hens eventually caused segregation and subsequent dispersal of the subadult males.

Young gobblers harassed young hens not only at bait sites but whenever the two sexes were close to each other. The peck order descended from a dominant male through the other males to the female poults. This peck order existed only when poults were feeding as a unit away from the immediate vicinity of the adult hen.

The adult hen reinforced the position of the female poults in the group of hens by not harassing them. The final result was the formation of a stable all-female flock.

Hale and Schein (1962:556) stated: "Both male and female turkeys [domestic] develop a typical peck-right type of peck order with each sex forming an independent hierarchy in heterosexual groupings. . . . Female hierarchies tend to be highly stable while male hierarchies may be in an almost continuous state of change."

This clear-cut poult hierarchy has possible benefits. The experience of dominating may benefit the male poults when they are no longer a part of the hen-poult hierarchy. Those individuals having high position in the poult hierarchy may subsequently enjoy a similarly high position in the new all-male group thereby enhancing their chances for mating success and access to food.

A stable peck order may also benefit poults if the adult hen is lost. The dominant bird may assume leadership and hold the group together, thus preventing a breakdown in organization. Moreover, turkeys in flocks are at an advantage in finding food and detecting predators (Etkin 1964:267).

In the fall of 1967, D. W. Speake (personal communication) drugged a hen and eight poults about 85 days old. The poults recovered fully from the drug 2 days later and were released at the capture site without the hen. Shortly after release, one male poult assumed leadership, and the poults moved and fed as an organized unit. The adult hen joined another flock shortly after release and did not meet the poults until 1 week later. She did not rejoin her poults and was not seen with them again. The poult flock remained intact longer than was normal before winter breakup. All members of the group survived until April 1968.

Observations of poult flight. -Daily and periodic observations of hens and poults revealed several facets of turkey behavior. One of these observations concerned the age at which poults are able to fly. On June 3, 1969, 7 days after leaving the nest, the poults of Hen 45 flew 50 yards down a logging road. They were flushed again the next day and flew for at least 40 yards at a height of 5 feet. Unsuccessful attempts were made to observe the poults of this age flying up to roost. These poults were first seen on the roost, 10 days after leaving the nest, in a post oak *(Quercus stellata)* containing a large muscadine vine. Some of the poults were roosting in the vine, approximately 12 feet from the ground. The hen could be seen at about the same height, but whether she was brooding any of the poults could not be determined.

The eight 12- to 15-day-old poults of Hen 2 were observed flying over a 22-yard-wide stream on May 31 to join two other hens and their poults.

Some of the reported differences in the age at which poults can fly can probably be attributed to the different criteria used for age determination. In some cases the age is based on the number of days after leaving the nest, and in others the age is more accurately based on the date of hatch. In this paper, dates of flight are given in number of days after leaving the nest. Judd (1905:49) stated that young turkeys fly up to roost when 2 weeks old. Mosby and Handley (1943:122) stated that young turkeys are capable of flights of 25 to 50 feet when they are about 4 weeks old. Leopold (1944:170) implied that poults cannot fly until 1 month of age. Wheeler (1948:41) in Alabama stated that poults are unable to fly the first 2 weeks. However, observations made during the present study agree with Nixon's (1962:115) statement that captive wild turkey poults at the Waterloo Wildlife Experiment Station were able to fly several feet when 1 week old.

This page has been intentionally left blank to preserve the continuity of the original document.

14

SEASONAL MOVEMENTS AND ACTIVITIES OF WILD TURKEY GOBBLERS IN ALABAMA*

Larry H. Barwick† and Dan W. Speake

ABSTRACT

A 4.5-year study of the seasonal ranges and activities of the eastern wild turkey *(Meleagris gallopavo silvestris)* was conducted on the Saugahatchee Research Area in Lee County, Alabama, which was stocked with 26 wild-captured turkeys in 1965 and 1966. Twenty marked gobblers and numerous unmarked gobblers provided the information for the study. The 20 marked gobblers were captured with an oral tranquilizer, leg-banded, wing-marked, and released on the study area. Eight of these gobblers were brought to the study area and released as part of the original stock; 12 were captured on the area and released at their capture sites. Twelve gobblers were instrumented with radio transmitters in September 1968. The transmitters remained operational for from 1 to 148 days. The annual ranges of 12 gobblers varied from 234 to 1,326 acres. The ranges for 1966 and 1967, when calculated from visual observations, were approximately one-half of the size of the annual ranges that were calculated from visual observations and telemetry locations. The average seasonal range for six instrumented gobblers was largest during the winter and smallest during the summer. There was some evidence that changes in the availability of food could have been an important influence on the shift from fall to winter range. The average distance traveled during the spring dispersal of 16 gobblers was 1.3 miles.

In order to manage wild turkeys properly, it is necessary to determine their range requirements. This is a difficult task because of the wary nature and the mobility of the wild turkey. Radiotelemetry techniques are being used to collect data that have been impossible to obtain before.

The primary objective of this study was to examine the annual range, seasonal range, movements, daily activities, and behavior patterns of gobblers. This investigation is part of a study of the dynamics of a newly introduced wild turkey population (Speake et al. 1970).

We are grateful to the 21 landowners who have allowed us the use of their land holdings since 1965. We are also grateful to M. K. Causey, E. P. Hill, A. K. Burttram, W. L. Cooper, D. T. Gardner, H. O. Hillestad, Walker Stickney, and K. R. Williams for their assistance in trapping and observing turkeys.

Transmitters and receivers were manufactured by Differential Electronics, Inc. of Atlanta, Georgia. Reference to commercial products here does not imply an endorsement.

* A contribution of the Alabama Cooperative Wildlife Research Unit, Auburn University Agricultural Experiment Station, Game and Fish Division of the Alabama Department of Conservation, the U.S. Fish and Wildlife Service, and the Wildlife Management Institute, cooperating.

† Present address: Game and Fresh Water Fish Commission, Wildlife Research Projects, 2606 N. E. 17th Terrace, Gainesville, Florida 32601.

METHODS

STUDY AREA

The 9,083-acre Saugahatchee Research Area was established in 1965 through an agreement between the Alabama Cooperative Wildlife Research Unit and 21 private landowners. This area, which has not contained turkeys for the past 28 years or more (Davis 1962), is about 2 miles west of Auburn, Alabama.

Major habitat types are cut-over pine woods, mixed pine and hardwoods, upland hardwoods, stream-bottom hardwoods, and permanent pasture. Primary land uses are production of timber and cattle.

TRAPPING, MARKING, AND RELEASING TURKEYS

The anesthetic alpha-chloralose applied to cracked corn bait (Williams 1966) was used to capture turkeys. Each bird was leg-banded and marked with a 2.25- x 6-inch, plasticized fabric tag in each wing as described by Knowlton et al. (1964). The turkeys' ages and weights and the lengths of the gobblers' spurs and beards were recorded.

The turkeys were then placed in boxes in a dry, warm area and allowed to recover. Recovery usually took from 24 to 36 hours, depending on the amount of drug ingested. When the turkeys had completely recovered, they were transported to their points of capture and released. Twenty-six turkeys obtained from three areas in Alabama were banded, color-marked, and released near the center of the study area in 1965 and 1966. In 1967, 1968, and 1969, 79 descendants of the original turkeys released were captured, wing-marked, leg-banded, and released at their capture points.

COLLECTION OF DATA

Most of the locations of turkeys, obtained from March 1965 to December 1968, were determined during 1,020 hours spent on the study area (Speake et al. 1970).

From September 1968 to September 1969, 12 gobblers were instrumented with radio transmitters to permit close, frequent observations.

The transmitters weighed 8 ounces each and had an estimated operating life of 4 months. They were attached to the backs of the gobblers between the wings and were held in place with 0.25-inch rubber tubing secured under the wings. A loop antenna was placed under the breast feathers and beard. Transmitters were designed to send continuous pulsating signals on separate frequencies so that each instrumented bird could be readily identified.

The 27 MHz receiver weighed 3 pounds and had 12 channels. A 96-inch whip antenna attached to a jeep was used to locate distant signals. A 72-inch loop antenna was used to determine direction at close range. Over level terrain, this antenna was effective for 0.25 to 0.5 mile. The instrumented gobblers were located by triangulation (Cochran and Lord 1963).

Tracking periods varied from 1 to 12 hours per day. Transmitters operated continuously for from 1 to 148 days. Each instrumented gobbler was located and tracked at least once each week. Most locations were plotted from visual observations made during the tracking of the instrumented turkeys. It was still possible to make many visual observations of the gobblers after the transmitters stopped functioning.

Treatment of Data

All observations and telemetry locations were plotted on maps of the study area. The outermost locations were joined and the enclosed area was considered to be the minimum range (Mohr 1947). Area was measured with a compensating polar planimeter. Annual ranges were not calculated for turkeys that had been located less than 10 times per year.

RESULTS AND DISCUSSION

Annual Range

The annual ranges of 12 gobblers were recorded (Table 32). Four were wing-marked; six were wearing wing markers and transmitters; two more were observed with wing markers only in 1966-1967, but were observed with wing markers and transmitters in 1968-1969. Average annual ranges, determined by visual locations only, were 450 acres for six gobblers in 1966 and 511 acres for five gobblers in 1967. The average annual range of eight gobblers, based on telemetric locations and visual observations, was 984 acres in 1968 and 1969. The data in Table 32 indicate that telemetry is extremely helpful in determining the ranges of gobblers. The average annual range, established from visual observations of wing-marked turkeys during 1966 and 1967, was approximately half that determined by radio-tracking and by visual observations in 1969. Ellis and Lewis (1967:577) found that ranges established by observing four gobblers during a complete year averaged only two-thirds as large as those determined by using radiotelemetry for 1 month. Raybourne (1969:50, 51) found that the minimum home range for two 4-week tracking periods was 424.8 acres prior to the hunting season and 552.0 acres during the hunting season.

Table 32. Acreage used annually by wild turkey gobblers from 1966 to 1969 on the Saugahatchee Research Area, Alabama.

Band Number	Age-Class[a]	Range Based on Visual Observations 1966	Range Based on Visual Observations 1967	Range Based on Telemetric Locations and Visual Observations September 1968 to September 1969
1	1965	422	462	877
6	1965	272	362	877
2302	1964	790		
5	1965	234	358	
2303	1964	738	496	
506	1965	242	878	
503	adult(1966)[b]			1,192
552	adult(1968)[b]			947
20	1967			886
24	1967			886
508	1967			883
509	1967			1,326
Average		450	511	984

[a]All except 503 and 552 were captured and tagged as juveniles and the age-class used here is the summer of hatch.

[b]These birds were adults when trapped.

Early studies of the range size of wild turkeys show considerable variation. According to Mosby and Handley (1943 : 207)) the average cruising radius of the turkey in Virginia was about 2 miles in the eastern part of the state and somewhat greater in the mountains.

Wheeler (1948:22) believed that turkeys used between 400 and 1,000 acres as a home range, varying with the seasonal abundance of food. Lewis (1963: 100) found that winter home ranges averaged 435, 492, and 683 acres, depending on the sex composition of flocks. Ellis and Lewis (1967: 577) determined from telemetry data that the mean annual range of four Missouri gobblers was approximately 1,100 acres. Some of the differences are probably due to regional and local variations in habitat, population, and the different methods used in determining range size.

SEASONAL MOVEMENTS AND ACTIVITIES

Fall and winter. -Seasonal ranges of six gobblers are given in Table 33. Outline maps of two ranges are presented in Figures 36 and 37. Two flocks of

Table 33. Seasonal ranges (in acres) of six wild turkey gobblers as determined from telemetric locations and visual observations in 1968 and 1969 on the Saugahatchee Research Area, Alabama.

Band Number	Age-Class[a]	Fall (1968)	Winter (1968)	Spring (1969)	Summer (1969)
503	adult (1966)[b]	461	782	430	459
552	adult (1968)[b]	461	782	222	266
24	1967	403	611	302	370
25	1967	403	611	-	
508	1967	403	611	502	219
509	1967	403	611	1,069	-
Average		422	668	505	329

[a]All except 503 and 552 were captured and tagged as juveniles and the age-class used here is the summer of hatch.

[b]These birds were adults when trapped.

gobblers were monitored and observed frequently from September 1968 through January 1969. Gobblers 503 and 552 were in one flock. Gobblers 24, 25, 508, and 509 were in the other flock. Both flocks spent most of the daylight hours in large open pastures and adjacent stands of mixed pine and hardwood.

Observation and analysis of droppings (Table 34) indicated that these gobblers fed primarily on grass, dogwood fruit *(Cornus florida),* insects, corn *(Zea mays),* and acorns *(Quercus* spp.) for 3 to 4 hours in the early morning and late afternoon. They loafed in shaded areas at the edges of pastures or in wooded areas with open understory for 3 to 4 hours each day. As fall progressed into winter, the gobblers extended their ranges into wooded areas (Table 35). They occasionally moved back into the pastures to feed on waste corn left in cattle-feeding areas.

During October and November of 1968, a poor year for acorn mast on the research area, 117 droppings were collected and analyzed to determine the major food items (Table 34). The droppings were collected in the ranges of the gobblers under observation. The method of analysis was essentially the one described by Glover and Bailey (1949). The turkeys found some acorns, but the single most important food was dogwood fruit. Forest-management prac-

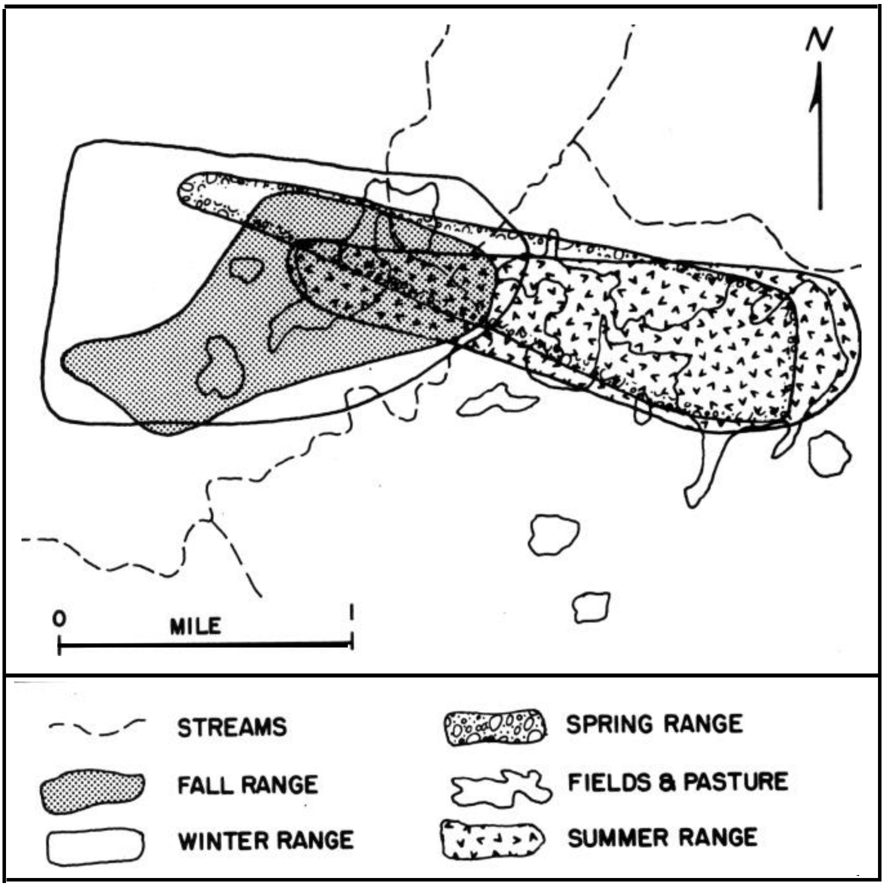


Figure 36. Seasonal ranges of Gobbler 503 on the Saugahatchee Research Area.

tices on the area had left numerous midstory hardwoods, including dogwood, uncut.

When Tables 34 and 35 are compared, it becomes evident that food supply could be an important factor in the shift from open fields and pastures (fall range) to forested areas (winter range). When foods such as crabgrass *(Digitaria sanguinalis),* other grasses, and insects, which were available during the summer and fall, became less plentiful, turkeys began to spend more time in forested areas where mast was becoming available.

The fall ranges of the two monitored flocks of gobblers were 403.4 and 460.8 acres; their winter ranges were 610.8 and 782.4 acres. These data indicated that the gobblers were moving more in winter than in fall, probably in order to find an adequate food supply.

During winter, gobblers used mixed uneven-aged stands of pine and hardwood. Important species of trees present on the winter range included loblolly pine *(Pinus taeda),* shortleaf pine *(P. echinata),* water oak *(Quercus nigra),* southern red oak *(Q. falcata),* post oak *(Q. stellata),* sweet gum *(Liquidambar styraciflua),* and dogwood. Most of the area has been recently cut over for sawtimber or pulpwood.

Activity of gobblers changed little from fall to winter except that in winter more time was spent in moving and less in loafing.

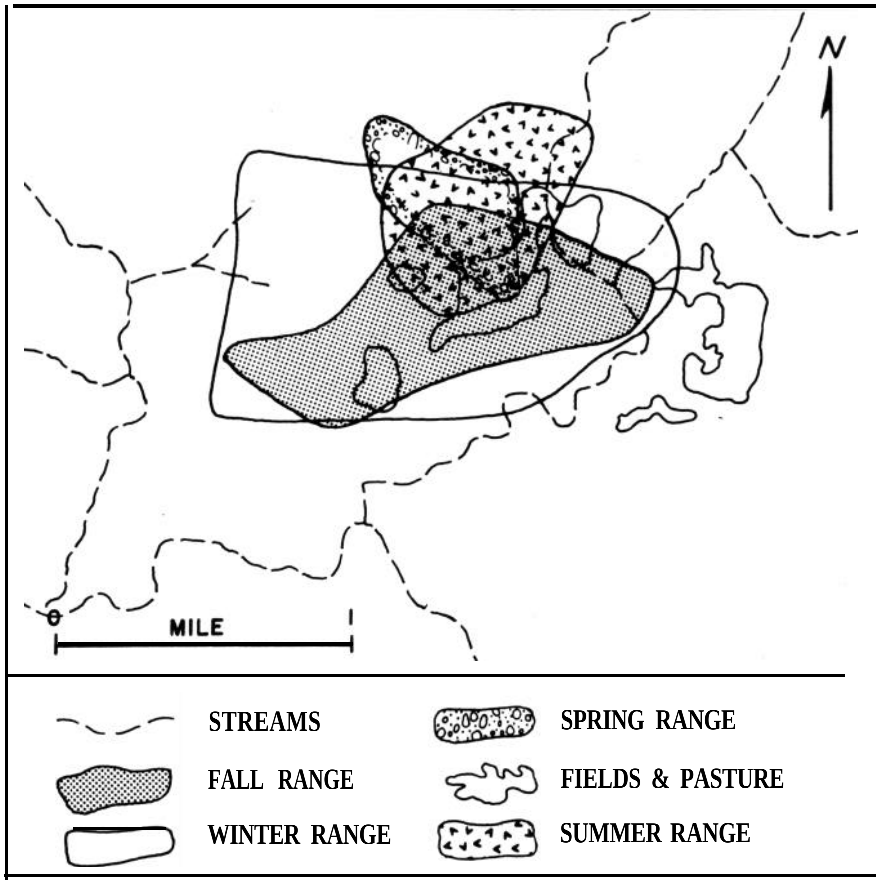


Figure 37. Seasonal ranges of Gobbler 552 on the Saugahatchee Research Area.

Spring. -The exact time of spring breakup of winter flocks varied from year to year. In 1967 it occurred about March 12, in 1968 about March 1, and in 1969 about March 25. According to Ellis and Lewis (1967:572), spring weather influences the precise time of dispersal, and perhaps this factor explains the yearly variation in this study.

Immediately after the breakup of the flock, adult gobblers dispersed to gobbling and strutting areas. Table 36 contains the linear spring-dispersal distances of 16 gobblers over a span of 4 years. Yearly averages ranged from 1.2 to 2.0 miles. The greatest dispersal was 3.1 miles. These data were calculated by plotting the distances moved from the preceding winter locations of flocks and winter areas to their strutting and gobbling areas. Mosby and Handley (1943: 171) found that some turkeys moved as much as 2 to 5 miles from winter to spring range in Virginia. In Missouri some gobblers dispersed as far as 2 miles to establish gobbling territories (Dalke et al. 1946:42). Ellis and Lewis (1967: 573) found that the dispersal from winter areas averaged 1.3 miles for adult gobblers.

In our study, most gobbling and strutting areas were established in and around permanent pastures. Ten wing-marked gobblers observed in flock formation the preceding winter were observed later in the spring. All had gobbling and

Table 34. Food items occurring in 117 turkey droppings collected in October and November 1968 on the Saugahatchee Research Area, Alabama.

Kind of Food	Percentage of Occurrence October	Percentage of Occurrence November
Dogwood *(Cornus florida)*	90	95
Miscellaneous plant material[a]	87	83
Acorns *(Quercus spp.)*	53	45
Crabgrass *(Digitaria sanguinalis)*	38	8
Insect fragments	30	10
Crabgrass *(Digitaria filiformis)*	10	10
Corn *(Zea mays)*	8	0
Black gum *(Nyssa sylvatica)*	7	5
Black cherry *(Prunus serotina)*	7	0
Poison ivy *(Rhus radicans)*	5	3
Grass *(Paspalum sp.)*	4	0
Grass *(Panicum sp.)*	3	3
Wild plum *(Prunus sp.)*	3	0
Common lespedeza *(Lespedeza striata)*	3	0
Greenbrier *(Smilax sp.)*	1	0
Chufa *(Cyperus esculentus)*	1	0
Unknown	1	0

[a]Includes leaves, stems, fibers, or any plant material that could not be identified to genus.

strutting territories at the edge of permanent pastures. Mosby and Handley (1943:109) noted that gobblers preferred logging roads, edges of fields, and other openings for strutting.

In spring, adult gobblers were more active in mating than in feeding. Food is not as important during this season because the fat stored in the *breast sponge* acts as a source of energy (Schorger 1966:100).

Gobbling was most intense during April and occurred most often just after daybreak. As the mating season advanced, gobbling was sometimes heard throughout the day. On April 7, 1968, an unidentified turkey gobbled well over 100 times between 5:30 AM and 10:00 AM. Most gobbling and strutting had ceased by mid-May, but a few gobblers were observed strutting in June, July, and October of 1969.

The ranges of four of the five gobblers under observation decreased from winter 1968 to spring 1969, but Gobbler 509 increased his range (Table 33). This particular gobbler left a flock of five gobblers with which he had been associated during the fall and winter. He moved 2.3 miles to a stream bottom and remained there until the end of March. He then moved 1.4 miles to the vicinity of an open pasture where he stayed until April 9. On April 10, he moved 1.8 miles to another pasture and then disappeared.

Summer. -In summer, gobblers once again began to form flocks. Most of their time was spent feeding in pastures and loafing around the edges of the pastures.

BEHAVIOR

Flock structure. -Some turkeys seemed to form bonds throughout most of the year. Some individuals stayed together for 4 years. Watts (1968 : 205) found that male poults of the Rio Grande turkey, raised by a single hen, remained permanently together during a 2-year study. Adult Gobblers 1, 5, and 6 were

Table 35. Percentage of total daylight hours spent in three habitat types by two flocks of instrumented turkey gobblers from September 23, 1968, to January 17, 1969, on the Saugahatchee Research Area, Alabama[a]

	Habitat Types		
Month	Fields and Pastures	Mixed Pine and Hardwoods	Stream-bottom Hardwoods
September	67.7	25.9	6.4
October	48.4	49.2	2.4
November	22.7	74.5	2.8
December	19.8	80.2	
January	17.0	83.0	

[a]Tracking period included 215 hours of radio contact.

seen together constantly from 1967. These gobblers were caught as sibling poults in October 1965 and released on the study area as part of the original brood stock. In 1967 and 1968, the same three turkeys were seen together throughout the spring gobbling season. Gobbler 5 was killed during the fall of 1968. Gobblers 1 and 6 formed part of a flock of seven marked gobblers and four unmarked gobblers that spent the fall and winter of 1968 together. During the spring of 1968, Gobblers 1 and 6 set up a gobbling territory and were always observed together until they disappeared in mid-April. Ellis and Lewis (1967: 579) found that gobblers sometimes establish joint gobbling territories.

Wheeler (1948:28) stated that mature birds remain isolated by sex, in flocks of various sizes, in all seasons except the breeding season. During the fall of 1968, seven adult gobblers and four subadult gobblers were seen together often enough to be considered one flock of birds. Bailey (1967:103) stated that in small populations, young males will associate with adult males. Our study was conducted on an expanding turkey population that had reached an estimated level of 10 turkeys per square mile in October 1968 (Speake et al. 1970).

Table 36. Spring-dispersal from preceding winter locations of flocks to strutting and gobbling areas of various gobblers from 1966 to 1969 on the Saugahatchee Research Area, Alabama.

	Miles Dispersed			
Band Number	1966	1967	1968	1969
1	1.3	1.3	0.6	
2301	1.8			
2302	1.8		3.0	
2303	0.5		0.9	
5		1.3		
6		1.3	0.6	
506		3.1	1.0	
510				0.6
511				0.6
533				2.1
532				1.1
508				0.6
503				2.5
24				0.8
20				1.1
509				1.4
Average	1.4	2.0	1.2	1.2

Twelve adult gobblers were observed in the spring of 1969. Eight of the gobblers were constantly seen in pairs. In each pair, one gobbler was dominant and did most of the strutting and gobbling. The same type of relationship was observed by Ellis and Lewis (1967:579). McIlhenny (1914) stated that an old monarch might take a companion gobbler into the midst of his harem. Latham (1956:29) found that young gobblers quite often attached themselves to the harem of an adult gobbler and that they lived in harmony as long as the young gobblers showed no tendency to mate.

Nine of the adult gobblers observed during the spring of 1969 allowed subadult gobblers to stay near them while the courtship was in progress. Aggression occurred only when the subadults moved near one of the hens. Then the adult gobbler lowered his head and moved toward the young gobbler, or simply pecked in his general direction. Either action quickly made the subadult gobbler move away.

This page has been intentionally left blank to preserve the continuity of the original document.

15

MOVEMENTS OF WILD TURKEYS IN SOUTHWESTERN ALABAMA*

James R. Davis

ABSTRACT

This study examines the movement of wild turkeys in southwestern Alabama. Data on 1,200 birds captured and banded in the area in the past 20 years and on 103 additional birds wing-marked with combinations of colors and designs from 1965 to 1968 were used. Most of the information presented, however, was obtained from intensive research carried out on 37 of 39 birds marked in the Upper State Game Sanctuary during the 3-year period.

Distance traveled from trap site to recovery for 115 eastern wild turkey gobblers *(Meleagris gallopavo silvestris)* banded with leg bands as adults averaged 2.5 miles and ranged from 0 to 10 miles. Much of the movement occurred between February banding and April recovery. Spring breeding dispersal is believed to have been a prime factor in this movement. The movement of 105 gobblers banded as juveniles averaged 2.5 miles and ranged from 0 to 8 miles; the movement of 28 hens banded as adults averaged 1.8 miles and ranged from 0 to 16 miles; the movement of 15 hens banded as juveniles averaged 2.2 miles and ranged from 0 to 22.5 miles. Turkeys of both sexes were also marked with wing tags for individual identification. Marked gobblers were observed more frequently than hens. The greatest distance traveled by a wing-marked gobbler was about 7.5 miles, and the greatest distance traveled by a hen was 16.5 miles. Gobblers apparently carried out all activities within an area of about 600 acres or less except during spring breeding. Observations showed marked hens confined to about 345 acres or less, except during nesting (and to some extent during brooding), when they could not be found.

Natural movements of wild turkeys may be a source of consternation for landowners and club managers who wish to retain the birds on their lands. These movements are often determined by food supplies (Schorger 1966) or represent spring dispersal related to the breeding season (Davis and Hamrick 1969). During the breeding season, range considered marginal for winter use is sometimes attractive to nesting hens. Gobblers often follow the hens into such range, which then becomes important spring hunting territory.

Movement of wild turkeys, particularly in spring, assumes great significance when we consider that more than half of the annual turkey harvest in Alabama occurs during the spring gobbler season (Davis 1969).

Approximately 75 percent of the turkey-hunting habitat in southwestern Alabama is privately controlled and hunting privileges are jealously guarded. The purpose of this study was to provide information about movements of wild turkeys in southwestern Alabama and to relate the information to considerations about the size of managed areas.

*A contribution of Pittman-Robertson Activities, Project 35-R, Work Plan 2, Alabama Department of Conservation, Game and Fish Division.

METHODS

It has been standard procedure to band all turkeys trapped in Alabama. Subsequently, retrapping or harvesting has yielded data on movements, longevity, and growth. Records for approximately 1,200 wild turkeys banded in southwestern Alabama during the past 20 years were examined in this study. All band returns and recoveries were assembled and average movements computed.

A supplemental and superior marking method, the wing-marking technique described by Knowlton et al. (1964), was used, beginning in 1965, for research phases of the study. One hundred and three wild turkeys were wing-marked during 1965-1968. Combinations of colors and designs were employed that permitted individual identification.

These marking methods were utilized on four areas in southwestern Alabama: the Scotch Wildlife Management Area, the Rob Boykin Wildlife Management Area, the Choctaw Bluff Hunting Club, and the Upper State Game Sanctuary. Intensive studies were carried out on the Upper State Game Sanctuary, and 37 of the 39 marked turkeys on this area provided most of the marked-turkey data presented in this paper. Although there were 28 marked turkeys on the Choctaw Bluff Hunting Club lands, other commitments and difficult terrain prevented collection of appreciable data. The other two areas were little studied.

The habitat types of three of the four study areas are almost identical. These areas have a forest cover of oak-pine *(Quercus-Pinus)*, which is mature or nearing maturity, with a mixed understory principally of dogwood *(Cornus* spp.) and the shrub and pole stages of the overstory species. Native hardwood species are dominant along the rivers and streams. Clearings are man-made and maintained through annual planting, grazing, mowing and/or a combination

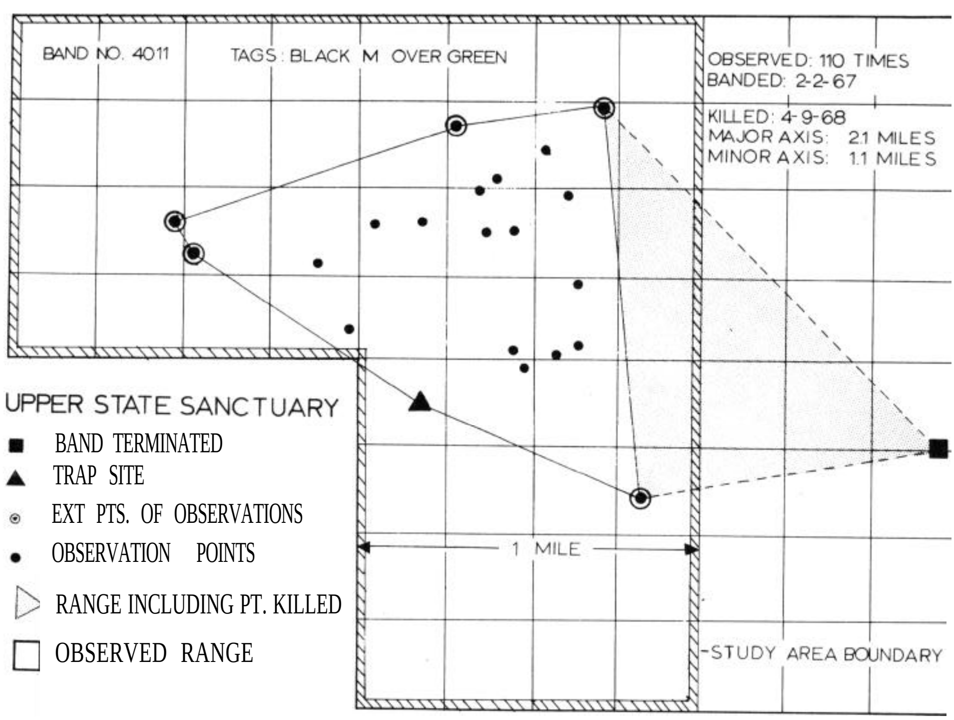


Figure 38. Typical map of range of wing-marked wild turkey.

of these operations. Their sizes vary. This habitat type is typical of the forest cover adjoining the study areas and generally of Baldwin, Clarke, Mobile, Monroe, and Washington counties of Alabama.

The Rob Boykin Wildlife Management Area (part in Washington and part in Mobile counties) is the only one of the four study areas that has a different forest cover. The area is under an intensive forest management program in which the native forest cover is removed by clear-cutting; the site is prepared by burning and/or chopping and is replanted to pine seedlings in pure stands. The areas treated vary from about 400 to 1,300 acres in a block or cutting unit. These treated blocks have not been utilized by wild turkeys for many years.

Wing-marked wild turkeys provided data that made it possible to map the ranges utilized. These are minimum ranges, because, for extended periods, no observations of most of the marked turkeys occurred. I assume that the birds were not on the study areas during these periods. The range utilized by each turkey was mapped by lines connecting the outer points of observation (Figure 38).

RESULTS

RETURNS OF LEG-BANDED BIRDS

There were 263 records of band returns available for this study. Table 37 presents a summary of these data.

Table 37. Data on movement of 263 leg-banded wild turkeys, 1947-1968, southwestern Alabama.

Age at Banding	Sex	Number of Birds	Average Distance Moved Between Banding and Recapture or Harvest (miles)
Juvenile	Hens	15	2.2[a]
Adult	Hens	28	1.8[b]
Juvenile	Gobblers	105	2.5
Adult	Gobblers	115	2.5

[a]If a 22.5-mile record of one juvenile hen is excluded, the average distance is 0.9 mile.
[b]If a 16.0-mile record of one adult hen is excluded, the average distance is 1.2 miles.

Juvenile hens. -Fifteen of the returns were from hens banded as juveniles, but only 14 yielded movement data. Seven returns were from hens that had attained maturity. Their average movement from the release site (which was also the trap site) was 2.2 miles. Extremes were 0 and 22.5 miles (all distances scaled as straight lines). Excluding the single long-distance move, the average distance moved by turkey hens banded as juveniles was 0.9 mile.

Adult hens. -Band returns were available from 28 hens banded as adults in the southwestern section of the state. On the average, these hens moved 1.8 miles from the band site to the site of retrapping or recovery. Excluding an unusually long movement of 16.0 miles, the average was 1.2 miles.

Juvenile gobblers. -Returns and recoveries were available from 105 wild turkey gobblers banded as juveniles. Their average movement from the release site was 2.5 miles, with extremes of 0 and 8.0 miles. Thirty gobblers were recovered as part of the hunter harvest while they were still juveniles or subadults. The average movement of these 30 was also 2.5 miles.

Adult gobblers.-Band recoveries from 115 wild turkey gobblers banded as adults showed an average movement from the banding site of 2.5 miles. Extremes were 0 and 10.0 miles.

DATA FROM WING-MARKED TURKEYS

Of the 103 wild turkeys marked with individually identifying markers, only 39 were observed on 10 or more occasions; only these 39 are considered in this report (Table 38). Twenty hens and 19 gobblers were represented. Gobblers were observed 1,769 times, and hens were identified 679 times.

Table 38. Utilization and movement and range of 39 wing-marked wild turkeys, 1965-1968, primarily from Upper State Game Sanctuary.

Age at Banding	Sex	Number of Turkeys	Average Acreage Utilized	Average Length of Major Axes of Observed Range (miles)	Average Length of Minor Axes of Observed Range (miles)	Average of Greatest Distances All Observations[a] (miles)
Juvenile	Hens	7	249	1.1	0.5	1.1
Adult	Hens	13	275	1.1	0.5	1.1
Total		20	266	1.1	0.5	1.1
Juvenile	Gobblers	15	523	1.4	0.9	2.2[b]
Adult	Gobblers	4	571	1.3	1.0	1.5
Total		19	534	1.4	0.9	2.0
All hens observed 11 months or longer		12	345	1.3	0.6	1.3
All gobblers observed 11 months or longer		15	602	1.5	1.0	2.2

[a]Includes points outside study area where turkeys were harvested by hunters.
[b]Approximately 95 percent were recovered or terminated as adult turkeys.

Juvenile hens. -Seven hens were tagged as juveniles. The average minimum range determined from these observations was 249 acres. The smallest minimum range was approximately 80 acres during 5 months of observations, and the largest was 435 acres during 11 months of observations. Long axes of the observed ranges of these hens averaged 1.1 miles, and the short axes averaged 0.5 mile.

Adult hens. -Thirteen hens marked as adults utilized an average minimum range of 275 acres. The smallest range was 50 acres (5 months of observation). The largest area utilized by an adult hen was 515 acres, as ascertained from 71 observations during a span of 2 years, 7 months, and 26 days. Long axes of the observed ranges averaged 1.1 miles, and short axes averaged 0.5 mile.

Gobblers. -Only 4 of the 19 gobblers marked were adults at banding and the available records are insufficient for reliable measurement of their movements, although these data are presented in Table 38. Because movements of juvenile and adult gobblers were similar, they are discussed collectively.

The average minimum range utilized by all 19 gobblers during this period was approximately 534 acres. The largest acreage utilized by a gobbler was 895 acres, as determined from 107 observations during 1 year, 4 months, and 16 days.

Movements of turkeys observed 11 months or longer. -Marked turkeys observed for more than 11 months had larger apparent ranges than did those observed less than 11 months, as suggested by the data in Table 38. Ranges utilized by hens over a period of 11 months or longer averaged 345 acres, with the long axes averaging 1.3 miles and the short axes 0.6 mile. Ranges of gobblers observed more than 11 months averaged 1.5 miles for the long axes and 1.0 mile for the short axes and encompassed 602 acres.

Movement in the spring. -It was possible to determine, to a degree, the movements of some individual gobblers in the spring, because much of the trapping and banding was accomplished during January and February in connection with restocking activities. Gobblers banded at this time of the year that were killed within 3 months should reflect movements associated in part with spring dispersal. Thirty such records were available.

For the 30 gobblers, this movement averaged 2.5 miles within a 3-month period. One gobbler moved 10.0 miles from the banding site in 2 months and 26 days, a second one moved 7.5 miles in 2 months and 15 days, and a third one moved 7.5 miles in 1 month and 27 days. All 30 gobblers were released at the trap sites.

The greatest movement record for a wing-marked hen was 16 miles between March 4 and July 1, 1968. This is the only available significant record of hen movement during the nesting season.

DISCUSSION

Mosby (1967:129) suggested that large acreages are desirable for wild turkeys; however, large acreages are rarely available to the small landowner or club, so a minimum range size was determined from data on wild turkey movements to provide a guideline for those seeking this management information. It was thus determined that in southwestern Alabama, an area to be managed for wild turkeys should contain at least 600 acres with a long axis of about 1.5 miles and a short axis of about 1.0 mile.

Movements in excess of these averages obviously occur. In most instances, food shortages do not appear to be the cause of these movements in this section of Alabama. Spring dispersal did appear to be an important factor. It is suspected that population levels exert a strong influence on this seasonal movement, and competition for attractive nesting and brooding ranges seems to me to be an important element influencing movements of wild turkeys.

In the fall, movements from the brooding or summer ranges to the winter ranges may be governed entirely by food and/or cover requirements. However, movements greater than average were not reflected in the data for this season. Thus, fall movements appear less important than spring movements for determining the size of a management unit.

This page has been intentionally left blank to preserve the continuity of the original document.

III

FOOD HABITS
DISEASE
AND PREDATION

Leroy J. Korschgen

The welfare of wild turkeys is dependent upon many factors, both positive and negative. Some of these, including foods, diseases, parasites, and predation, are discussed in the following pages.

Nutritious food in sufficient quantity is essential for all ages of birds and, thus, is a positive factor in their lives. Knowledge of principal foods utilized throughout the year provides a basis for fulfilling the needs of turkeys through management, whether for reintroductions into ranges or in support of existing populations. Sportsmen, too, often utilize information concerning food habits, in conjunction with field observations, to seek out prospective hunting sites. These and other studies show that wild turkeys are adaptable to changing food conditions brought about by the vagaries of weather, land use, and normal schedules of plant production. Diversity of habitat within the annual range of turkeys has been shown to be the key to adequate and continuous food supplies.

Diseases, parasites, and predation generally are detrimental in their effects and thus represent negative values for turkeys. Disease and parasite controls applicable to domestic flocks seldom are practical or possible with wild populations. Diseases may be introduced and inadvertently spread among wild flocks by their unavoidable association with domestic birds or through activities associated with management. Releasing pen-raised birds into occupied range can introduce infectious diseases such as blackhead and coccidiosis into wild populations. Supplemental feeding and trap sites often are established as tools of management. Rotation of such sites is strongly recommended to lessen the danger of contamination of the environment by disease-producing organisms. True relationships between wildlife diseases and effects upon particular game species, domestic poultry, livestock, human health, and economics remain largely unknown. The possibility of wild species serving as hosts or carriers of infectious diseases that affect domestic species and man needs further investigation. The protozoan-caused diseases have been shown to be the most virulent ones and are most apt to thwart the efforts of turkey management. Other aspects of potential problems are reported in the following five papers.

Other internal and external parasites (flukes, tapeworms, roundworms, lice, ticks, chiggers) of more than 50 kinds are known to affect wild turkeys to some degree. Many of these parasites occur in small numbers and permit the normal life-span of the host. Unusually heavy infestations are capable of producing adverse pathological conditions in individuals and may result in periodic declines in populations. Generally, however, these parasites are found to be universally present and not seriously pathogenic.

Predation upon turkeys leaves a lasting impression on anyone who sees it. Scientific study of the subject is difficult at best, and findings often must be based upon the interpretation of evidence rather than upon direct observation.

The magnitude of the different effects of various avian and mammalian predators on turkeys remains a controversial issue. The consensus prevails that, in general, predation does not limit wild turkey populations. Support for this opinion will be found in the last paper of this section.

16

APRIL FOODS OF WILD TURKEYS IN MISSOURI *

Leroy J. Korschgen

ABSTRACT

April foods of the wild turkey *(Meleagris gallopavo silvestris)* in Missouri were ascertained from analyses of crop and gizzard samples from 698 gobblers collected during late April hunting seasons of 1960, 1963-1965, inclusive. Samples from 16 hens provided limited information for comparison. Plant foods of 101 kinds and 35 animal foods were identified. Oak mast *(Quercus* spp.) comprised 49.8 percent and corn *(Zea mays)* 12.4 percent of all food consumed by gobblers. Green leaves and plant parts accounted for 7.9 percent, and green grass and sedge leaves, 3.9 percent. Other important foods and volume percentages were: fragrant sumac *(Rhus aromatica)*, 3.3; oats *(Avena sativa)*, 3.2; sedges *(Carex* spp.), 3.0; buttercups *(Ranunculus* spp.), 2.0; galls, 1.6; flowering dogwood *(Cornus florida)*, 1.1; black gum *(Nyssa sylvatica)*, 1.0; wild cherry *(Prunus serotina)*, 1.0; and scarab beetles (Scarabaeidae), 1.3 percent. Foods of gobblers and hens did not differ materially, except that hens consumed a larger proportion of snails. Sources of April turkey foods by plant type and volume percentages were: trees, 53.6; farm crops, 16.6; native forbs, 13.4; native grasses, 3.9; shrubs, 3.7; sedges, 3.1; and vines, 0.8. Animal foods accounted for less than 3 percent of average diets. Management for food production should be directed toward establishing and maintaining diversified habitat types within the annual range of turkeys. Succulent green forage is important and heavily utilized by turkeys in spring.

Spring foods of the wild turkey throughout its range have not been extensively studied and localized data scarcely provide a basis for proper management. The purpose of this paper is to supplement previous knowledge by reporting the principal foods utilized by wild turkeys in Missouri during late April of 4 different years.

Literature sources show results from studies of 116 stomach samples in Alabama (Good and Webb 1940), 90 dropping samples in Pennsylvania (Kozicky 1942), 993 dropping samples in Missouri (Dalke et al. 1942), 208 dropping samples in Michigan (Lewis 1962), and 117 dropping samples in New York (Eaton and Saylor 1962, personal communication). A summary of these studies shows 11 food types that exceeded 1.0 percent each of estimated volumes of spring turkey diets (Korschgen 1967:171). Two important spring foods of the eastern wild turkey (beech, *Fagus grandifolia;* and burdock, *Arctium minus)* are not common on Missouri turkey range, and two are of nonspecific identity (grass and sedge leaves and unidentified forbs). Oats, bluegrasses *(Poa* spp.), and chufa *(Cyperus esculentus)* were important foods only

* Research supported in part by Federal Aid in Fish and Wildlife Restoration Funds under Project Missouri 13-R.

in Missouri. Foods of more widespread usage during spring (March through May) included acorns, corn, sedges, and wheat *(Triticum aestivum).*

PROCEDURES

Materials for this investigation consisted of 139 crop and 684 gizzard samples collected from 698 gobblers taken during legal hunting seasons of 1960, and 1963-1965, inclusive. At checking stations, successful hunters were provided the necessary materials for mailing samples (self-addressed, labeled, postage-free envelopes) and were requested to save the crop and gizzard contents of their birds and submit them for study. All samples came from southern Missouri, with distribution as follows: 36 birds from 8 counties in 1960, 158 birds from 15 counties in 1963, 210 birds from 17 counties in 1964, and 294 birds from 16 counties in 1965. Total sampling represented 19 different counties. Collections were restricted to the open hunting seasons-April 27-29 in 1960, April 22-25 in 1963 and 1964, and April 27-30 in 1965.

Samples of 8 crops and 14 gizzards from 16 accidentally or illegally killed hens were examined during the period 1958-1969. Most of these samples were collected during April from nine southern Missouri counties.

Samples were checked when received at the laboratory, flesh and wrapping materials were removed, and the contents packaged and stored. Using the standard procedures for studying food habits, analyses were completed in 1969. Crop contents required no additional preparation. First, gravel in gizzards was removed by immersing the contents in a beaker of trichloroethylene. Food materials were separated from gravel by stirring and decanting the food portion into a 40-mesh sieve held over a second beaker. Gravel and food portions were dried separately on blotting paper; the gravel was measured and discarded; and the foods were repackaged for subsequent examination. Analyses were completed by sorting with the aid of a 10-power binocular dissecting microscope, identifying, and measuring the food items. Data were tabulated separately for each year of collection, and combined for all samples. Plant nomenclature essentially followed that of Steyermark (1963).

Possible biases in data, caused by differential digestibility of the various kinds of foods, must be recognized. Rates of digestion of the many identified foods were unknown, however, so they were not considered in this study. Also, foods from crops are more readily identified, sorted, and measured than are those from gizzards. Data from both crop and gizzard samples were combined in food lists, since crop contents comprised less than one-fifth of the total food volume.

RESULTS

Plant foods of 101 kinds and 35 animal foods were identified in the gobbler samples. Average percentages of principal foods from combined data for the 4 years comprise Table 39. The 25 most important plant foods are presented as percentages, by year, by volume and occurrence in Table 40.

PRINCIPAL FOODS

Acorns provided 49.8 percent of all food consumed by turkeys in late April and occurred in more than 86 percent of all samples. Volumetric percentages varied by year from 24 to 60 percent. Use generally followed production trends reported by Christisen (1968) on a relative scale of 0 to 300: poor, fair, good,

Table 39. Principal foods of 698 male wild turkeys during April 1960, 1963-1965, in Missouri. (Based upon 139 crop samples and 684 gizzard samples.)

Food Item	Percent by Volume	Percent by Occurrence
Acorns *(Quercus* spp.)	49.8	86.2
Corn *(Zea mays)*	12.4	13.2
Green leaf materials	7.9	32.5
Green grass and sedge leaves	3.9	16.8
Fragrant sumac *(Rhus aromatica)*	3.3	18.2
Oats *(Avena sativa)*	3.2	4.3
Sedges *(Carex abdita* and/or *C. umbellata)*	3.0	17.3
Swamp buttercup *(Ranunculus septentrionalis)*	2.0	12.9
Galls	1.6	41.3
Flowering dogwood *(Cornus florida)*	1.1	29.7
Black gum *(Nyssa sylvatica)*	1.0	19.2
Wild cherry *(Prunus serotina)*	1.0	7.9
Hogwort *(Croton capitatus)*	0.8	0.3
Korean lespedeza *(Lespedeza stipulacea)*	0.7	1.1
Wheat *(Triticum aestivum)*	0.7	1.9
Dandelion *(Turuxacum officinale)*	0.5	2.4
Hickory nuts *(Carya* spp.)	0.4	7.6
White clover *(Trifolium repens)*	0.4	0.7
Wild roses *(Rosa* spp.)	0.4	18.9
Small buttercup *(Ranunculus abortivus)*	0.3	6.7
Spring beauty *(Claytonia virginica)*	0.3	0.1
Raccoon grape *(Ampelopsis cordata)*	0.3	0.1
Hackberries *(Celtis Zaevigata* and C. *tenuifolia)*	0.2	5.2
Wild grapes *(Vitis* spp.)	0.2	17.2
Barley *(Hordeum vulgare)*	0.2	1.1
Lanceleaf ragweed *(Ambrosia bidentata)*	0.2	1.0
Carrion-flower *(Smilax herbacea)*	0.2	5.3
Chickweed *(Cerastium vulgatum)*	0.1	0.3
Plums *(Prunus* spp.)	0.1	1.7
Alfalfa *(Medicago sativa)*	0.1	0.4
Sedges *(Carex* spp.)	0.1	3.2
Undetermined seeds	0.1	1.0
Buttonweed *(Diodia teres)*	0.1	3.4
Dwarf sumac *(Rhus copallina)*	0.1	1.9
Bristly greenbrier *(Smilax tamnoides)*	0.1	4.9
Clover *(Trifolium* sp.)	0.1	0.4
65 additional plant foods, each in trace amount	0.3	
Scarab beetles (Scarabaeidae)	1.3	47.7
Snails (Gastropoda)	0.4	9.6
Millipedes (Diplopoda)	0.4	10.5
Ants (Formicidae)	0.2	27.5
Ground beetles (Carabidae)	0.1	7.7
Snake, unclassified	0.1	0.3
29 additional animal foods, each in trace amount	0.3	
Total	100.0	8,597 cc

and excellent (Figure 39). *Fair* production of acorns in 1959 was reflected in April 1960 as 32.8 percent of turkey foods. A borderline *fair-good* production index for 1962 resulted in 58.9 percent, by volume, turkey usage in April 1963. A low *fair* index in 1963 resulted in only 24.4 percent acorns in turkey diets in 1964, while *good* production in 1964 increased usage by turkeys to 60.0 percent of total diets in April 1965. Acorns in gizzards usually were not specifically identified, but utilization of different kinds of acorns by turkeys was evident

Table 40. Foods of male wild turkeys in April, 1960-1965, in Missouri. (Figures represent percentages by volume/occurrence.)

Food Item	1960 13C[a]/26G[b]	1963 33C/157G	1964 28C/210G	1965 65C/291G
Acorns	32.8/75.0	58.9/95.6	24.4/71.4	60.0/93.9
Corn	2.1/8.3	10.9/7.6	11.2/18.1	14.9/13.3
Green leaf materials	14.8/47.2	4.5/34.2	19.4/41.4	3.1/25.5
Green grass and sedge leaves	2.5/19.4	0.8/10.8	8.9/25.7	3.2/13.3
Fragrant sumac	3.2/25.0	5.9/38.0	4.5/13.8	1.3/10.2
Oats	18.6/13.9	1.5/ 1.3	5.3/11.0	1.2/ 3.4
Sedges	Tr/ 5.6	8.1/36.1	2.5/11.0	0.9/13.3
Buttercup, swamp and early	Tr/ 2.7	0.2/10.1	6.0/13.8	1.2/11.6
Galls	0.9/30.6	1.8/63.3	0.5/21.4	2.1/44.9
Flowering dogwood	1.1/22.2	0.1/ 8.9	1.0/28.6	1.7/42.5
Black gum	0.6/ 8.3	0.4/12.7	1.5/20.5	1.2/23.1
Wild cherry		0.2/ 3.2	1.1/ 8.1	1.5/11.2
Hogwort				1.8/ 0.7
Korean lespedeza	12.7/11.1	Tr/ 0.6	Tr/ 0.5	Tr/ 0.7
Wheat			2.1/ 2.4	0.3/ 2.4
Dandelion	0.3/ 2.7	0.9/ 2.5	1.1/ 3.8	Tr/ 1.4
Hickory nuts	0.5/ 8.3	0.1/ 2.5	0.5/ 7.1	0.6/10.5
White clover	5.4/ 5.6	0.1/ 1.3	0.4/ 1.0	0.1/ 0.7
Wild roses	0.1/11.1	0.1/10.1	0.8/35.7	0.3/13.3
Small-flowered crowfoot	0.7/19.4	0.3/ 7.6	0.3/ 4.3	0.3/ 6.5
Spring beauty		0.2/ 2.5	0.4/ 1.9	0.3/ 2.7
Raccoon grape				0.6/ 0.3
Hackberry		0.5/ 8.2	Tr/ 3.3	0.2/ 5.4
Wild grapes	Tr/ 5.6	Tr/12.7	Tr/ 1.9	0.4/32.0
Barley	0.1/ 2.7	Tr/ 0.6	0.7/ 2.4	Tr/ 0.7
Total	96.4	95.5	92.6	97.2

[a] C = Crops.
[b] G = Gizzards.

during analyses. Species of the black oak group produced most heavily in 1962, and those of the white oak group in 1964. High usage of acorns in April 1963 and 1965 indicated that both kinds were acceptable to turkeys and were utilized within limits of availability.

Corn ranked second as 12.4 percent by volume in 13.2 percent of all samples. Corn was chosen less frequently than many native foods, but usually in larger amounts when eaten. Some of this food undoubtedly resulted from baiting, but most and largest samples consisted of weathered grain.

Green forb leaves and plant parts occurred in 32.5 percent of all samples and comprised 7.9 percent of total foods. Amounts consumed were in inverse proportion to acorns in spring diets. Some of the green materials eaten were suspected to be buttercups, dandelion *(Taraxacum officinale)*, and spring beauty *(Claytonia virginica)*, because their seeds were associated with the samples.

Another category of green plant foods, green grass and sedge leaves, appeared in 16.8 percent of the samples and accounted for 3.9 percent of food volume. Succulent growth of domestic grains probably was included in this category.

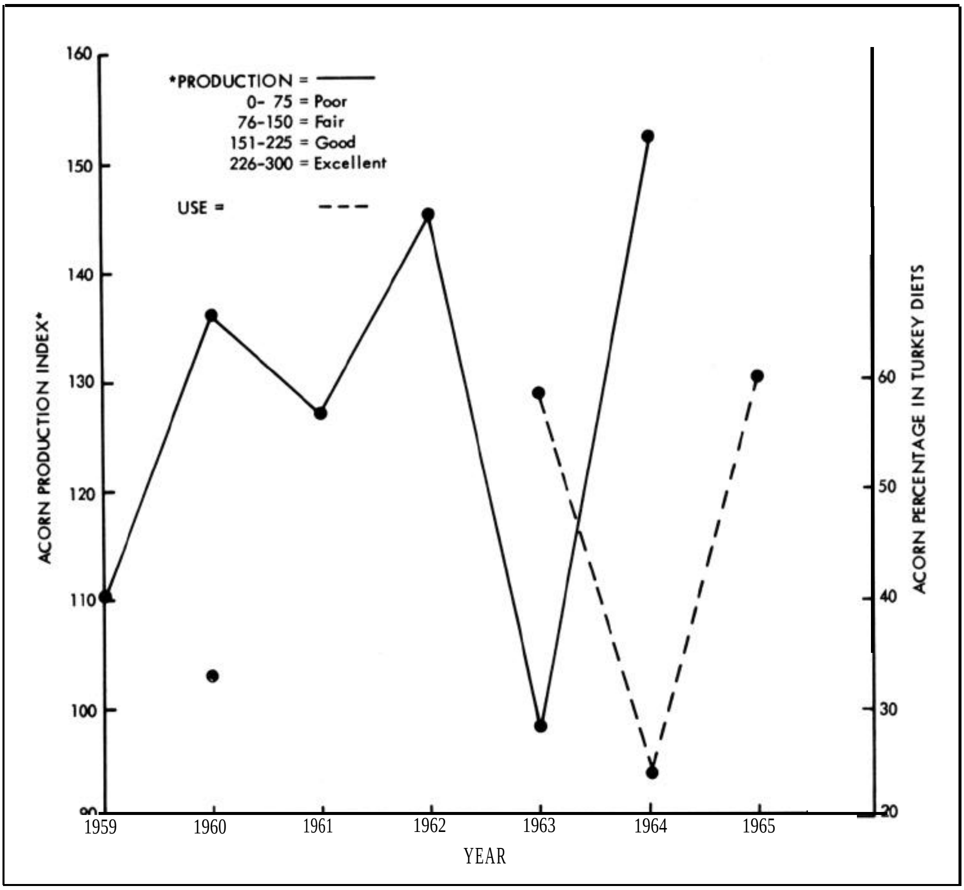


Figure 39. Index of acorn production and of use by turkeys.

Fragrant sumac catkins, fruits, flowers, and leaves occurred in 18.2 percent of the gobbler samples in April and accounted for 3.3 percent of the total bulk. These sumac fruits mature early and usually were available by late April in the southernmost counties, while only catkins and flowers were consumed farther north. Frequent occurrence of fragrant sumac in both crop and gizzard contents was evidence of regular and preferred usage.

Oat gram was taken less frequently than many other foods, but because relatively large amounts were consumed when it was eaten, this item comprised 3.2 percent of the volume. Clean, unsprouted grain was found with greatest frequency and in largest amount during the first hunting season in 1960. These findings were interpreted as evidence of baiting by hopeful but inexperienced hunters.

Seeds and green leaves of sedges, identified primarily as *Carex abdita* and/or *C. umbellata,* occurred in 17.3 percent of the samples and accounted for 3.0 percent of total foods. Yearly volumes varied from a trace to 8.1 percent, and occurrence from 5.6 percent in 1960 to 36.0 percent in 1963. Entire seed heads were stripped or clipped and ingested.

Seeds and leaves of buttercups and crowfoots were consumed by 12.9 percent of the birds and comprised 2.0 percent of food volume. Yearly use varied from a trace to 6.0 percent by volume. Swamp buttercup *(Ranunculus septen-*

trionalis) and small-flowered crowfoot *(R. abortivus)* were the important species, with possibly some early buttercup *(R. fascicularis)* and others included. Greatest use of buttercups occurred in 1964, when acorn usage was lowest and green plant usage was greatest.

Four other kinds of foods exceeded 1.0 percent by volume. Multichambered plant galls containing insect larvae appeared in 41.0 percent of the samples and made up 1.6 percent of food volume. Galls invariably were identified with acorns. Greatest amounts were consumed during years of greatest acorn use, suggesting an association with oaks. Flowering dogwood seeds made up 1.1 percent of food volume and occurred in nearly 30.0 percent of all samples. Incidence in gizzards (30.3 percent) was much greater than in crops (4.3 percent), indicating that the seeds were retained longer than the normal periods of digestion for other foods. Black gum seeds were taken by 19.2 percent of all birds and made up 1.0 percent of total foods. The tough, fibrous seeds were evidently retained in the gizzard, because none were found in crop contents. Wild cherry fruits accounted for 1.0 percent of foods and occurred in 7.9 percent of the samples. The fact that they occurred more frequently in gizzards than in crops indicated that cherry seeds also were retained longer than soft foods and served to some extent as a substitute for grit.

Several foods accounted for 0.2 to 0.8 percent, by volume, because they were used infrequently, but heavily when used at all. Hogwort *(Croton capitutus)* seeds appeared in only two birds. Korean lespedeza *(Lespedeza stipulacea),* mainly green foliage, was found in eight samples. Wheat grain was consumed by 13 birds. Dandelion seed heads and foliage comprised 0.5 percent. Hickory nuts *(Carya* sp.) were identified in more than 10.0 percent of the samples in 1965. White clover *(Trifolium repens)* foliage was eaten infrequently. High frequency of wild roses *(Rosa* spp.) indicated preference for this food within limits of availability. Small buttercup, spring beauty, and raccoon grape *(Ampelopsis cordata)* were eaten occasionally.

The remainder of the 25 leading foods, hackberries *(Celtis laevigata* and *C. tenuifolia),* wild grapes *(Vitis* spp.), and barley *(Hordeum vulgare)* each amounted to 0.2 percent of average diets, but only grapes were eaten frequently. High occurrence showed a preference for grapes, while low volume indicated poor production or depletion of this kind of food before the April season. Another 76 identified foods contributed smaller amounts to the average diets.

Animal foods usually were identified only to family or larger group. It was recognized that animal foods were underrated in gizzard analyses, because only indigestible portions of soft-bodied insects remained for identification. Among 35 kinds identified, scarab beetles were the most important as 1.3 percent of total foods, but they occurred in 47.7 percent of all samples. Snails *(Gastropoda)* of several kinds, including *Ventridens Zigerus, Paravitrea capsella,* and *Polygyra* spp. occurred in 9.6 percent of the samples and made up 0.4 percent of the contents. Millipedes (Diplopoda) contributed an equal volume and were found in 10.5 percent of the samples. Ants (Formicidae), nearly all carpenter ants *(Camponotus* sp.), were taken by 27.5 percent of the birds, but amounted to only 0.2 percent of the diets. Ground beetles (Carabidae), which appeared in 54 samples, and snakes in 2, each amounted to 0.1 percent. Other animal foods were consumed in trace amounts by volume.

Gravel occurred in 47 of 139 crops and in all 684 gizzards. Average amounts in crops were 0.47 cc where present, and 0.16 cc in all crops examined. Only two crops contained more than 1.0 cc of grit, indicative of low daily ingestion. Gizzards contained an average of 15.6 cc of grit (range 3.0 to 39.0 cc); these amounts greatly exceeded grit contents of 137 stomachs measured and reported by Mosby and Handley (1943:153) in Virginia. Contents varied from no grit in seven to as much as 25 cc in one, for an average of 7.1 cc of grit material in the total sample of stomachs.

Data in Table 41 show comparatively little difference between the feeding habits of hens and gobblers (Table 39). Acorns and corn were the leading foods, percentages of which conformed closely to amounts consumed by gobblers in late April. Wheat appeared more important for hens only because it was utilized heavily by one bird. Other important plant foods comprised less than 5.0 percent each of average diets. Only two foods consumed in percentage amounts, dwarf sumac *(Rhus copallina)* and wild geranium *(Geranium maculatum)*, did not appear as important items in the larger sample for gobblers.

Animal foods were consumed in slightly larger amounts by hens than by gobblers and accounted for 3.2 percent of total foods. The kinds eaten were the same as those that comprised 2.8 percent of gobbler diets. Calcium-rich snails

Table 41. Foods in crops and gizzards of 16 female wild turkeys, 1958-1969, in Missouri. (Based upon 8 crops and 14 gizzards.)

Food Item	Percent by Volume	Percent by Occurrence
Acorns *(Quercus* sp.)	52.6	81.3
Corn *(Zea mays)*	10.6	18.8
Wheat *(Triticum aestivum)*	6.4	6.3
Galls	3.7	37.5
Flowering dogwood *(Cornus florida)*	3.4	25.0
Green grass and sedge leaves	3.4	25.0
Green leaf materials	3.2	43.8
Fragrant sumac *(Rhus aromatica)*	2.7	18.8
Dwarf sumac *(Rhus copallina)*	2.0	12.5
Wild geranium *(Geranium maculatum)*	1.4	6.3
Sedge *(Carex abdita)*	1.3	12.5
Wild cherry *(Prunus serotina)*	1.2	6.3
Hickory nuts *(Carya* spp.)	0.9	6.3
Poison ivy *(Rhus radicans)*	0.9	6.3
Buttercup *(Ranunculus* sp.)	0.8	6.3
White clover *(Trifolium repens)*	0.6	6.3
Wild grapes *(Vitis* spp.)	0.3	18.8
Tick trefoil *(Desmodium* sp.)	0.3	18.8
Swamp buttercup *(Ranunculus septentrionalis)*	0.2	6.3
Greenbrier *(Smilax herbacea)*	0.2	12.5
Black gum *(Nyssa sylvatica)*	0.2	12.5
Cleavers *(Galium aparine)*	0.2	6.3
Bluegrass *(Poa* sp.)	0.1	6.3
Wild roses *(Rosa* spp.)	0.1	6.3
Buttonweed *(Diodia teres)*	0.1	6.3
Hackberry *(Celtis tenuifolia)*	0.1	6.3
21 additional plant foods, each in trace amount		
Snails (Gastropoda)	1.8	37.5
Scarab beetles (Scarabaeidae)	0.8	37.5
Ants (Formicidae)	0.3	25.0
Squash bugs (Coreidae)	0.1	12.5
Snout beetles (Curculionidae)	0.1	18.8
9 additional animal foods, each in trace amount		
Total	100.0	300 cc

were taken more often and in greater amount by hens for first rank among animal foods. Scarab or June beetles were eaten less frequently and in smaller amounts by hens than by gobblers. Other animal foods comprised relatively minor portions of average diets.

DISCUSSION

April foods of wild turkeys in Missouri show a close relationship to principal foods during other seasons (Korschgen 1967), particularly those not limited by seasonal availability. Acorns provide sustenance for turkeys throughout the year, and amounts utilized in spring are affected by production of the previous year. Domestic grains, corn and oats, are foods favored by turkeys but are limited in the range turkeys occupy in southern Missouri. Most and greatest amounts of domestic grain identified in this study appeared to represent waste grains; some of the grain undoubtedly was bait for attracting turkeys to hunting sites. Evidence of baiting, however, was considered minimal during the years of this study, because of the small amount of clean, unweathered grain in crop contents.

Feeding upon the succulent new growth of forbs, grasses, and sedges in spring was most extensive when mast and woodland fruits were in shortest supply. However, turkeys naturally seek green food supplements in late winter and spring, when such feeding is not necessarily related to food scarcity in forested habitats. Physiological needs probably are met by this type of feeding.

April turkey foods were derived from plant types in the following amounts by volume; trees (primarily oaks), 53.6 percent; farm crops, 16.6 percent; forbs, 13.4 percent; native grasses, 3.9 percent; shrubs, 3.7 percent; sedges, 3.1 percent; and vines, 0.8 percent. Animal foods and galls accounted for the remainder.

Results of this study show that wild turkeys utilize a wide variety of foods and that management should be directed toward establishing and maintaining diversified habitat within the annual range of turkeys. Extensive use is made of foods produced in open woodlands and clearings, which are more productive of understory plants such as fragrant sumac, roses, sedges, and native grasses than are other types of habitat. Preservation of noncommercial trees such as flowering dogwood, black gum, wild cherry, and hackberry will add diversity of foods and improve habitat for turkeys. Wild grapes and other vines produce best in locations not shaded by large-canopied trees and should be preserved in selected locations. Small fields and clearings planted to domestic cereal grains or clovers can be beneficial in providing succulent green forage.

17

SEASONAL FOOD HABITS OF MERRIAM'S TURKEYS ON THE FORT APACHE INDIAN RESERVATION

Virgil E. Scott and Erwin L. Boeker

ABSTRACT

The seasonal feeding habits of Merriam's wild turkey *(Meleagris gallopavo merriami)* were studied on the Fort Apache Indian Reservation over a period of 3 years. Comparative data were obtained from the Moqui District of the Kaibab National Forest. The study included analyses of crops and droppings. Turkeys were found to be opportunists in their feeding habits. Grasses and forbs were important food items yearlong, especially in years of mast crop failures. Fruit- and mast-producing species such as manzanita *(Arctostaphylos pungens)*, skunkbush *(Rhus trilobata)*, ponderosa pine *(Pinus ponderosa)*, and oak *(Quercus* spp.) added substantially to the seasonal diet, and juniper berries *(Juniperus* spp.) were utilized in the absence of other mast crops. Animal material (mostly insects) was consumed throughout the year but was more important during the summer months.

This paper presents information on seasonal and annual changes in the diet of Merriam's wild turkey based on analyses of crops and droppings collected over a 3-year period. Studies by Reeves and Swank (1955) and Hoffman (1962) added significantly to the knowledge of annual food habits; nevertheless, according to Korschgen (1967:187), knowledge of foods and feeding habits of *merriami* is generally inadequate for all seasons.

The authors gratefully acknowledge the assistance of Charles Pase, U.S. Forest Service, and Elinor Lehto, Department of Botany, Arizona State University, for their aid in identifying plant material; the cooperation of the Fort Apache Tribal Council and the Arizona Game and Fish Department for their permission to collect turkeys for the study; and the aid of Harley Shaw, Arizona Game and Fish Department, who collected turkey crops at hunter check stations on the Moqui District of the Kaibab National Forest.

STUDY AREA

The study area was located in Arizona on the Fort Apache Indian Reservation in southern Navajo and northern Gila counties and included approximately 11,000 acres. A dry, grassy creek runs through the center of the area. Terrain on both sides of the creek is characterized by rolling hills cut by deep canyons. Elevations range from 5,500 to 7,000 feet. Annual precipitation averages between 17 and 18 inches and occurs with peaks in winter and late summer. The study area has never been logged commercially but is heavily grazed by livestock during summer and fall months, Elk *(Cervus canadensis)*, white-tailed deer *(Odocoileus virginianus)*, mule deer *(O. hemionus)*, and turkeys are present throughout the year. Peak turkey populations occur during the spring and fall migration periods.

Overstory vegetation at lower elevations is a complex of Colorado piñion pine *(Pinus edulis),* one-seed juniper *(Juniperus monosperma),* alligator juniper *(J. deppeana),* Utah juniper *(J. osteosperma),* and scattered stands of ponderosa pine located on all aspects. Dense stands of manzanita are present on some of the southern slopes. The predominant grass is blue grama *(Bouteloua gracilis).* Lesser amounts of side-oats grama *(B. curtipendula)* and muhlys *(Muhlenbergia* spp.) are common. Forbs, including mountain dandelion *(Agoseris* spp.), common dandelion *(Taraxacum officinale)* , common sunflower *(Helianthus annuus),* and golden weed *(Aplopappus* spp.) are present during moist seasons. Gradual changes occur in the overstory composition from lower to higher elevations. At the higher elevations ponderosa pine is more abundant and is found in small pure stands or in association with Gambel oak *(Quercus gambelii),* Emory oak *(Q. emoryi),* gray oak *(Q. grisea),* and juniper. The understory vegetation at all elevations is quite uniform.

METHODS

Data for this paper are based on analyses of 29 turkey crops and 503 fresh droppings collected during the period 1964-1968. Crops were obtained by collecting turkeys during each of the four climatic seasons from 1964 through 1966 under a special permit issued by the Fort Apache Tribal Council. Droppings were collected from January 1966 through February 1969. Additional data for comparison were obtained from 20 crops collected on the Moqui District of the Kaibab National Forest during the regular hunting seasons in 1967 and 1968. Material from each crop was separated by species, percent composition by volume was determined, and samples were oven-dried and weights recorded for each species.

All seasons were represented by collections of droppings, made during at least 2 months of each year, except the summer of 1968 when collections were made only in August. Quantitative determinations of the contents of droppings were made by an ocular estimate through a binocular microscope in increments of 5 percent. We recognize that an ocular estimate of the composition of the droppings is not as accurate as crop analysis, and some foods may be overrated because of different digestion rates. Martin et al. (1951:30) stated: “The fact that digestion alters the proportion of different foods in a stomach makes it necessary to keep constantly in mind that food information is not precise, exact, and final. Instead, it gives only an approximate indication of the kind and extent of food use.” Reeves and Swank (1955) questioned the validity of analysis of droppings since they found large differences between analyses of crops and droppings from collections made in the same general locations. However, the differences found may indicate a difference in feeding behavior of individual turkeys or local availability of food items rather than errors in analysis of droppings. In our study, large differences were also noted among crop contents collected from the same location at the same time.

Comparative analyses were made of turkey droppings and crops collected in 1966. Even though the number of crops was small, nearly the same items were identified in both crops and droppings (Table 42). The largest difference was noted in the March collections, when 77 percent (by volume) of the crop contents but only 21 percent of the droppings consisted of juniper berries. However, differences were even greater between crop contents of two turkeys collected from one roost on the same evening in February 1966. Juniper berries made up 88 percent of the contents of one crop and 21 percent of the other. In October 1967, piñion pine seed ranged from 0 to 72 percent of the crop con-

Table 42. Comparative percentage, by volume, of food items in crops and in droppings from Merriam's turkeys in 1966 on the Fort Apache Indian Reservation, Arizona. (Numbers of samples are given in parentheses.)

	February 1966		March 1966		April 1966		November 1966	
	Crop	Dropping	Crop	Dropping	Crop	Dropping	Crop	Dropping
Food Item	(2)	(9)	(1)	(5)	(1)	(16)	(2)	(8)
Juniper	55	60	77	21	5	10		<1
Grasses	15	28	5	40	7	23	37	37
Forbs	4	6	13	26	79	61	38	42
Acorns	<l	3	<l	5		2	14	17
Pine seed	10	<l	1			<1		1
Insects	<l	1	1	14	<1	3	<l	4

tents from turkeys harvested on the Kaibab National Forest. On the same area, acorns ranged from 0 to 84 percent in October 1968.

RESULTS AND DISCUSSION

Analysis of 29 turkey crops, collected on the study area over a 3-year period and during all four seasons, revealed 51 separate food items. Smith and Browning (1967) reported 64 food items taken throughout the year in California, and Dalke et al. (1942) reported 73 genera of plants taken by turkeys in Missouri. Reeves and Swank (1955) showed 42 genera of plants taken in Arizona during October. The number of crop samples collected in this study is not considered adequate to show annual changes in seasonal diet, but it does indicate the seasonal changes and variation in the diet of Merriam's turkey (Table 43).

Juniper berries were consumed in large quantities during the winter of 1965-66 and in the spring of 1966. One crop collected in February contained 134 grams (oven-dried weight) of juniper berries and another collected in March contained 125 grams. The high consumption of juniper berries during winter probably resulted from availability rather than from a food preference. Since the ground under dense juniper canopies usually remained free from snow, the juniper berries were exposed at a time when other food supplies were snow covered. During the summer of 1967, juniper berries comprised 20 percent (by volume) of the contents of turkey droppings on the study area. Fruits of manzanita and skunkbush, normally taken in large quantities in June, July, and August, failed to mature, and the turkeys apparently resorted to juniper berries as a substitute.

Forbs and grasses were important food sources throughout the year. Leaves, flowers, and seed heads of both mountain dandelion and common dandelion were taken in large quantities when available during wet seasons. Results from crop analyses of turkeys harvested in October on the Kaibab National Forest also showed relatively high use of common dandelion, averaging 4.4 percent (by volume) in 1967 and 5.9 percent in 1968 (Table 44).

Whole plants of rock jasmine *(Androsuce* spp.) were taken by turkeys in the spring months. Black medic *(Medicago lupulina)* and filaree *(Erodium cicutarium)* were used in small amounts consistently throughout the year. Higher use of mature forb seeds was noted on the Kaibab Forest than on the Fort Apache study area during the fall months. Seeds of tansy mustard *(Descurainiu* spp.), stickseed *(Luppula* spp.), and vetch *(Vicia* spp.), which were used on the Forest, were not available in quantity on Fort Apache because of heavy cattle grazing.

Seedpods of prostrate loco *(Astrugulus humistrutus)* were not found in the

Table 43. Percentage of volume and occurrence of food items identified in 29 Merriam's turkey crops from 1964 to 1969 on the Fort Apache Indian Reservation, Arizona. (Numbers of samples are given in parentheses.)

Food Item	Spring (3) Vol	Occ.	Summer (7) Vol.	Occ.	Fall (16) Vol.	Occ.	Winter (3) Vol.	Occ.
Juniper berries *(Juniperus* spp.)	27.7	100	-	-	<0.1	19	36.3	66
Dandelion *(Taraxacum oficinale)*	6.3	66	17.6	57	9.7	94	27.9	100
Manzanita *(Arctostaphylos pungens)*	-	-	37.8	86	12.4	44	-	-
Pine seed *(Pinus ponderosa)*	0.3	33	-	-	24.0	50	6.7	66
Mt. dandelion *(Agoseris* spp.)	38.7	100	-	-	-	-		-
Acorns *(Quercus* spp.)	<0.1	33	0.3	29	23.4	94	<0.1	66
Animal material (insects)	0.3	100	9.2	100	2.4	88	1.2	100
Unidentified forbs	6.3	66	3.3	86	0.4	44	3.1	100
Unidentified grasses	1.7	66	4.6	71	3.1	50	3.4	33
Lovegrass *(Eragrostis* spp.)	<0.1	33	-	-	10.0	50	-	-
Bluegrass *(Poa* spp.)	2.3	33	-	-	-	-	7.0	33
Rock jasmine *(Androsace* spp.)	8.0	66	0.7	43	-	-	-	-
Junegrass *(Koeleria cristata)*		-	5.3	14	-	-	-	-
Skunkbush *(Rhus trilobata)*		-	5.3	57	-	-		-
Unidentified mass	1.1	66	1.1	100	1.1	44	1.8	100
Black medic *(Medicago lupulina)*	3.7	66	0.3	14	0.3	38	<0.1	33
Buttercup *(Ranunculus* spp.)	-	-	4.3	14	-	-		-
Fleabane *(Erigeron* spp.)	-	-	3.5	29	<0.1	19	-	-
Needlegrass *(Stipa* spp.)		-	3.3	14	-	-		-
Bromegrass (Bromus spp.)	-	-	-	-	-	-	3.2	66
Ticklegrass *(Muhlenbergia sinuosa)*		-	-	-	2.7	44	-	-
Mariposa *(Calochortus* spp.)	0.3	33	1.3	29	<0.1	6	-	-
Goldeneye *(Viguiera annua)*	-		-	-	1.6	19	-	-
Filaree *(Erodium cicutarium)*	<0.1	66	<0.1	43	1.4	44	<0.1	66
Purslane *(Portulaca oleracea)*	-	-	0.1	14	1.1	13	-	-
Blue grama *(Bouteloua gracilis)*	-	-	-	-	1.4	31	-	-
Stinkgrass *(Eragrostis cilianensis)*		-	-	-	1.2	19	-	
Hymenoxys (Hymenoxys spp.)	–	-	1.0	14	-	-		-
Wood betony *(Pedicularis centranthera)*	–		0.4	14	-	-	–	-
Milk vetch *(Astragalus* spp.)	–	-	0.1	14	0.4	14	–	-
Wild buckwheat *(Eriogonum* spp.)	–	-	0.1	14	0.4	38	–	-
Panicum *(Panicum* spp.)	–	-	-	-	0.4	6	–	-
Green algae (Chlorophyceae)	–	-	-	-	0.4	6	–	
Scurf pea *(Psoralea tenuiflora)*		-	-	-	0.3	13	–	-
Euphorbia *(Euphorbia* spp.)	-	-	-	-	0.3	13	–	-
Side-oats grama *(B. curtipendula)*	-	-	-	-	0.3	6	–	-
Wormwood *(Artemisia* spp.)	-	-	-	-	0.3	6		-
Hog potato *(Hoffmanseggia* spp.)	-	-	-	-	-	-	0.3	66
Wooly yarrow *(Archillea lanulosa)*	<0.1	66	-	-	-	-	-	-
Piñon *(Pinus edulis)*	<0.1	33	-	-	-	-	<0.1	33
Tansy mustard *(Descurainia* spp.)	-	-	0.1	14	-	-		-
Rocky Mt. iris *(Iris missouriensis)*	-	-	<0.1	14	-	-	-	-
Gaura *(Gaura* spp.)		-	-	-	0.1	19	-	-
Bluestem *(Andropogon* spp.)	-	-	-	-	0.1	6	-	-
Lupine *(Lupinus* spp.)	-	-	-	-	<0.1	13	-	-
Menodora *(Menodora* spp.)	-	-	-	-	<0.1	6	-	-
Prickly pear *(Opuntia* spp.)	-	-	-	-	<0.1	6	-	-
Hymenothrix *(Hymenothrix* spp.)	-	-	-	-	<0.1	6	-	-
Amaranth *(Amaranths* spp.)	-	-	-	-	<0.1	6	-	-
Sand dropseed *(Sporobolus cryptandrus)*	-	-	-	-	<0.1	6	-	-
Crownbeard *(Verbesina* spp.)	-	-	-	-	<0.1	6	-	-
Common sunflower *(Helianthus annuus)*	-	-	-	-	<0.1	6		-
Unidentified seeds	-	-	-	-	<0.1	6	-	-
Fungi	-	-	-	-			8.3	33
Stones and gravel	3.3	100	0.3	71	0.8	81	0.8	100
Total forbs	63.3		32.8		16.3		31.3	
Total grasses	4.0		13.2		19.2		13.6	

Table 44. Percentage of volume and occurrence of food items identified in 20 Merriam's turkey crops in 1967 and 1968 from the Moqui District of the Kaibab National Forest, Arizona. (Sample sizes given in parentheses.)

Food Item	October 1967 (11)		October 1968 (9)	
	Vol.	Occ.	Vol.	Occ.
Acorns *(Quercus* spp.)	5.4	36	29.0	67
Piñon *(Pinus edulis)*	18.2	46		
Animal material	7.6	100	10.3	89
Leaves of grasses (Gramineae)	7.8	100	8.0	89
Lovegrass *(Eragrostis* spp.)	14.8	55	<0.1	11
Mt. muhIy *(Muhlenbergia montana)*	6.5	27	6.7	33
Dandelion *(Taraxacum officinale)*	4.4	55	5.9	67
Tansy mustard *(Descurainia* spp.)	0.3	9	8.4	44
Goosefoot *(Chenopodium* spp.)	2.0	64	5.9	67
Blue *grama (Bouteloua gracilis)*	5.1	82	2.1	22
Spike muhly *(Muhlenbergia wrightii)*	1.0	55	4.9	33
Loco *(Astrugulus* spp.)			5.6	56
Salsify (Tragopogon spp.)	2.8	73	2.2	78
False buffalo *grass (Munroa squurrosa)*	3.2	36	1.0	33
Unidentified forb leaves	3.7	73		
Pine dropseed *(Blephuroneuron tricholepis)*	3.6	27		
Prostrate loco *(Astrugulus humistratus)*	3.3	64		
Stickseed *(Luppula redowskii)*	0.7	36	2.2	22
Lettuce *(Luctuca* spp.)	1.9	27		
Thistle (Cirsium spp.)	1.3	27	2.1	67
Unidentified seeds	<0.1	18	1.9	22
Vetch *(Vicia* spp.)	1.4	27	0.1	33
Bromegrass *(Bromus* spp.)	1.6	27	<0.1	11
Ticklegrass (Muhlenbergia sinuosa)	0.7	18	0.2	11
Filaree *(Erodium cicuturium)*	0.3	18	0.6	44
Silene *(Silene* spp.)	0.6	18	<0.1	11
Rocky Mt. *iris (Iris missouriensis)*			0.6	33
Goldeneye *(Viguieru unnua)*	0.1	18	0.4	11
Scarlet gaura *(Gaura coccinea)*	0.3	18		
Plantain *(Plantago* spp.)	0.2	9		
Unidentified mass	<0.1	9	0.3	44
Indian *ricegrass (Oryzopsis hymenoides)*	<0.1	9		
Needlegrass *(Stipa* spp.)	<0.1	9		
Prickly pear *(Opuntia* spp.)	<0.1	9		
Grape (Vitis spp.)	<0.1	9		
Pine seed *(Pinus ponderosa)*	<0.1	9	<0.1	11
Rose (Rosa spp.)	<0.1	9		
Juniper *(Juniperus* spp.)			<0.1	11
Stones and gravel	1.2	100	1.6	100
Total forbs	21.9		23.9	
Total grasses	44.3		34.9	

crop samples taken on the study area, but fragments of the pods were found in abundance in the samples of droppings collected during the spring and summer of 1967 and 1968. Seeds of Indian root *(Lomatium* spp.) were also identified in droppings during summer months.

The greatest use of grasses was noted during fall months when seeds of several species of lovegrass *(Eragrostis* spp.), muhlys, needlegrass *(Stipa* spp.), bromegrass *(Bromus* spp.), and gramas had matured. During the fall of 1967, a year of poor mast crops, ticklegrass *(Muhlenbergia sinuosa)* accounted for an unusually high proportion of the turkey diet. Seeds and leaves of bluegrass

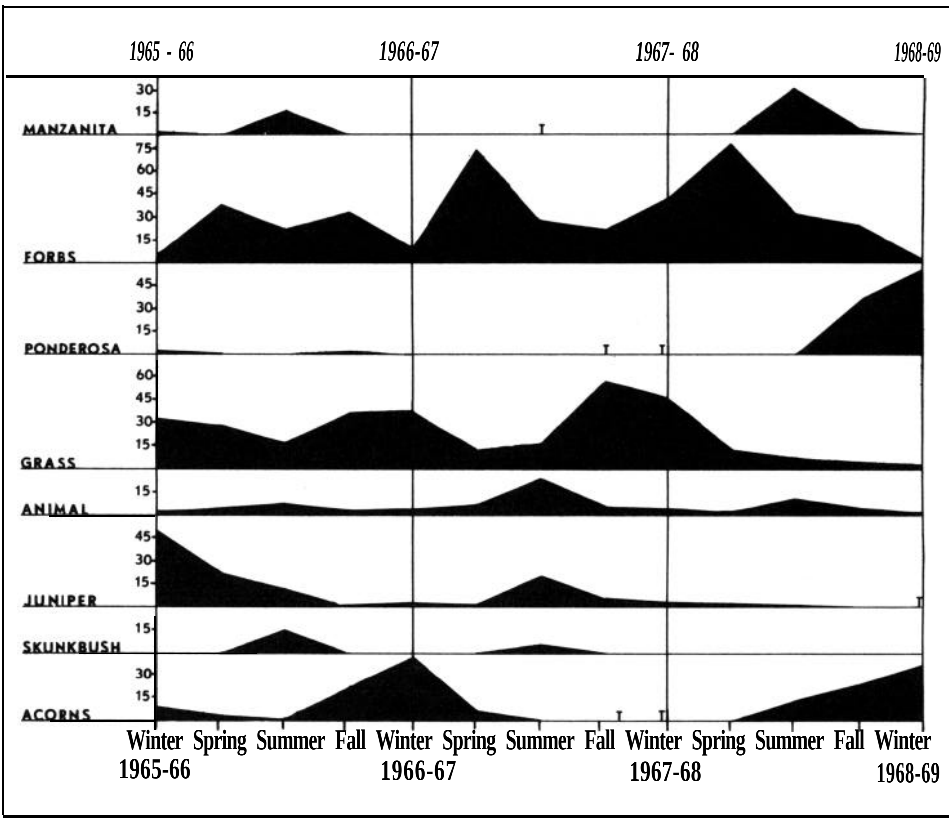


Figure 40. Seasonal percentages, by volume, of eight major food items in the droppings of Merriam's turkeys on the Fort Apache Indian Reservation. T = trace.

(Poa spp.) and Junegrass *(Koeleria cristata)* were taken in small amounts when they were available during the wetter winter and summer seasons. Extremely heavy livestock grazing on the study area during the summer and fall of 1968 resulted in a shortage of forbs and grasses for turkeys, as indicated by the absence of these items in droppings collected during the fall and winter of 1968-69 (Figure 40).

Results of this study indicated high utilization of pine seeds when they were available. Crops collected in November 1965 contained 18 to 64 grams (oven-dried weight) of ponderosa pine seeds. The contents of two crops collected on the Kaibab Forest in 1967 were nearly all piñon pine seed; one contained 629 seeds (171 grams, oven-dried weight) and the other 480 (123 grams). Jonas (1966) also found that pine seeds were used extensively in Montana when they were available. As pointed out by Fowells (1965), however, pine seed production occurs at irregular intervals and cannot be relied on as a source of food every year.

At least four species of oak, Gambel, Emory, gray, and shrub live oak *(Quercus turbinella),* are present on the study area. Some acorns are available throughout the year, but the greatest number and use occur in fall months. Twelve crops collected in October and November 1964 and 1965 all contained acorns. The average oven-dried weight of acorns from these crops was 36.5 grams with a range of 7 to 65 grams per crop. A crop from an adult gobbler harvested on the Kaibab Forest in 1968 contained 198 grams of acorns.

Table 45. Percentage of volume and occurrence of food items identified in 503 Merriam's turkey droppings from January 1966 to February 1969 on the Fort Apache Indian Reservation, Arizona. (Numbers of samples are given in parentheses.)

	Spring (109)		Summer (170)		Fall (111)		Winter (113)	
Food Item	Vol.	Occ.	Vol.	Occ.	Vol.	Occ.	Vol.	Occ.
Forbs	63.0	100	27.0	96	28.0	71	15.0	87
Grasses	19.0	93	17.0	88	36.0	71	31.0	97
Acorns	3.0	33	3.0	25	16.0	51	22.0	83
Animal material	5.0	70	17.0	90	4.0	57	4.0	75
Juniper berries	9.0	60	15.0	78	2.0	24	14.0	49
Manzanita(fruit)		10.0	44	1.0	14	<1.0	20	
Skunkbush(fruit)		8.0	44	<1.0	1			
Pine seeds	<1.0	1			13.0	32	14.0	36
Garrya spp (fruit)							<1.0	6
Unidentified seeds	1.0	7	3.0	13				

The fruits of manzanita and skunkbush received heavy use by turkeys. Since skunkbush berries normally mature in June and manzanita a month later on this study area, they provide important food sources during the dry, late-spring period.

Animal material, primarily insects (not separated by species), was found yearlong in turkey crops and droppings (Table 45). Heaviest use occurred during summer months, when animal material appeared to be highly important food for poults. Snails were also found in the crops, and in one instance a horned lizard *(Phrynosoma* sp.) 5.5 inches long was found in the crop of an adult gobbler from the Kaibab Forest.

CONCLUSIONS

Food habits data presented in this paper indicate that Merriam's turkeys are highly diversified in their feeding habits and have the ability to substitute less desirable foods for preferred foods, when preferred foods are not available. Wide fluctuation in yearly precipitation on Arizona turkey ranges results in highly variable production of forbs and grasses. This, coupled with the cyclic nature of mast production, implies that turkey habitat should be managed to include a wide variety of plant species to insure against a complete failure of food supplies in any one year.

Overgrazing by livestock reduces the availability of turkey foods and becomes a serious factor in years of mast crop failure. The high yearlong use of forbs and grasses indicates that range quality is an important factor in the evaluation of turkey habitat.

This page has been intentionally left blank to preserve the continuity of the original document.

18

PARASITISM AND DISEASE AMONG SOUTHEASTERN WILD TURKEYS *

Annie K. Prestwood, Forest E. Kellogg, and Gary L. Doster

ABSTRACT

During the 6 years from 1964 to 1970 nearly 400 eastern wild turkeys *(Meleagris gallopavo silvestris)* were examined for parasites and diseases. Adult and immature turkeys from Alabama, Arkansas, Mississippi, and West Virginia have been studied on an annual or semi-annual basis for 3 consecutive years, and additional information has been obtained from turkeys dying of natural causes. Southeastern turkeys harbor at least 60 different parasites including 9 protozoans, 11 trematodes, 10 cestodes, 1 acanthocephalan, 17 nematodes, and 12 arthropods. Parasitism may vary with age of the host, area of collection, and density of the host population. Significant diseases that were encountered among southeastern wild turkeys include blackhead, coli-granuloma, and fowl pox. Population implications are discussed, and a partially annotated bibliography of parasites of wild turkeys is presented.

The wild turkey once occupied a range that included all but 11 of the United States. An increasing human population, the clearing of land for agricultural purposes, and intensive farming practices on the land reduced the range of the turkey to 21 states and to a population estimated at less than 100,000 prior to World War II (Mosby and Handley 1943:21). Through intensive restoration and management programs, more than 750,000 wild turkeys presently inhabit 37 states (Aldrich 1967:33). Approximately 343,500 (45.5 percent) of these are located in southeastern states.

In addition to being blessed with sizable turkey populations and good turkey habitat, the Southeast possesses a warm climate with mild winters, moderate to high amounts of rainfall, and high humidity, which often are conducive to the development of parasitism and disease. An awareness of disease and parasite potential in the Southeast was expressed as early as 1935, when Stoddard (1935:329) cautioned that sites of food plots and artificial feeders should be rotated to lessen the likelihood of disease becoming established.

More recently, studies on parasitism and disease entities have been intensified in the Southeast. Data to delineate the geographic distribution and prevalence of parasites in southeastern wild turkeys were presented by Maxfield et al. (1963:261-271). Since that time, research has been concentrated in specific localities in the Southeast. Emphasis has been placed on replication of work to detect variations in parasite burdens due to age of the host, density of the host population, and environmental factors such as habitat, temperature, and pre-

* This study was supported by an appropriation from the Congress of the United States. Funds were administered and research coordinated under the Federal Aid in Wildlife Restoration Act (50 Stat. 917) and through Contract No. 14-16-0008-676, Bureau of Sport Fisheries and Wildlife, U.S. Department of the Interior.

cipitation. These studies are still in progress. We will present a summary of the progress of these research efforts.

From 1964 to 1970, 396 eastern wild turkeys were examined for parasites and diseases. Turkeys originated from Alabama, Arkansas, Mississippi, and West Virginia and included 241 adult birds collected primarily in late March and early April, 32 juvenile birds collected in October, and 123 poults collected in late July or early August. In most instances, turkeys were obtained on an annual or semi-annual basis for 3 consecutive years.

The authors would like to express sincere appreciation to the Southeastern Association of Game and Fish Commissioners and to the Game Biologists throughout the region who assisted in obtaining specimens for study. For aid and advice, special thanks are extended to: James R. Davis and William J. Hamrick, Alabama Department of Conservation; Robert Leonard, Arkansas Game and Fish Commission; Lovett Williams, Florida Game and Fresh Water Fish Commission; Champ Clark and William H. Turcotte, Mississippi Game and Fish Commission; and R. Wayne Bailey and Kermit T. Rinell, West Virginia Department of Natural Resources. Cooperation of the Beulah Island Hunting Club, Catfish Point Club, Choctaw Bluff Hunting Club, Duck Lake Hunting Club, Merigold Hunting Club, and the Tunica Wildlife League is gratefully acknowledged.

RESULTS

A checklist of parasites inhabiting wild turkeys in the United States, with a partially annotated bibliography, is presented in Table 46.

PROTOZOA

Intestinal and blood protozoans occur frequently in southeastern wild turkeys. Of the protozoans known to occur in wild turkeys, *Histomonas meleagridis* is potentially the most devastating. *Histomonas meleagridis,* the etiologic agent of blackhead or enterohepatitis, is usually transmitted from bird to bird while encapsulated in the egg of the cecal worm, *Heterakis gallinarum.* Reid (1967) presented an extensive review of the etiology and dissemination of the blackhead syndrome among domestic turkeys and chickens.

Apparently, blackhead is widespread among turkey populations in the southeastern United States. It has been diagnosed in the wild host in Alabama (Davis 1964:23b), Georgia (Stoddard 1935:29), North Carolina (Craig and Barkalow 1950:18), Pennsylvania (Kozicky 1948a:263; Snyder 1953:19; Roberts 1956:7), Texas (Thomas 1964:292), and Virginia (Mosby and Handley 1943:144). In addition we have diagnosed blackhead in eastern turkeys from Arkansas, Mississippi, South Carolina, and West Virginia.

Different hosts vary greatly in degree of susceptibility to blackhead. An accepted maxim in domestic poultry production is, “Don’t raise chickens and turkeys together.” This saying is based on the fact that chickens are quite resistant to blackhead and frequently harbor the organism indefinitely without becoming diseased. The same apparently is true with certain other gallinaceous game birds. Kellogg (1969:76) demonstrated that bobwhite quail *(Colinus virginianus)* are more resistant to blackhead than turkeys and can shed infective material for long periods. Transmission of blackhead from apparently normal bobwhites to parasite-free turkeys occurred when both species were maintained in the same pen. Kellogg (1969:72) also reported the decline of a wild turkey population in Florida associated with a pronounced rise in the bobwhite population. Blackhead was the only disease noted in wild turkeys during

Table 46. A checklist of parasites of wild turkeys *(Meleagris gallopavo* spp.) in the United States.

Parasite	Location in Host	Author
PROTOZOA		
Eimeria adenoeicles	Ileum, ceca, rectum	Prestwood 1968
Eimeria gallopavonis	Ileum, rectum	Prestwood 1968
Eimeria meleagridis	Ceca	Kozicky 1948[a] Prestwood 1968
Eimeria meleagrimitis	Jejunum	Prestwood 1968
Eimeria subrotunda	Duodenum, jejunum, ileum	Prestwood 1968
Haemoproteus meleagridis	Red blood cells	Cook et al. 1966 Goggans 1966 Kozicky 1948[a] Love et al. 1953 Roslien 1963
Histomonas meleagridis	Ceca, liver	Craig & Barkalow 1950 Kozicky 1948[b] Mosby & Handley 1943 Prestwood 1968 Roberts 1956 Snyder 1953 Stoddard 1935 Thomas 1964
Leucocytozoon smithi	White blood cells	Goggans 1966 Kozicky 1948[a] Mosby & Handley 1943 Wehr & Coburn 1943
Trichomonas sp.[a]	"Upper digestive tract"	Kozicky 1948[a]
Trichomonas gallinarum	Ceca	Prestwood (unpublished data)
TREMATODA		
Athesmia heterolecithodes	Liver	Byrd et al. 1967
Brachylaema virginiana	Intestine	Maxfield et al. 1963
Cotylurus flabelliformis	Intestine	Self & Bouchard 1950 Maxfield et al. 1963 Prestwood 1968
Echinoparyphium recurvatum	Intestine	Self & Bouchard 1950 Maxfield et al. 1963 Prestwood 1968
Leucochlordium sp.	Intestine, ceca	Prestwood 1968
Psilotornus audacirrus	Intestine, ceca	Byrd & Prestwood 1969
Prosthogonimus ovatus	Bursa, oviduct	Prestwood 1968
Renicola sp.	Kidney	Byrd et al. 1969
Rhopalias macracanthus	Intestine	McKeever 1961
Tanaisia zarudnyi	Kidney	Prestwood 1968
Zygocotyle lunata	Intestine, ceca	Prestwood 1968
CESTODA		
Amoebotaenia cuneata	Intestine	Prestwood 1968
Davainea meleagridis	Intestine	Gardiner & Wehr 1949 Maxfield et al. 1963 Prestwood 1968
Drepanidotaenia watsoni[b]	Intestine	Maxfield et al. 1963 Prestwood & Reid 1966

Table 46. Cont'd.

Parasite	Location in Host	Author
Hymenolepis cantaniana	Intestine	Maxfield et al. 1963
Hymenolepis carioca	Intestine	Maxfield et al. 1963
Metroliasthes lucida	Intestine	Maxfield et al. 1963 Mosby & Handley 1943 Prestwood 1968 Self & Bouchard 1950 Williams 1931
Raillietina cesticillus[a,c]	Intestine	Gardiner & Wehr 1949
Raillietina georgiensis	Intestine	Maxfield et al. 1963 Prestwood 1968
Raillietina ransomi	Intestine	Maxfield et al. 1963 Prestwood 1968 Williams 1931 Wehr & Coburn 1943
Raillietina williamsi	Intestine	Gardiner & Wehr 1949 Maxfield et al. 1963 Prestwood 1968 Williams 1931
Raillietina sp.	Intestine	Mosby & Handley 1943
ACANTHOCEPHALA		
Mediorhynchus grandis[a]	Intestine	Huggins & Dauman 1961
Mediorhynchus sp.	Intestine	Prestwood 1968
NEMATODA		
Ascaridia dissimilis	Intestine	Gardiner & Wehr 1949 Kozicky 1948[b] Maxfield et al. 1963 Mosby & Handley 1943 Prestwood 1968 Wehr & Coburn 1943
Ascaridia galli	Intestine	Maxfield et al. 1963
Capillaria annulata	Crop, esophagus	Maxfield et al. 1963
Capillaria caudinflata	Intestine	Gardiner & Wehr 1949 Maxfield et al. 1963 Prestwood 1968
Capillaria contorta	Crop, esophagus	Wehr 1965 Prestwood 1968
Capillaria obsignata	Intestine	Maxfield et al. 1963 Prestwood 1968
Cheilospirura sp.[a]	Gizzard	Wehr & Coburn 1943
Dispharynx nasuta	Proventriculus	Prestwood 1968
Gonggylonema ingluvicola	Esophagus	Maxfield et al. 1963
Heterakis gallinarum	Ceca	Burget 1957[b] Fox 1923 Kozicky 1948[b] Maxfield et al. 1963 Prestwood 1968
Heterakis sp.	Ceca	Prestwood 1968
Oxyspirura sp.	Eye	Prestwood 1968
Seurocyrnea colini	Proventriculus, gizzard	Maxfield et al. 1963
Seurocyrnea sp.	Proventriculus, gizzard	Maxfield et al. 1963 Prestwood 1968
Singhfilaria hayesi	Connective tissue	Anderson & Prestwood 1969
Strongyloides avium	Intestine, ceca	Maxfield et al. 1963

Table 46. Cont'd.

Parasite	Location in Host	Author
Strongyloides sp.	Intestine	Maxfield et al. 1963 Prestwood 1968
Syngamus trachea	Trachea	Wehr & Cobum 1943 Prestwood 1968
Trichostrongylus tenuis	Ceca	Gardiner & Wehr 1949 Maxfield et al. 1963 Prestwood 1968
ACARINA		
Amblyomma americanum	Skin	Bishopp & Trembley 1945 Cooley & Kohls 1944 Kellogg et al. 1969
Amblyomma cajennense	Skin	Bishopp & Trembley 1945 Prestwood 1968
Argus miniatus[a]	Skin	Bishopp & Trembley 1945
Rhipicephalus sanguineus	Skin	Kellogg et al. 1969
Knemidokoptes mutans[a]	Legs	Thomas 1964
Neoschoengastia americana	Skin	Kellogg et al. 1969
Megninia cubitalis[a]	Feathers	Gardiner & Wehr 1949
Megninia sp.	Feathers	Kellogg et al. 1969
MALLOPHAGA		
Chelopistes meleagridis	Feathers	Emerson 1951 Hightower et al. 1953 Kellogg et al. 1969
Lipeurus bakeri[a]	Feathers	Carriker 1956
Menacanthus sp.[a]	Feathers	Hightower et al. 1953
Menacanthus stramineus	Feathers	Kellogg et al. 1969
Oxylipeurus corpulentus	Feathers	Carriker 1954 Clay 1938 Emerson 1951 Hightower et al. 1953 Kéler 1958 Kellogg et al. 1969
Oxylipeurus polytrapezius	Feathers	Clay 1938 Emerson 1951 Hightower et al. 1953 Kéler 1958 Kellogg et al. 1969
DIPTERA		
Lynchia americana	Feathers	Bequaert 1933 Bequaert 1945 Kellogg et al. 1969
Ornithoctona erythrocephala	Feathers	Kellogg et al. 1969
Olfersia sp.	Feathers	Kellogg et al. 1969

[a]Not reported from southeastern wild turkeys.
[b]Reported by Maxfield et al. (1963) as unknown hymenolepid tapeworm.
[c]Probably misidentified according to Maxfield et al. (1963) since it closely resembles *R. ransomi.*

this decline. Other upland game birds that possibly could serve as reservoir hosts for blackhead among wild turkeys are grouse, pheasants, and jungle fowl.

Blackhead outbreaks in native turkeys have been associated with the release of pen-raised turkeys into wild populations (Snyder 1953:23). The pen-raised birds contaminated the environment before they died. The practice of releasing pen-raised birds into existing turkey populations is highly questionable and should be avoided.

Coccidiosis, caused by several species of *Eimeria*, poses a considerable threat to wild turkey poults. Southeastern turkeys harbor at least five species of coccidia, three of which are the most pathogenic known in domestic turkeys. Kozicky (1948a:264) collected droppings from wild turkeys in Pennsylvania and found 40 percent to contain oocysts. Prestwood (1968:26) examined 82 poults, 5 to 13 weeks old, in Arkansas and Mississippi and found that 46 percent contained oocysts. Laboratory transmission experiments with a mixed culture of oocysts from a wild poult revealed this culture to be highly pathogenic to domestic poults.

Examination of 10 livetrapped turkey poults from an area in West Virginia revealed 100 percent infection with coccidia. This trap site had been used for several seasons, and due to regular baiting and heavy turkey use, substantial environmental contamination probably had occurred. Trap sites therefore should be rotated to prevent extensive contamination with coccidian oocysts or other disease and parasite organisms.

Haemoproteus meleagridis and *Leucocytozoon smithi* are quite common among southeastern wild turkeys. The pathogenicity of *Haemoproteus* is questionable, whereas *Leucocytozoon* may cause acute disease in domestic turkeys (Wehr 1962:196). Concomitant infection with a bacterial or viral agent may be necessary for production of clinical signs by blood protozoans.

TREMATODA

Eleven species of flukes occur in the digestive or urinary tracts of southeastern turkeys. Overall incidence of flukes is low, but they may occur frequently in birds of a particular area. Prestwood (1968:26) found flukes in only 19 of 216 wild turkeys from the Delta region of Arkansas and Mississippi. Byrd et al. (1967:1116) reported a 50 percent incidence of liver flukes *(Athesmia heterolecithodes)* in adult wild turkeys collected during a 2-year period in Alabama. Byrd et al. (1969:75) noted that kidney flukes *(Renicola* sp.) occurred in 7 of 20 (35 percent) adult turkeys in Tunica County, Mississippi.

Pathogenicity has not been attributed to flukes in wild turkeys. Annereaux (1940:64), however, attributed death of domestic turkey poults to heavy *Echinoparyphium recurvatum* infections; and the injurious effects of oviduct flukes *(Prosthogonimus macrorchis)* in domestic poultry also are well known (Price 1965:1051). Except in isolated instances, the number of parasites is evidently too low to cause mortality in the wild host.

CESTODA

Tapeworms are common in southeastern wild turkeys, and multiple infections with two or more species frequently are encountered. Of the 10 species of cestodes found in this region, *Metroliasthes lucida* and *Raillietina williamsi* are the most common. Prestwood (1968:33) found these two species in approximately 50 percent of 216 turkeys in the Mississippi Delta. *Raillietina ransomi* was the third most prevalent cestode found in this study, and it occurred in approximately 20 percent of turkeys in the Mississippi Delta.

Tapeworm infections seldom have been found to be pathogenic in domestic fowl. Botero and Reid (1969:538) found that domestic chickens fed a complete ration did not suffer depressed weight gains, egg production, or feed conversion when heavily infected with *Raillietina cesticillus*. Intestinal blockage by the larger cestodes may be an occasional problem.

ACANTHOCEPHALA

Members of this phylum occur rarely in wild turkeys. *Mediorhynchus* sp. was found in only 20 of 216 wild turkeys in Arkansas and Mississippi (Prestwood 1968:35) even though grasshoppers (Locustidae), the intermediate hosts, are plentiful in this region. Pathogenicity was not noted in these infections.

NEMATODA

The nematodes or roundworms are the most frequently encountered parasites of wild turkeys, and multiple infections are common. Nematodes having direct life cycles are most prevalent; those requiring intermediate hosts occur less frequently. Seventeen different roundworms are harbored by southeastern wild turkeys. Of these, *Heterakis gallinarum* and *Ascaridia dissimilis* are the most common. Prestwood (1968) found *Heterakis* in 97 percent and *Ascaridia* in 96 percent of wild turkeys in the Mississippi Delta. The incidence of these parasites is also high in turkeys elsewhere in the Southeast. *Strongyloides sp.* and *Capillaria* spp. were the third and fourth most commonly encountered roundworms (Prestwood 1968:36-44).

From a biological point of view, *H. gallinarum* is one of the most important helminths harbored by turkeys, because it is the vector of blackhead. This disease entity was discussed previously under protozoan parasites. Potentially pathogenic nematodes, *Dispharynx nasuta* and *Syngamus trachea,* are encountered infrequently among wild turkeys but, when found, occur primarily in the young. This is significant since digestive and respiratory impairment can be most detrimental to the young bird.

Infections with nematodes that have direct life cycles quite frequently reflect environmental changes or other factors affecting wild turkeys. For example, Prestwood (1968:28, 38, 42) found statistically significant age, area, and yearly variations in burdens of *Heterakis* and *Ascaridia* in wild turkeys on three ecologically similar study sites in the Mississippi Delta. These differences were attributed to such variables as duration of exposure of turkeys to the contaminated environment, rainfall or available moisture necessary for embryonation of helminth ova, available food for turkeys, and density of hosts in the areas.

ARTHROPODA

Wild turkeys frequently have ectoparasites, and 12 species of arthropods have been reported from wild turkeys in the Southeast. *Menacanthus stramineus,* the chicken body louse, is the most common ectoparasite of turkeys in this region. *Chelopistes meleagridis* and *Oxylipeurus polytrapezius* also occur frequently (Kellogg et al. 1969:329). Young turkeys appear to have a larger variety of ectoparasites than do older birds (Kellogg et al. 1969:329). This may be a result of collecting poults only during the warmer months of the year. The only pathologic lesions that could be attributed to arthropod infestations were associated with chiggers, *Neoschoengastia americana.* Lesions consisted of raised, rounded areas 3 to 5 mm in diameter with depressed centers containing large numbers of chigger mites.

VIRAL AND BACTERIAL DISEASES

In addition to blackhead, two other significant disease entities have been diagnosed in southeastern wild turkeys. Fowl pox, a viral disease, has been observed in turkeys from Alabama (Davis 1966:28b), Florida (Powell 1965:25), Mississippi (Prestwood 1968:48), and South Carolina (SCWDS, unpublished records). According to Powell (1965:25), fowl pox caused virtual decimation of a wild turkey flock in Volusia County, Florida, when pen-raised turkeys harboring the virus were introduced. Fowl pox virus is extremely stable and can survive under favorable laboratory conditions for many years in scabs from lesions. Several species of mosquitoes, which spread the disease in nature, can harbor the virus for up to 3 months.

A disease of the digestive tract, resembling coli-granuloma, was found in wild turkeys from Arkansas and Mississippi (Prestwood 1968:48). Reports from sportsmen indicated that this disease was common in birds on several areas along the Mississippi River. The disease apparently was of long duration and its chronicity may have prevented isolation of organisms other than *Escherichia coli.*

POPULATION IMPLICATIONS

The status of parasitism and disease as limiting factors of wild turkey populations is virtually unknown. Although declines in population have been noted on many areas, precipitating causes have remained largely undetermined.

Numerous factors make diagnosis of disease among wild turkeys difficult. Carcasses of turkeys are difficult to locate among vegetation in the native habitat. The secretive habits of the birds and the remoteness and inaccessibility of much of the terrain further complicate location and detection of dead turkeys. Carrion eaters, both vertebrate and invertebrate, consume carcasses and prevent location by man for diagnostic purposes. It seems logical that sick or otherwise weakened turkeys also are more subject to predator activity than are healthy birds. This activity should be welcomed, since by removing sick birds the infectious agent also is removed from the population and the additional spread of disease is prevented. It is only when mortality is severe enough to cause carcasses to be readily available that disease is detected and diagnosed.

While discussing population dynamics of wild turkeys, Mosby (1967:125) estimated the total annual mortality of eastern turkeys of West Virginia to be 76.1 percent of the population. Similar data for Florida turkeys revealed 60 percent annual mortality. Each of the above states has an either-sex hunting season, and Mosby (1967:123) considers that hunting removes 20 percent of the total population. In contrast, only 8 percent of the population is taken by hunters in states where a gobblers-only season prevails. Thus, no particular cause can be assigned to 40 to 55 percent of annual mortality in states where either-sex seasons prevail. In states where gobblers-only seasons are allowed, 50 to 65 percent of total annual mortality cannot be attributed to a definite cause.

It seems logical that parasitism and disease may account for a large proportion of total annual mortality currently attributed to unknown causes. Kozicky (1948b) was of the opinion that disease was second only to man as a limiting factor of wild turkey populations in Pennsylvania. He postulated that turkey populations would not expand with total cessation of hunting since disease would exact a greater toll.

Parasitism is widespread among southeastern wild turkeys, and exceedingly high parasite burdens frequently are encountered. Generally, parasite burdens are higher in areas where turkey population density is high, thus reflecting host density on a given area. A precipitous decline in hunter harvest (from an average of 60-70 birds to 2 birds) of wild turkeys occurred in one of our study areas in Mississippi that had previously supported a very high population of turkeys with heavy parasite burdens. Decreased turkey populations on this area apparently were due to failure of poults to hatch or to survive for two consecutive summers. Dead or dying poults were not recovered for examination, therefore the cause of mortality was not determined.

RECOMMENDATIONS

Considering parasitism and disease in southeastern wild turkeys, the following management recommendations can be made. Pen-raised birds should not be introduced into existing wild turkey populations. Locations of food plantings and trap sites should be rotated to prevent excessive contamination of the soil. Vigorous programs to control predators should not be condoned, because predators exert a sanitizing effect by removing sick or weakened birds from the environment. Either-sex hunting should be encouraged on many areas where high populations of turkeys now exist.

This page has been intentionally left blank to preserve the continuity of the original document.

19

SOME DISEASES OF WILD TURKEYS FROM TEXAS AND WISCONSIN

Daniel O. Trainer

ABSTRACT

From 1964 to 1969 livetrapped wild turkeys from a study area in southern Texas and turkeys shot during the hunting seasons in west-central Wisconsin were tested for evidences of various types of encephalitis and several other diseases. Serologic, bacteriologic, and hematozoic methods of analysis were used on sera extracted from the turkeys. The object of the study was to increase understanding of diseases and disease agents in wild turkeys. Results of tests on wild turkey sera from south Texas suggested little or no activity of eastern, California, and Venezuelan encephalitis; encephalomyocarditis; Newcastle Disease; ornithosis; *Salmonella pullorum;* and S. *typhimurium.* A small number of reactors to western encephalitis were detected annually. Significant numbers of serologic reactors against St. Louis encephalitis and vesicular stomatitis were detected in wild turkeys, and their serologic patterns paralleled disease activity in humans and livestock of the area. Mycoplasmas that were different from recognized poultry strains were isolated from the 100 turkeys examined in Texas and 14 examined in Wisconsin. More than 80 percent of 133 turkeys from Texas were infected with *Haemoproteus meleagridis.* The significance of these findings and the potential role of disease in wild turkey management were discussed.

The study was supported and conducted jointly by the Department of Veterinary Science, University of Wisconsin; the Wisconsin Department of Natural Resources, Division of Conservation; and the Rob and Bessie Welder Wildlife Foundation, Sinton, Texas, and was published as V.S. Paper No. 625 and Welder Contribution No. 134

Knowledge of diseases of wild turkeys, for the most part, has been assimilated from information available on domestic or captive birds and the examinations of wild birds involved in die-offs, individual deaths, or parasitological surveys (Halloran 1955:359-381, Markley 1967:230-245).

To increase our understanding of the diseases and disease agents that exist in wild turkeys, one population in south Texas and one in west-central Wisconsin were studied utilizing serologic, bacteriologic, and hematozoic methods. Cook et al. (1966), Glazener et al. (1967), and Trainer et al. (1968) have previously reported some results of these studies.

This study would not have been possible without the collaboration of other researchers. Special appreciation is extended to W. C. Glazener, Welder Wildlife Foundation, and C. F. Smith, Wisconsin Department of Natural Resources, for their field participation and contributions.

MATERIALS AND METHODS

One study area, the Welder Wildlife Foundation, was located on the coastal bend of south Texas. Rio Grande turkeys *(Meleagris gallopavo inter-*

media) were livetrapped and sampled on their winter ground (Glazener et al. 1967). Serologic, bacteriologic, and hematozoic studies were conducted on this population,

The second study area, the Meadow Valley Wildlife Area, was located in west-central Wisconsin, where the eastern turkey *(Meleagris gallopavo silvestis)* was reintroduced in 1954 (Plis and Hartman 1958). Bacteriologic specimens only were collected from turkeys shot during the spring hunting season (1968).

As part of the serologic investigation, whole blood was drawn by needle and syringe from either the brachial or jugular vein and allowed to clot at room temperature for 24 hours. The serum was then removed, heat inactivated at 56 C for 30 minutes, and stored at -20 C until tested.

Turkey sera were screened for the presence of selected virus-neutralizing antibodies in a HeLa cell metabolic inhibition tissue-culture system (Thompson and Evans 1965). Virus antibodies tested for included Eastern (EE), Western (WE), California (CE), St. Louis (SLE), and Venezuelan (VE) encephalitis, vesicular stomatitis (VS), and encephalomyocarditis (EMC).

The micro-hemagglutination inhibition test was used to screen turkey sera for the presence of Newcastle Disease (ND) antibodies (Sever 1962). Turkey sera were tested for *S. pullorum* and *S. typhimurium* antibodies using the standard tube agglutination procedure (Van Roekel 1965). An indirect complement fixation test was performed on sera to detect complement-fixing antibodies against ornithosis (Brumfield et al. 1961).

For bacteriologic examination, tracheal swabs were made from captured and dead birds. The swabs were placed in screw-capped tubes containing mycoplasma media (Frey et al. 1968), incubated for 24 hours, frozen, and shipped to the laboratory where they were reincubated, passed to fresh media, and identified (Gramowski 1969).

Individual blood films were made from captured turkeys and examined microscopically for blood parasites (Cook et al. 1966).

RESULTS

SEROLOGICAL

During the serologic study at Welder (1964-1969), approximately 900 wild turkey sera were collected and tested. Results (Table 47) indicated little or no activity of EE, CE, VE, EMC, and ND.

Table 47. Summary of serologic results from wild turkeys from 1964 to 1969 on the Welder Wildlife Refuge, Texas.

	Results[a]						
Disease	1964	1965	1966	1967	1968	1969	Totals
EE	0/34	0/99	0/321	4/227	0/11	0/110	4/802
WE	3/83	4/99	35/321	34/227	1/11	10/110	87/851
CE	0/91	0/75	1/173		0/11	0/110	1/460
SLE	0/45	18/84	78/321	60/227	1/11	3/110	160/798
VE	2/64	1/108	0/321	6/148	0/11	0/110	9/762
VS	0/23	0/50	78/224	3/148			81/445
EMC	0/73		0/224				0/297
ND			0/310	0/203			0/513
Ornithosis		2/118					2/118
Salmonellosis	0/31	0/87					0/118

[a]The number of positive sera over the number of sera tested; a dash indicates none tested.

From the limited sample of 148 birds tested, it did not appear that Welder turkeys had previous experience with *S. pullorum* or *S. typhimurium*, and only 2 of 118 turkeys reacted to ornithosis antigen.

Reactors to WE were detected in all years of the study, with an apparent increase in reactors in 1966 and 1967 (Table 47). During the entire study period, WE reactors were almost equally divided between male and female turkeys, with slightly more reactors among adult birds than among immatures. None of these sex and age differences were statistically significant (chi-square).

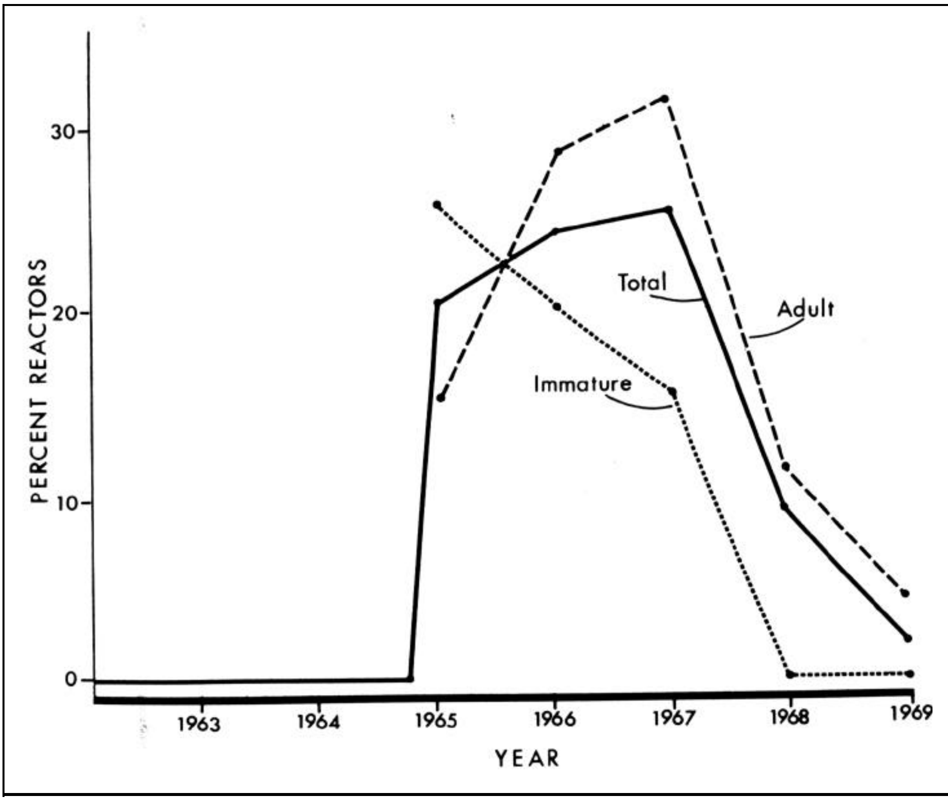


Figure 41. Prevalence of St, Louis viral encephalitis serologic reactors of various ages in a wild turkey population in south Texas, 1963-1969.

Reactors to SLE appeared for the first time in the 1965 sample, when 21 percent of the birds were positive (Table 47). In 1965, the ratio of infected birds was greater among immature than among adult birds (Figure 41), but in 1966 and 1967 there was an increase in the proportion of adult reactors. The percentage of SLE reactors decreased sharply in 1968 and 1969.

Serological reactors to VS were not detected until 1966, when almost 35 percent of the turkeys tested were positive (Table 47). The number of reactors dropped to approximately 2 percent the following year.

BACTERIOLOGICAL

Mycoplasmas were isolated from all of the turkeys swabbed in Texas and Wisconsin. The results included 20 isolates from Texas in 1968, 80 in 1969, and 14 from Wisconsin in 1968. Morphological and biological characteristics were similar for all of these isolates.

HEMATOZOICAL

Blood films from 133 turkeys from Welder during 1964 and 1965 were examined for blood parasites. All of the 63 immature turkeys and 63 percent of the 70 adult turkeys were infected with *H. meleagridis*. All of the infections were light. Other blood parasites specifically searched for but not found were *Leucocytozoon, Trypanosoma, Plasmodium,* and microfilariae (Cook et al. 1966).

DISCUSSION

Serologic results of this investigation indicated that turkeys at the Welder Refuge had little or no previous exposure to most of the diseases studied. There were several exceptions, however, including WE, which was detected annually in low numbers, and SLE, which occurred in 1965 and subsequent years. The serological results in 1965 showed more immature than adult reactors to SLE. Since immature birds constituted more than half of the sample, these results suggested a primary exposure. The percentage of reactors in the adult sample increased in subsequent years; the probable cause was additional opportunity for exposure. The percentage of reactors dropped off substantially by 1969 and SLE infection in turkeys had evidently ended.

Epidemics of SLE have occurred periodically in Texas. During the summer of 1965, human cases were reported in Corpus Christi, 30 miles from the Welder Refuge. In the summer of 1966, a significant SLE epidemic occurred in the Corpus Christi area. The serological results of turkeys on the Welder Refuge paralleled SLE activity in human populations of the area. The infection in turkeys preceded by a year the outbreak in man and might have been used to predict the human epidemic.

The importance of WE and SLE to wild turkeys is not known, but population data on turkeys at the Refuge during this period do not reflect any substantial change in numbers that could be attributed to these maladies. This suggests that they are probably not important wild turkey mortality factors.

The relatively large number of VS reactors in wild turkeys was of interest, since avian species are not usually considered natural hosts of this disease. Neutralizing antibody, however, has been found in the sera of other wild avian species, and domestic chickens are susceptible to experimental VS.

Vesicular stomatitis is common in Texas; an epizootic occurred in Texas cattle in 1964. Correspondence with local veterinarians indicated that VS was prevalent in cattle and horses in the refuge area during the summer of 1965. Assuming that the VS serologic reactors were specific, the turkey serology appears to have paralleled VS activity.

This is the first documented report of mycoplasmas in wild turkeys. The isolates from Texas and Wisconsin appeared to be similar but unrelated to other recognized strains of avian mycoplasmas based on growth and serological characteristics (Gramowski 1969). Experimentally, the isolates infected both poults and adult domestic turkeys, but they did not cause any gross pathological changes or overt disease.

All of the wild turkeys tested from Wisconsin and Texas were infected with mycoplasmas, suggesting a wide distribution of this potential pathogen. Mycoplasmas cause a chronic respiratory infection of domestic turkeys, as well as chickens, involving the upper and lower respiratory systems, including the air sacs. Mortality is highest in young birds and can exceed 50 percent. Outbreaks among breeding flocks can severely reduce reproduction by affecting fertility and hatchability. Of greatest economic importance are the chronic effects of the disease, which cause weight losses, general unthriftiness, and increasing susceptibility to other factors.

This study illustrates (1) that disease studies can often be easily integrated into existing turkey-research programs and (2) that a great variety and number of disease agents-viral, bacterial, and protozoan-exist in *normal* wild turkey populations. For the most part, the significance of disease to wild turkeys remains unknown. Based on knowledge of diseases in domestic turkeys, however, the potential of disease, alone and in combination with other ecological factors, is such that additional information about these agents in wild turkeys is important. Infectious diseases are an ecological factor that should be seriously considered in the management of the wild turkey.

This page has been intentionally left blank to preserve the continuity of the original document.

20

ARMADILLOS TESTED AS POTENTIAL EGG PREDATORS OF WILD TURKEYS IN THE MISSISSIPPI DELTA

James Earl Kennamer and William H. Lunceford, Jr.

ABSTRACT

To explore indirectly the allegations that armadillos *(Dasypus novemcinctus)* are important predators on wild turkey *(Meleagris gallopavo)* nests, we placed 42 dummy nests, each containing three to six chicken eggs, in areas of recent armadillo activity in the Mississippi Delta. During 84 nest nights in May, 1969, armadillos walked by or rooted through 21 nests without damaging eggs. In three nests they broke the eggs, probably accidentally while rooting for insects. There was no evidence that they ate the contents of any of the eggs. Even allowing for some behavioral differences at real turkey nests, we doubt that armadillos are serious predators on wild turkey nests under conditions prevailing in this immediate area.

According to Schorger (1966:325), the blame accorded the armadillo as a predator of turkey nests is excessive. Fuller (1927:30) stated that in southwestern Texas the armadillo was positively harmful. He reported that turkeys suffered severely from egg destruction from 1906, when large numbers of armadillos invaded this area, until about 1916, when hunting armadillos for their armor was initiated. Smith (1916:188) reported that the increase in the number of turkeys in Kerr County, Texas, was in part due to the reduction of armadillos by commercial hunting.

In an examination of scats of the armadillo by Bailey (1905:56), the only animal food revealed was insects. Kalmbach (1944:48) reported, "Stomach examination disclosed nothing concerning the relationship of armadillos to wild turkeys." However, he stated (p. 48) that two observers in Texas had witnessed the destruction of nests of wild turkeys by armadillos. Kalmbach (1944:48) concluded: "The fact that armadillos can and do on occasion destroy the nests of wild turkeys should not be made the basis of far-reaching conclusions as to the amount of harm done. The true relationship between predator and prey cannot be determined on the basis of fragmentary evidence, while contrary or negative data are ignored." Kalmbach (1944:51) further reported, "The evidence from stomach examination of the armadillo as a destroyer of birds' eggs, rests on 5 instances of egg eating disclosed in 281 stomachs. One of these represented eggs taken from a dummy nest. Observations made at 27 natural nests of quail definitely incriminated the armadillo at only one (3.7 per cent). While armadillos certainly destroy some eggs of ground-nesting birds, the extent of this predation is not considered excessive." The identity of the eggs eaten in the five instances is not clear from his report, but infertile quail eggs and hen eggs were used in the dummy nests in his study.

Schorger (1966:325) further stated that destruction of turkey nests by armadillos must be rare. Taber (1945:222) found that captive armadillos ignored chicken eggs unless they were broken. "A set of five bantam eggs in a dummy nest placed in the center of the pen remained untouched by five armadillos for 21 days." Taber (1945:220) said that armadillo scats are typically spherical, are about the size of a marble, and appear to be composed of mud. Upon close examination, these balls are seen to be composed of hundreds of indigestible insect parts held together by soil incidentally ingested.

PROCEDURE

Our study area was located on Catfish Point Hunting Club, Scott, Bolivar County, Mississippi. Sizable turkey populations exist in the Northern Delta counties of Mississippi, principally between the Mississippi River and the levee (Loveless 1951:11). This narrow zone, where our study took place, supports a luxuriant, mature bottomland hardwood forest.

The first series of tests was conducted May 1, 2, and 3, 1969. A total of 10 dummy nests, of six chicken eggs each, were placed in locations most likely to be seen by armadillos. The nests were set near or in *runs*, in the openings of armadillo dens, and in places of recent armadillo rooting. The ground was spaded and smoothed around the nest so that predators could be identified by their tracks. Three nests were camouflaged, but the other seven were left exposed.

The second test was conducted May 16 and 17, 1969. Twenty-four dummy nests, containing three eggs each, were located at 12 sites near a woods road at 0.1-mile intervals. At each of the 12 sites, a Victor No. 2 trap was camouflaged in an area of recent armadillo activity, often 4 to 6 feet from the burrow. The eggs were exposed and were placed in a triangle around each trap. On the opposite side of the road at each site a dummy nest was constructed in a similar location and each of three eggs containing 1 cc of strychnine alkaloid solution was placed on bare soil. The solution contained 1 ounce of strychnine, 9 ounces of honey, and 10 ounces of water.

The third test was conducted May 17, 1969. Eight sites were located approximately 200 yards apart near a woods road. The same procedure was used as for the strychnine test described above, except that 3 cc of strychnine solution per egg was used.

In tests conducted more than one night, all broken eggs were replaced and the destroyed nests were reconstructed except at one site in Test 2 (making a total of 46 nest nights instead of 48 in this test).

RESULTS AND DISCUSSION

The results are summarized in Table 48. Armadillos were known to have gone through dummy nests 24 times, as determined by tracks, but in only 3 instances (3.5 percent of the total nest nights) were eggs broken. No eating of the egg contents was found; instead, the eggs seemed to have been crushed and the contents spilled upon the ground. No eggs were broken by armadillos in either Test 2 or Test 3, so there was no opportunity for armadillos to ingest the contents of the eggs containing strychnine. The traps did not hold the armadillos, but fragments of armor were broken off in two instances.

On fifty-two of the nest nights (62 percent), nests were neither destroyed nor molested. (In Table 48, this figure includes "Eggs not broken" by armadillos and "Nest undisturbed.") On 16 nest nights (19 percent), nests were destroyed by raccoons *(Procyon lotor)*. One raccoon was found dead from the strychnine eggs, and three were caught in traps. Birds destroyed eggs on five nest nights (6 percent). Undetermined predators, probably raccoons but possibly skunks

Table 48. Results of 42 dummy nests exposed for 84 nest nights to potential predators of turkey nests, May 1969 on Catfish Hunting Club area, Mississippi.

Event	Occurrences			Totals
	Test 1	Test 2	Test 3	
Armadillo went through or near nest				
Eggs not broken	11	8	2	21
Eggs broken	3	0	0	3
Nest destroyed by raccoon	7	8	1	16
Nests in which birds pecked eggs	3	2	0	5
Nest destroyed by unknown predator	3	5	0	8
Nest undisturbed	3	23	5	31
Total nest nights	30	46	8	84

(Mephitis mephitis) and opossums *(Didelphis marsupialis)*, accounted for destruction of nests on eight nest nights (10 percent).

Three wild turkey nests were found while Test 2 was being conducted. Two of the nests contained 10 eggs each and a third 12 eggs. All three nests appeared to have been destroyed by raccoons.

Even allowing for some behavioral differences at real turkey nests, we doubt that armadillos are serious predators on wild turkey nests under conditions prevailing in this immediate area.

This page has been intentionally left blank to preserve the continuity of the original document.

IV

TECHNIQUES OF TURKEY MANAGEMENT

R. Wayne Bailey

Although management of habitat of the wild turkey no doubt has a promising future, the outstanding restoration successes of the last 2 decades were primarily the result of progress in managing the bird itself. That progress was capped by application of the cannon net in livetrapping procedures and the development of techniques for handling and transporting turkeys. In the seven papers that follow, we will note that oral drugs offer a valuable additional technique to the capturing and handling of turkeys and that releasing and handling procedures are undergoing refinement. The next big step in oral drug techniques will probably be the discovery or synthesis of an antidote that will eliminate mortality due to overdosage.

The 1940's and 1950's witnessed such marked disillusionment with *pen-raising* or *game-farming* systems that they were abandoned in all but a few states. Increases in numbers of turkeys often occurred after abandonment of such programs. More than 10 years ago, Foote (1959), in his summation of the First National Wild Turkey Symposium, expressed the view that those papers sounded the death knell of attempts to establish pen-raised turkeys in the wild. The papers were not exactly prophetic and, as will shortly be seen, Wunz rings the knell again for what would seem to be the inevitable, final time. Nevertheless, it will be morbidly interesting to note how much longer, in the language of the old duck-hunting story, "That gol-durn bird will keep on flying with its heart shot out." Let us hope that it will not be necessary to toll the knell again at the Third National Wild Turkey Symposium.

In reporting how restoration has been accomplished in areas where it was previously considered impossible and how some races have been established in nontypical habitat, these papers pinpoint the necessity for bold imagination and innovation in management. They further reveal the multitude of unanswered questions about turkeys, particularly about the relation of behavior to habitat, and stress the importance of conducting the research necessary to acquire the information that can hasten restoration and the consequent increase in hunting opportunities.

This page has been intentionally left blank to preserve the continuity of the original document.

21

RESTORING WILD-TRAPPED TURKEYS TO NONPRIMARY RANGE IN WEST VIRGINIA*

R. Wayne Bailey

ABSTRACT

Twenty-one releases of wild-trapped turkeys *(Meleagris gallopavo silvestris),* involving 213 birds, were made on 19 areas in nonprimary range. Turkeys still exist on 18 of the areas. Differences between the primary (original) and nonprimary (restocked) ranges are discussed and attempts to evaluate the releases are described. Interviews with hunters during spring seasons were the most valuable means of determining relative success of the transplants. Some areas have been subjected to fall hunting for 11 years, and all are open to spring gobbler hunting. Most areas appear to be unable to endure fall either-sex hunting, and spring gobbler hunting only is recommended.

The wild turkey was never extirpated in its primary range in West Virginia (Figure 42). The primary range is mountainous and broad valleys are common. Elevations range from 500 to nearly 5,000 feet, averaging about 2,000 feet (Price et al. 1938). The proportion of forested land, on a county basis, varies from 39 to 87 percent, averaging 71 percent (Ferguson 1964). Nonforested lands are usually well dispersed. Public lands comprise approximately 1 million acres, and areas up to 50,000 acres are unoccupied by people. Based on the 1960 census, human densities vary from 11 to 107 per square mile, with a mean of 32 (Myers 1968). The seven counties with the largest turkey populations-based on reported kill (Bailey 1957:2; 1959a:8)-have human densities of less than 30 per square mile.

The nonprimary range was largely devoid of turkeys during the first half of the twentieth century. This region is hilly to mountainous, with elevations from 500 to 3,000 feet, averaging approximately 1,000 feet (Price et al. 1938). The topography is rugged, characterized by narrow ridges and valleys. The proportion of forested land varies from 47 to 90 percent, with a mean of 70 percent (Ferguson 1964). The interspersion of nonforested land is unfavorable to turkeys, particularly in the southern portion of the region. Public lands comprise less than 100,000 acres, and large portions of the forested areas are owned by coal and pulp companies. Human densities range from 22 to 279 per square mile, averaging 82 in 1960 (Myers 1968). Few minor watersheds are without people, and illegal hunting of all game species is generally more prevalent in the nonprimary than in the primary wild turkey range.

The writer is indebted to the following for critical review of the manuscript and for valuable suggestions: Jack Ward Thomas, U.S. Forest Service;

* This study was conducted by the West Virginia Department of Natural Resources as a contribution of the Pittman-Robertson Project W-39-R.

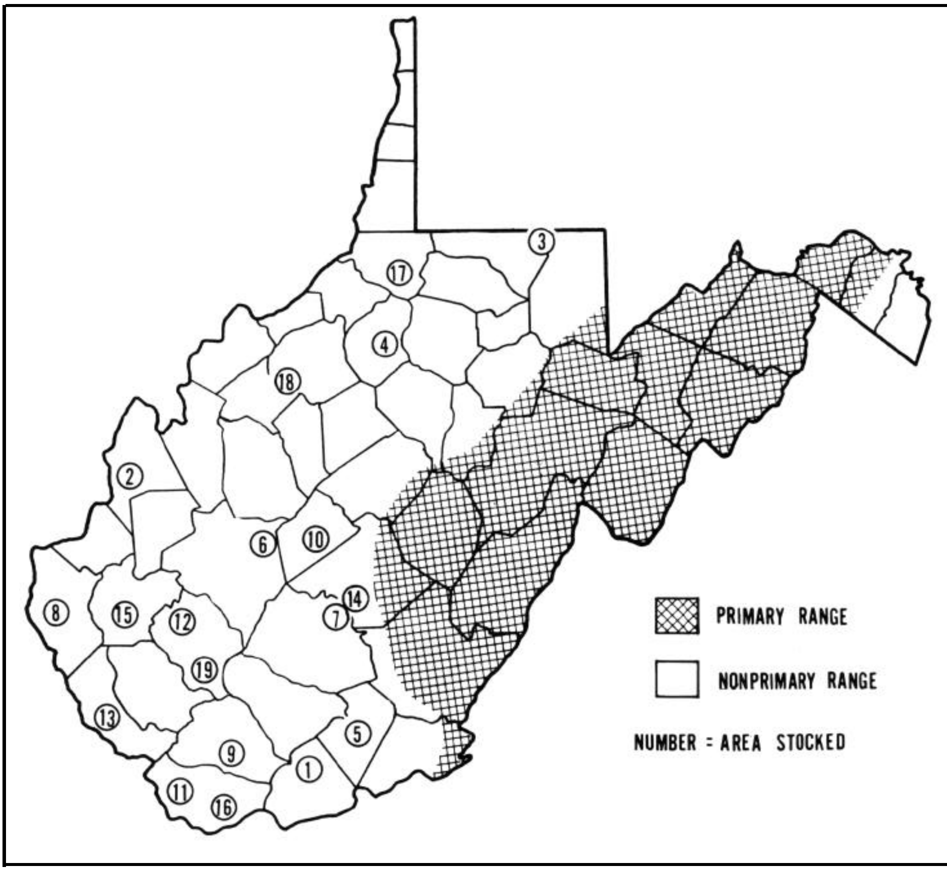


Figure 42. Ranges of turkeys in West Virginia.

John B. Lewis, Missouri Conservation Commission; and William H. Goudy, West Virginia Department of Natural Resources.

TECHNIQUES USED

Turkeys for the releases were trapped on state parks, state forests, and national forest lands in West Virginia. Cage-type wire traps, similar to those described by Baldwin (1947), were used during the period 1950-1955, sparingly thereafter. Mortar-thrown nets were used from 1955 to 1963, following the procedures outlined by Dill and Thornsberry (1950) and Bailey (1959b). Releases were made in fall (October and November) and spring (February and March); some were made in daylight, others at night. Birds per release ranged from 6 to 19 (Table 49). Turkeys were held and transported in burlap bags in the earlier releases. After 1958, the more satisfactory method of using plywood crates, measuring 36 by 24 by 8 inches, was devised. These had bottoms of hardware cloth and tops cushioned on the inside with foam rubber.

Study of the releases was based upon: (1) observations made by local persons, often employees of the Department of Natural Resources; (2) counts of broods; (3) winter track counts; (4) interviews with hunters; and (5) reported kill (hunters are required by law to report kills, and check stations are maintained to facilitate reporting).

Table 49. Releases of wild turkeys and results of hunting, 1950-1969, in West Virginia.

Area	Time of Stocking	Birds Stocked: Gobblers Ad	Gobblers Imm	Hens	Total	Hunting History[a]: Fall Seasons Number	Fall Seasons Kill	Spring Seasons Number	Spring Seasons Kill
			Multiple Releases						
1	Feb.-Mar. 1956	1	2	4	7				
	Feb.-Mar. 1957	1	1	4	6	6	67	4	9
2	Feb.-Mar. 1957	1	2	2	5				
	Feb.-Mar. 1962	1	1	7	9	1	6	4	3
Average		2	3	9	14				
			Single Releases						
3	Feb.-Mar. 1950	2	0	4	6	11	32	4	0
4	Feb.-Mar. 1961	3	0	7	10	5	25	2	2
5	Feb.-Mar. 1953	5	0	4	9	7	19	4	0
6	Feb.-Mar. 1958	2	2	5	9	1	0	2	0
7	Feb.-Mar. 1959	2	1	5	8	1	0	2	1
8	Feb.-Mar. 1960	1	5	4	10	1	0	4	0
9	Feb.-Mar. 1960	3	1	4	8	1	1	2	0
10	Feb.-Mar. 1962	1	2	5	8	1	1	2	1
11	Feb.-Mar. 1960	3	1	3[b]	7	1	0	4	0
Average		2	1	5	8				
12	Oct.-Nov. 1960	2	5	9	16	1	0	4	3
13	Oct.-Nov. 1961	4	3	8	15	1	0	2	0
14	Oct.-Nov. 1961	3	2	6	11	2	5	2	0
15	Oct.-Nov. 1963	3	6	10	19	1	0	2	0
16	Oct.-Nov. 1959	2	2	6	10	1	1	2	0
17	Oct.-Nov. 1961	2	4	7	13	6	7	4	0
18	Oct.-Nov. 1962	1	7	5	13	3	3	2	0
19	Oct.-Nov. 1963	2	3	9	14	1	0	2	0
Average		2	4	8	14				
Total		45	50	118	213		167		19

[a]See Tables 50 and 51 for years open to hunting.
[b]All immature. This release failed, but reproduction occurred and the population persisted for 7 years.

FINDINGS

The first transplant of wild-trapped turkeys to nonprimary range was made in 1950. Although that release consisted of only two gobblers and four hens, it produced quick results (Gilpin 1959). The area stocked (Area 3, Figure 42) still has turkeys, and a large adjoining area in Pennsylvania was probably occupied as a result of this release (G. A. Wunz 1967, personal communication). Spurred by this success, 20 additional releases of wild-trapped turkeys were made on 18 other areas (Figure 42 and Table 49). Eighteen of the 19 areas stocked still have turkeys. One release failed after 7 years. This failure coincided with an expansion of coal mining on the area during a period in which 150 mine openings and 8 miles of haul roads were constructed.

Fifteen counties without turkeys prior to the transplants now support turkeys and have at least one type of open season (Bailey and Rinell 1968:12). Most of the areas have been open at least once to fall either-sex hunting, while all have been open to spring gobbler hunting since 1968. A total of 186 turkeys, 167 in fall, 19 in spring, have been reported killed on the stocked areas (Table 49).

Year-round field observations yielded the greatest amount of information; these did not lend themselves to numerical treatment and are not presented herein. However, these observations indicated to our satisfaction that turkeys were *scarce*, *common*, or *plentiful* on a given area.

Brood counts were made during July on less than half the areas and usually involved only a day or two per area per year. These counts were generally made from an automobile driven along roads in suitable habitat, although some were conducted on foot. Positive results (four broods seen) were obtained in only one instance-on an area regarded as having the highest population of any restocked site.

Snow tracking was usually more rewarding than brood counts but often failed to reveal turkeys when they were known to be present somewhere in the general area. Rough topography often made foot travel exceedingly difficult. On one area (Area 13, Figure 42) in January 1968, a 15-man crew did not find a turkey track in 2 days; however, five gobblers were heard the first 2 days of the following spring season.

Interviews with hunters-when sufficient numbers were in the field to allow it-were the most effective means of determining success of the transplants; however, on some areas known to have turkeys no kills were reported in either spring or fall seasons (Tables 50 and 51). The highest kill density ever reported in the entire state-3.3 per square mile-occurred on one of the restocked areas (Area 1, Figure 42) when it was first opened.

Of four areas open 6 or more years to 2-week fall either-sex seasons, the

Table 50. Observations of turkeys reported by hunters during l-week spring seasons, 1966-1969, on restocked areas in West Virginia.

			Number of Hunters Interviewed[a]				Number of Toms Heard[a]				Number of Toms Killed				Number of Turkeys Seen[a]			
Area	Year Stocked	First Year Open	1966	1967	1968	1969	1966	1967	1968	1969	1966	1967	1968	1969	1966	1967	1968	1969
1	1956, 1957	1960	0	54	0	21	–	30	–	12	–	2	3[b]	4	–	12	–	8
2	1957, 1962	1965	0	20	9	39	–	17	5	69	–	1	0	2	–	7	1	6
3	1950	1959	51	24	3	10	6	4	0	6	0	0	0	0	6	3	0	0
4	1961	1965	0	0	22	29	–	–	38	25	–	–	1	1	–	–	11	11
5	1953	1958	0	2	0	0	–	0	–	–	–	0	–	–	–	5	–	–
8	1960	1965	0	11	3	0	–	2	0	–	–	0	0	–	–	0	0	–
12	1961	1965	77	99	62	70	45	29	29	52	1	2	0	0	35	7	5	15
13	1962	1965	0	0	1	9	–	–	3	20	–	–	0	0	–	–	0	4
15	1964	1967[c]	0	2	22	0	–	0	27	–	–	0	0	–	–	8	0	–
17	1962	1964	35	14	9	2	1	1	0	0	0	0	0	0	0	0	0	0
18	1963	1965	0	2	2	6	–	0	1	2	–	0	0	0	–	0	0	1
19[d]	1963	1968	–	–	0	0	–	–	–	–	–	–	–	–	–	–	–	–

[a]Includes repeats.
[b]Killed by hunters not interviewed.
[c]Spring season; all others first open in fall season.
[d]No hunters could be found on Area 19.

Table 51. Harvest trends on restocked areas open to 3 or more years of fall hunting, 1958-1969, in West Virginia (C = closed).

Area[a]	Year Stocked[b]	Reported Kill by Year												Total
		58	59	60	61	62	63	64	65	66	67	68	69	
1	1956, 1957	C	C	33	16	5	2	9	C	2	C	C	C	67
3	1950	C	7	4	0	2	0	1	10	7	0	1	0	32
4	1961	–	–	–	C	C	C	C	2	4	2	11	6	25
5	1953	9	3	6	1	0	0	0	C	C	C	C	C	19
17	1961	–	–	–	–	C	C	2	0	2	0	0	3	7
18	1962	–	–	–	–	–	C	C	C	C	3	0	0	3

kill decreased substantially on two and remained at a low level on two. Of two areas open 5 years or less, it remained at low levels, showing no definite trend (Table 51). The two areas that decreased substantially in kill when open to fall hunting for 6 or more years were closed to fall hunting in 1965. One of them was reopened in 1966 (Area 1), and only two kills were reported. Thereafter, both areas were closed to fall hunting. Observations and field reports indicated a quick population recovery on these areas after fall hunting was no longer allowed-particularly on Area 1, which produced seven spring gobbler kills in 1968 and 1969.

A noticeable difference among the releases was that higher kills occurred on the two areas receiving two spring releases in different years. An average of 10 turkeys was bagged per fall season and 2 per spring season in the spring multiple-release areas. One was harvested per fall season and 0.2 per spring season in the fall single-release areas. Although slightly larger numbers were released in the fall, such releases have thus far yielded smaller hunting returns than have spring releases (Table 49). The numbers involved above are small, statistically invalid, and include many variables; hence, no solid conclusions were possible.

No significant differences in success were noted between releases made in the fall or spring, nor between those made in daylight or darkness. More than likely, the differences that did exist were determined mainly by variations in habitat. The complex variables of the different habitats and our scant knowledge of habitat requirements precluded the possibility of a sound habitat-based evaluation. Human variables, universally difficult to measure, may have been the most important factor.

DISCUSSION

Turkeys were reestablished in 15 West Virginia counties that they had not occupied for decades. It was concluded that the opening of 150 coal mines eliminated turkeys on a 10,000-acre area and that a multiple release may be better than a single one. It is recommended that the nonprimary range be closed to fall hunting in order to give the turkey the maximum opportunity to become firmly established. Allowing only spring hunting seasons may permit sufficient expansion and consolidation of ranges to allow fall hunting at some future time, assuming that poaching in this area, where human population is high, is not an overriding factor.

Our findings concerning the possible hazards of fall hunting may be helpful to those states having marginal ranges and high human densities. Spring hunting is sufficiently self-restrictive to be feasible in marginal ranges and at low population levels, allowing recreational use under these conditions.

This page has been intentionally left blank to preserve the continuity of the original document.

22

RELEASES OF MERRIAM'S TURKEYS IN NONTYPICAL HABITAT*

Karl Menzel and James J. Hurt

ABSTRACT

Early releases of Merriam's turkeys *(Meleagris gallopavo merriami)* in Nebraska in *typical habitat,* areas characterized by native ponderosa pine *(Pinus ponderosa),* were highly successful. Releases of 93 Merriam's turkeys in *nontypical habitat*, areas of primarily deciduous timber, resulted in apparent establishment at 7 or 8 of 11 release sites. Approximately 90 birds have been taken from these areas by hunters, and 18 turkeys were removed by trapping.

In early 1959, wild-trapped Merriam's turkeys, obtained from the Black Hills of South Dakota and Wyoming, were released in the Pine Ridge of northwestern Nebraska. Success of the introductions was outstanding, and hunting was initiated after four breeding seasons (Suetsugu and Menzel 1963). Turkeys were trapped from the Pine Ridge to stock other areas where native ponderosa pine is present. Releases along the Niobrara River and its tributaries met with good results, but those in the Wildcat Hills and Cheyenne Escarpment were less successful, resulting in eventual establishment of less than 200 birds.

By 1963, turkeys had been released on all areas with natural stands of ponderosa pine. In at least one area, near the eastern limit of ponderosa pine along the Niobrara River, some birds apparently became dissociated with the pines and utilized areas made up almost exclusively of hardwoods. Primary tree species in this area include bur oak *(Quercus macrocarpa)*, cottonwood *(Populus deltoides)*, American elm *(Ulmus americana),* box elder *(Acer negundo),* green ash *(Fraxinus pennsylvanica),* willow *(Salix* spp.), and eastern red cedar *(Juniperus virginiana).* Partially because of this favorable indication, the transplanting program was extended to include some of the more extensive areas of primarily deciduous timber. Two of the sites selected had received prior releases of Rio Grande turkeys *(M. g. intermedia),* but these had failed to become established, at least in significant numbers.

According to MacDonald and Jantzen (1967:498-499)) "Merriam's turkey is basically associated with ponderosa pine. Its habitat is by no means limited to this vegetative type, but in nearly all of its range, including non-historic range, this tree covers a significant portion of occupied habitat." In this paper we will discuss the success of releases of Merriam's turkeys in areas of nontypical habitat characterized by primarily deciduous timber.

METHODS

Areas considered for turkey releases were evaluated by biologists, using reconnaissance forms to standardize data and to permit selection of *better* sites. Selection of sites was based primarily on extent of timber and on topography;

* Contribution of Federal Aid Projects W-15-R and W-17-D.

Table 52. Releases of wild-trapped Merriam's turkeys in nontypical habitat, 1963-1967, in Nebraska.

Release Area	Date of Release	Number Released: Adults M	Adults F	Juveniles M	Juveniles F	Brood Observations (number): Hens	Broods	Hunting Seasons (number): Spring	Fall	Number Harvested	Turkeys Present
Verdigre Creek Knox County – 1	Feb. 1963	2	1	0	6	17	143	4	3	56[a]	Yes
Bessey Division Nebr. Natl. Forest Thomas County – 2	Feb. 1963	0	4	2	3	18	89	4	2	19	Yes
Missouri breaks Cedar County – 3	Nov. 1963	0	1	3	3	6	18	1[b]	–	0	50[a]
Missouri breaks Dixon County – 4	Nov. 1963	0	0	3	4	–	–	1[b]	–	0	No
Dismal River Thomas County – 5	Mar. 1964	0	2	2	2	9	27	3	2	15	25[a]
Elkhorn River Washington County – 6	Mar. 1964	1	2	1	4	3	15	–	–	–	No
Howe Creek Knox County – 7	Feb. 1965	0	1	4	4	–	–	1[a]	–	0	30[a]
Little Blue River Thayer County – 8	Feb. 1965	0	2	4	3	–	–	2[c]	–	4[c]	Few
Turkey Creek Pawnee County – 9	Jan. 1966	0	3	2	2	–	–	–	–	–	2
South Loup River Buffalo County – 10	Jan. 1967	0	0	2	6	–	–	–	–	–	Few
Missouri breaks Knox County – 11	Jan. 1967	0	2	4	8	–	–	1[a]	–	0	No

[a]Estimate.
[b]Missouri breaks areas were included with Verdigre Area in 1969.
[c]Some Rio Grande turkeys were present in the area open to hunting; the harvest may not have been Merriam's turkeys.

rougher terrain with greater timbered acreage was preferred. In effect, rougher sites were favored over areas where bur oak and eastern red cedar were present in the breaks, and other species such as cottonwood, willow, box elder, American elm, and green ash in the draws and bottomlands. Availability of free water and interspersion of crops (small grains) in relation to the timber were also considered.

Turkeys were trapped from established populations during winter months, primarily by means of a cannon net (Taber and Cowan 1969 : 295-297). Birds were taken mainly from the Pine Ridge and Niobrara River drainage, and were probably all ancestrally related to the turkeys received from Wyoming. Individual release sites received from 6 to 14 birds, with an average sex ratio of two hens per tom (Table 52).

Between 1963 and 1970, 19 sites were stocked with a total of 166 birds (Figure 43). Three or more breeding seasons have elapsed at 11 of the 19 release sites. The remaining eight releases are too recent to permit realistic assessment.

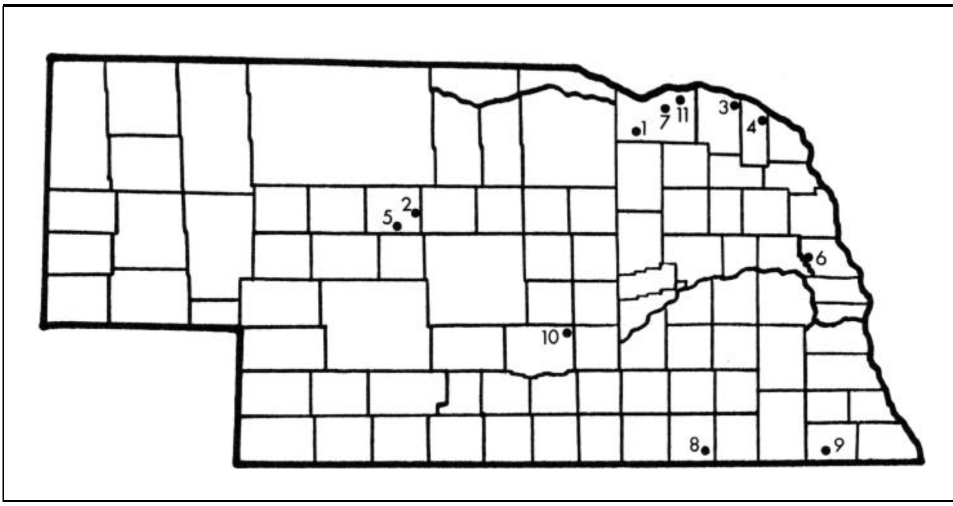


Figure 43. Release sites of wild-trapped Merriam's turkeys. (Numbers refer to release areas listed in Table 52.)

Data relative to subsequent population levels were obtained from personal observations by biologists and conservation officers and through contacts with landowners. Additional information was obtained from hunting seasons in some areas. Spring seasons were for gobblers only; fall seasons permitted the taking of birds of either sex.

RELEASE SITES AND RESULTS

MISSOURI RIVER

Fourteen toms and 23 hens were released at four sites in the Missouri River breaks in northeastern Nebraska from November 1963 to January 1967 (Areas 3, 4, 7, 11; Table 52 and Figure 43). The Missouri River breaks contain some of the most extensive hardwoods in Nebraska, with stands of timber up to 3 miles in width. Timber is generally continuous, at least in narrow strips, so it is not practical to determine potential habitat acreage. Primary tree species include bur oak, cottonwood, American elm, box elder, green ash, willow, and eastern red cedar. Common grasses include big bluestem *(Andropogon gerardi),* little bluestem *(A. scoparius),* western wheatgrass *(Agropyron smithii),* slender wheatgrass *(A. trachycaulum),* needle-and-thread (Stipa *comata),* and gramas *(Bouteloua* spp.). Terrain is fairly steep to rolling. Crops, such as corn *(Zea mays),* sorghum *(Sorghum vulgare),* oats *(Avena sativa),* and alfalfa *(Medicago sativa),* are grown in suitable areas. The remainder of the land is grazed by cattle.

Turkey broods were observed near two of the four sites, and in February 1970 about 80 birds were present in these two areas. This population level was reached within two to three breeding seasons of the initial releases. At the other two sites, turkeys apparently have not become established.

SOUTHEAST

Four widely separated releases were made along stream courses in the southeast portion of Nebraska from March 1964 to January 1967 (Areas 6, 8, 9, 10). Ten toms and 22 hens were released in these areas. Species of trees are similar to those along the Missouri River, except that bur oak is of lesser importance in the overall composition in these areas in southeastern Nebraska than it is along the Missouri River. Width of the main belt of timber averages 0.25 mile or less at all sites, with occasional extensions up to 0.5 mile wide. Primary grass species include big bluestem, little bluestem, switchgrass *(Panicum virgatum),* Indian grass *(Sorghastrum nutans),* prairie dropseed (*Sporobolus heterolepis),* buffalo grass *(Buchloë dactyloides),* and side-oats grama *(Bouteloua curtipendula).* Terrain is relatively flat to moderately rolling.

Turkey production was observed at three of the four sites but was apparently insufficient to offset losses. In February 1970, birds were present at three of the areas, but there were generally fewer than the total released.

VERDIGRE CREEK

Two toms and seven hens were released on Verdigre Creek (Area 1) in northeastern Nebraska in February 1963. Timber occurs primarily along the main creek and along two major and several minor tributaries. Vegetation is similar to that found along the Missouri River in northeastern Nebraska. Width of the wooded area varies from 200 yards to a maximum of about 0.5 mile. Terrain is moderately rough, with the creek bottom entrenched 150 to 200 feet below the general upland level.

About the same time as the release of Merriam's, private groups released others in this area that were probably crosses between eastern game-farm birds and Merriam's. These private releases obviously complicate analysis of results.

Records of brood observations from 1963 to 1968 show 17 hens with 143 young, an average of 8.4 young per hen with brood. This compares favorably with brood size in the Pine Ridge.

Turkeys probably reached their highest level, 150 to 200 birds, within three breeding seasons. Distribution included most of the *suitable* areas of the Verdigre Creek drainage, with slight extensions along the Niobrara and Missouri rivers. Hunting was initiated in the spring of 1966, and during four spring and three fall seasons at least 96 turkeys were known to have been taken from this area. Based on examination of upper tail coverts (Aldrich 1967:38) collected from 38 birds taken during three seasons, 16 (about 42 percent) were not Merriam's. Therefore, probable harvest of Merriam's turkeys was about 56.

In February 1970, 50 to 75 birds were present in this area.

DISMAL RIVER

Two toms and four hens were released on the Dismal River (Area 5) in central Nebraska in March 1964. Eastern red cedar is the most common tree species, with few cottonwood, ash, willow, box elder, and hackberry *(Celtis occidentalis)* present. Maximum width of timbered areas is about 0.5 mile, with the average about 200 yards. Common grasses include big bluestem, little bluestem, Indian grass, switchgrass, sand bluestem *(Andropogon hallii),* sand lovegrass *(Eragrostis trichodes),* and prairie sandreed *(Calamovilfa Zongifolia).* Terrain in the timbered area is moderately rough, with the river bottom 100 to 150 feet below the level of the upland. Cattle grazing is the primary land use.

Potential turkey range appears to include 8 to 10 square miles. Turkeys dispersed over about 5 miles of the stream course, occupying an area of about 1.5 square miles.

Brood observations have included 9 hens with 27 young, indicating considerably lower production than in other areas. The maximum winter count of 51 birds was obtained in 1965-66 after two breeding seasons. The number of turkeys probably increased again the third year, but has since declined to about 20 or 30.

Hunting was initiated in the spring of 1967, and 15 turkeys were taken during three spring and two fall hunting seasons. All birds were taken within about 2 miles of the release site.

Bessey Division, Nebraska National Forest

Two toms and seven hens were released in February 1963 on the Bessey Division of the Nebraska National Forest (Area 2) in the extensive grasslands of the Sandhills. About 26,000 acres on this area have been planted to trees. In 1965, fire burned approximately 20,000 acres, including 9,000 acres with timber. In the spring of 1970 the unburned area included about 17,300 acres of trees over 5 feet high, the tallest of which were about 55 feet in height. Primary species, in order of abundance, include jack pine *(Pinus banksiana),* ponderosa pine, red cedar, Austrian pine *(P. nigra),* and Scotch pine *(P. sylvestris).* Trees are planted mainly in rough sandhills, with slopes in excess of 18 degrees. Common grasses include prairie sandreed, sand dropseed *(Sporobolus cryptandrus),* sand lovegrass, rosette panic grasses *(Panicum scribnerianum* and *P. wilcoxianum),* little bluestem, and sand bluestem. Water is limited to windmill sites, with an average of one windmill per square mile. Cattle graze on the forest from May through October, but there is considerably less grazing than on adjacent private lands.

Records of brood observations show 18 hens with 89 young, an average of 4.9 young per hen with brood. This is lower than average brood size in the Pine Ridge.

The highest number of turkeys observed on the area was 54 during the winter of 1964-65, after two breeding seasons. The population may have increased after that date, but it is probably smaller than that attained within 2 years of the initial release. During four spring and two fall hunting seasons, 19 turkeys were taken. In addition, 18 birds were trapped on the area and transplanted to other sites.

DISCUSSION

Releases of Merriam's turkeys in areas of primarily hardwood timber resulted in establishment of low populations at a majority of the sites. In none of these areas was success comparable to that in areas where significant amounts of ponderosa pine were present.

Failure, or lack of significant success, in the southeastern part of the study area could be due entirely to the limited amount of timber present. Habitat here is generally less than 0.5 mile in width. Along the Niobrara River, where ponderosa pine is present and turkeys are well established, there is a similar scarcity of turkeys where timber width is less than 0.5 mile.

The Missouri River breaks in northeastern Nebraska appear to provide the necessary requirements for Merriam's turkeys, at least as far as food, cover, and water are concerned. However, ponderosa pine is absent, and only about 80 turkeys are present as the result of releases of 37 birds.

In Nebraska's main turkey range, significant seed production of ponderosa pine occurred during only 2 of the last 8 years. Pine seed was heavily utilized by turkeys during those 2 years. Domestic grains provide the bulk of at least the fall and winter food supply. Ponderosa pine is used commonly as a roost tree, but hardwoods are preferred during most of the year. The reason for the importance of ponderosa pine is open to question-possibly it is merely an indicator of suitable habitat, rather than essential in itself.

The comparatively successful releases on Verdigre Creek, an area of less extensive timber and higher human density than in the Missouri River breaks, may be due to hybridization with game-farm and/or domestic turkeys. Although releases of game-farm hybrids have failed to become established in Nebraska, the cross of these hybrids and wild strains may have produced birds more suited to this habitat than either wild turkeys or typical game-farm stock. As stated by Lindzey (1967a:248), "It even seems possible that introduction of the less nervous and less demanding game-farm birds may have permitted turkey establishment and survival under conditions which the traditional wild bird would not tolerate."

Results from releases in areas of hardwoods indicate that maximum population levels are reached within 3 years, at least in the stream-course habitat discussed herein. At most sites, the number of turkeys in February 1970 were considerably lower than the peak. This situation is not uncommon in other areas where exotics or previously extirpated species were introduced. These data suggest that, with any significant amount of reproduction, hunting should be initiated no longer than 3 years after stocking of similar habitat types. Even in areas where reproduction is not significant, it is doubtful that limited hunting for spring gobblers would affect the eventual result of the release. Future turkey hunting in Nebraska's hardwood areas is expected to include spring gobbler seasons only.

Turkeys succeeded in raising young at 8 of the 11 nontypical release sites. Some birds are still present at 8 of the sites and show promise of remaining in at least 5 areas. During hunting seasons, about 90 birds have been taken, and 18 birds were removed for transplanting to other sites. Although this return is somewhat larger than the investment of 93 birds at these sites, it is hardly a spectacular success.

23

THE HEN-BROOD RELEASE AS A RESTORATION TECHNIQUE

Gene Rush

ABSTRACT

As a result of turkey management and restocking in Arkansas in the past 10 years, several conclusions have been reached. The trapping of hens with broods for releases to restock has many advantages. The hen with young is much easier to trap than adults alone. Hens and young together can be trapped in larger numbers, and more birds can be transported with less loss than when adults without young are trapped and transported. When hens with young are released, release sites can be selected with some assurance that the turkeys will remain there, whereas adult birds tend to seek their own range. If hens with broods are planted, adult birds stocked later will unite with the hens and broods and stay in the areas of release. The releasing of young birds may result in longer survival of breeding stock than if only adults are released, since adult mortality due to old age and/or hunting pressure is a factor in some areas.

Some practical techniques and methods for trapping and establishing the eastern wild turkey *(Meleagris gallopavo silvestris)* were proven successful on three special land areas and with 73 special releases in Arkansas. The land areas are the Brandywine Island Wildlife Management Area, where turkeys have been trapped, and the Wapanocca National Wildlife Refuge and the Bayou Meto Wildlife Management Area, where special releases were made.

HEN-BROOD RESTOCKING PROGRAM

Over the past 10 years a special restocking program of trapping and releasing hens and broods was practiced in Arkansas, demonstrating advantages of stability, release, establishment, and survival. The best time to begin trapping and restocking hens with broods, as shown by the trapping program on Brandywine Island Wildlife Management Area, a wildlife refuge closed to hunting and to trespassing except by landowners, is the first part of July.

The procedure that gave the best results was to begin baiting several flocks at different locations on the same date and to make a daily check of use of bait by turkeys. When the flocks began eating the bait regularly, that is, at the same time each day for 4 or 5 days, the trapping began. After trapping began at a given bait site, the birds were caught in 1 week or less. The baiting began in mid-June, and trapping started within 10 to 15 days. Bait used from mid-June to September was a mixture of yellow corn *(Zea mays)*, milo *(Sorghum vulgare)*, and wheat *(Triticum aestivum)*. Young birds seemed to prefer the small grain, but after the first of September, only corn was used as bait. The two major factors that influenced the success of this trapping program were the availability of natural foods and the presence of man and/or his activities, such as timber cutting or the grazing of livestock.

It was found that the best weather conditions for trapping were in summer and fall. Rain and other undesirable weather conditions occurred less often in summer and fall than in the other seasons. Roads were better on the trap area as well as on release areas during these periods, because most of them were not all-weather roads. The better road conditions allowed quicker release, and the birds could be taken to more remote and better sites. Also, in summer and fall there was an abundance of insects and fruits available for both the young and the adults.

There were advantages to trapping hens with broods. The broods were much easier to trap than the adults, because the young started eating the bait with little delay. Adults remained at a distance until all looked well before cautiously coming to the bait. Trapping of broods resulted in a larger average number of birds per catch than does trapping of adults. Another advantage to trapping broods was that they usually were found grouped together. We found that when young birds were present, all birds tended to stay close together on the bait, making it possible to catch a better percentage of birds at the bait site than when young were not present.

A typical release at a site included 15 to 20 birds. A minimum of one hen with an average brood of five or six young was planted, but usually two or three hens and 10 or 12 young were released. In February and March, a release of three to five adult gobblers and three to five hens was made in the same area.

During the past 10 years, 911 turkeys were trapped with the cannon net on Brandywine Island, a method used in Arkansas for the past 15 years. There was an average of 13.6 birds in each catch. These catches were estimated to represent a minimum of 150 broods-there were 750 young, 156 adult hens, and 5 adult gobblers. The catch often included more than one adult hen with a brood of young, but there was seldom an adult gobbler with the young. Young were not trapped without at least one adult hen. There was an average of five young per hen. Since two or more adult hens were often caught with the young, it was difficult to determine the actual number of broods if 12 or 15 young of the same age were in the catch.

Releasing hens with broods has advantages over releasing adult birds only. Hens and broods stay in the immediate areas of release and do not wander to find their own ranges as some lone adult birds do. Of the 73 releases of hens with broods, all stayed in the areas of release. At later dates, a sufficient number of adult birds of both sexes were released to reproduce the first year in the immediate areas. In each of the 73 releases, the old birds joined the hens and young and stayed with them in the areas of release. Releasing hens with broods may provide for longer survival of brood stock than does releasing only adult birds, since old age and hunters take a toll of the adult birds.

Statewide trapping of adult birds has shown a 10 percent loss of birds during trapping and transporting. This 10-year trapping program of hens with young showed a loss of only nine young birds (1.2 percent) during trapping and transporting to release sites. Seven of these birds were believed to have died from heat and two from shock.

The turkeys were carried to release sites in specially designed two-compartment crates with sliding doors, constructed of 0.25-inch marine plywood, 48 by 20 by 18 inches. The outside edges and corners were protected with l-inch lightweight aluminum angle. The floor was constructed of 0.25-inch sand screen, 2 inches above the bottom of the crate, so that air could circulate through the crate from the underside. A detachable air scoop was mounted at each end on the front side for additional ventilation in hot weather. The crates were lined with 3 inches of foam rubber covered with nylon cloth and had carrying handles at each end.

Few problems were encountered during trapping and transplanting except in every case where livestock were present. The owners of the livestock were often in the woods frightening the turkeys. Even if they were not hunting them, the presence of humans in an area was enough to cause the failure of a release that would otherwise have been successful. As important as habitat is, man and his influence are even more important factors when establishing a flock of turkeys.

Release sites in 73 separate locations on public lands were carefully selected, and an average of two adult hens and 10.3 young were released at each site, with a later winter or spring release of five or six adults. The release sites were checked for turkeys each year for a 2-year period following the releases.

If release sites are preselected, food plantings and water development can be established in advance, if they are needed, with the assurance that the hens with broods will stay at the site where released. Careful selection of release sites assures the cooperation of local people in protecting the turkeys and restricting livestock competition, and may postpone timber cutting or other land uses until the flock is established.

I consider the prime requisite in selecting a release site for a successful restocking to be the cooperation of the people of the community where the release is made. We usually talked to the people in the community and often had meetings with them to assure their cooperation. For best results, a release site should not be smaller than 5,000 acres, and should be free from man and his activities, such as illegal hunting; legal hunting of the red fox *(Vulpes fulva),* gray fox *(Urocyon cinereoargenteus),* raccoon *(Procyon lotor)* ; free-ranging dogs *(Canis familiaris),* livestock-particularly hogs-and timber operations. Areas with abandoned homesites, including old fields with water holes, are highly desirable. Future plans of local landowners should be considered before releases are made. The overall food-producing species of plants available should also be considered. Restocking has been successful in every forest type in Arkansas in large, timbered land areas where man and his influences do not interfere.

We have usually opened stocked areas to hunting 3 years after restocking.

TURKEY DEMONSTRATION AREAS

BRANDYWINE ISLAND

Brandywine Island includes approximately 8,000 acres of bottomland hardwoods and is owned by the United States Gypsum Company. The Arkansas Game and Fish Commission has a long-term lease on this area for wildlife purposes. Typical habitat on this island consists of an overstory of bitter pecan *(Carya aquatica),* hackberry *(Celtis mississippiensis),* elms *(Ulmus fulva, U. americana, U. racemosa),* sycamore *(Platanus occidentalis),* sweet gum *(Liquidambar styraciflua),* cottonwood *(Populus deltoides),* box elder *(Acer negundo),* and willows *(Salix nigra* and *S. wardi).* In the understory we find common elder *(Sambucus canadensis),* common poke *(Phytolacca decandra),* rough-leaved dogwood *(Cornus drummondi),* switch cane *(Arundinaria tecta),* and the small plants of the overstory species. There are many large, open areas of sparsely timbered lands, primarily cottonwood, as well as a large acreage of willows and sandbars. The land is fertile and produces luxuriant growth.

The population of turkeys on Brandywine Island in September 1960 was estimated to be 350 to 400. This census was made by locating as many flocks as possible and counting the number of birds in each flock, where feasible. The number of other flocks was estimated by noting tracks and signs of usage, such as scratching and dusting. An aerial census was also made each year during the first week of December as well as immediately after all snows. Usually one or two aerial snow censuses were made each year, in addition to ground censuses in which each flock and the number of birds per flock were counted. A large part of the island was often flooded during the nesting period, but approximately 1,000 acres have remained unflooded during the past 10 years. The population of turkeys has remained stable over these years. On the other areas in Arkansas along the Mississippi River, the only removal of turkeys occurred during gobbler-hunting seasons. Without exception, the populations on these other areas have fluctuated, reaching peaks, and sometimes resulting in major die-offs. There has been no major die-off on Brandywine Island during the past 10 years.

Three management practices for turkeys were carried out on Brandywine Island that differed from those on other Mississippi River areas in Arkansas.

First, supplementary food was developed specifically for turkeys. Approximately 185 acres in food plots and road plantings were developed, consisting of Ky-31 fescue *(Festuca arundinacea),* dwarf Dutch white clover *(Trifolium repens),* vetch *(Vicia sativa),* chufa *(Cyperus esculentus),* and corn. One of the food plots was a 120-acre field in cultivation before the leasing of this area. As many as 100 turkeys have been seen at one time in this large food plot in late winter. The other food plots averaged 3.7 acres each. Most of the roads and road rights-of-way (approximately 40 miles) were planted to these foods. Occasionally, there was a mast crop failure of the native mast-producing species. When this occurred, supplementary food was important.

The second management practice was removal of both sexes by trapping. Approximately 150 turkeys, about equal percentages of each sex, have been removed by trapping every year for the past 10 years.

The third management practice was no predator control. There was a high population of predators on the island, including bobcats *(Lynx rufus),* coyotes *(Canis latrans),* and raccoons. Predator control was a common practice on most of the other areas. No livestock was allowed on this area.

WAPANOCCA NATIONAL WILDLIFE REFUGE

Wapanocca National Wildlife Refuge is a special release area demonstrating the success of restocking eastern wild turkeys. In 1969, the annual Wildlife Inventory from this refuge to the Regional Office, Bureau of Sport Fisheries and Wildlife, Atlanta, Georgia, stated : “Wapanocca is a wildlife oasis in a cotton and soybean desert, isolated and separated from other wildlife areas by miles of open fields, so it is known for certain that the turkeys we observe are permanent refuge residents” (Wapanocca National Wildlife Refuge 1969:32).

This area includes some 5,500 acres of land and water, with 1,200 acres consisting of lakes, sloughs, and ponds. Bottomland hardwoods grow on approximately 2,050 acres, and the remainder are open cultivated fields. The cultivated land is rented for crops, principally soybeans *(Glycine max),* milo, and green winter crops of wheat and oats *(Avena sativa)* for geese. There are no direct management practices for wild turkey on Wapanocca. Law enforcement protection is good on this area, and refuge personnel believe that no poaching occurs. No livestock is allowed on the area.

This refuge was stocked with seven adult hens and three adult gobblers on September 21, 1964. There were no other turkeys on the area at that time.

The procedure used in the Wildlife Inventory by refuge personnel was as follows (Wapanocca National Wildlife Refuge 1969:32-34):

Turkey will be censused by first locating all of the flocked adult females and young birds and simply counting the number of individuals in each flock. As the flocking habits and ranges of the adult gobblers are somewhat more erratic than the hens, it will not be possible to locate all of these birds. Rather, an assumed sex ratio of one adult hen to one adult gobbler will be used in this census, and the total adult populations will be arrived at by doubling the number of adult hens observed. . . .

Once the flocks are located and identified, a special effort will be conducted to count the number of individuals in each flock. This will be done by simultaneously placing observers in the three main fields . . . which the individual flocks are known to use, and with the aid of binoculars counting members of each flock. So as to eliminate the possibility of overlap or double counting of the same flocks by different observers, the time during which the individual flocks are in each field will be recorded. As soon as each count is completed, data from all three observers will be summarized. To insure completeness, three separate flock counts will be made, the count with the largest number of birds will be used for final determinations, and the two lower counts will [be] thrown out. The period of the counts will be set as the first week in November, December, and January. . . .

The fact that there is no way of being absolutely sure that all the individuals in a flock are counted, plus the fact that the adult gobbler population is being determined by assuming a sex ratio of l-l and doubling the number of adult hens observed to arrive at a total adult population prohibits a class A rating. The magnitude of the total population (176 birds optimum population) also assures a reliable census.

The population increased to 135 in five hatching seasons, as determined by a census made by state Game and Fish personnel in September 1969. Based on the Wildlife Inventory by refuge personnel, the 135 population count is within a reliable population range.

Bayou Meto Wildlife Management Area

In another isolated area of the state, the 36,000-acre Bayou Meto Wildlife Management Area, plus approximately 15,000 acres of private land-a total of some 50,000 acres of bottomland hardwoods-offers another example of successful stocking. A substantial increase in the number of turkeys was observed after stocking. Four adult hens with 13 young were released in July 1967. In March 1968, six adult gobblers and five adult hens were released in the same area. This area was opened to hunting for a spring gobbler season in 1970. Nineteen gobblers were killed and checked on this area. The population was estimated by the area manager to be 150 turkeys in October 1970.

CONCLUSIONS

It has been established by the present study that on a forested area managed for wild turkeys, with fertile soil and good protection from poaching, approximately 50 percent of the turkeys of both sexes can be removed every year. Supplementary food plots have been found to be important when native mast-producing species fail. No predator control is necessary to maintain good turkey flocks. A small number of wild birds released in fair habitat increases rapidly if man and/or his activities do not interfere.

There have been many examples of successful hen-brood restocking in Arkansas in the past 10 years. Only 3 releases of the 73 reported in this paper were considered to be unsuccessful.

This page has been intentionally left blank to preserve the continuity of the original document.

24

EVALUATION OF GAME-FARM AND WILD-TRAPPED TURKEYS IN PENNSYLVANIA*

Gerald A. Wunz

ABSTRACT

The relative merits of game-farm and wild-trapped stock in establishing self-sustaining turkey populations in Pennsylvania were studied over a 16-year period, from 1951 to 1967, by banding 10,590 game-farm turkeys. Releases of both types were evaluated on nine study areas ranging in size from 25 to 275 square miles. The tendency for game-farm turkeys to be less wild than wild-trapped birds was reflected by their poor survival, low reproductive success, and general inability to establish lasting populations. There was also evidence of harm to native flocks from large releases of game-farm stock through disease transmission and genetic dilution of survival abilities. None of the releases of wild-trapped stock were failures, and some showed extraordinary success in areas where repeated releases of game-farm birds had failed. Evidence that natural movements of native stock, rather than the releases of game-farm birds, were largely responsible for the northward extension of occupied range supports the findings from this study that wild-trapped stock is necessary to restore turkeys in the remaining unoccupied habitat of Pennsylvania.

The Pennsylvania Game Commission was one of the first state conservation agencies to achieve significant success in wild turkey restoration. Good law enforcement and an aroused, cooperative public were credited with saving the relict turkey population from complete extirpation in its south-central Pennsylvania retreat during the early 1900's. In the 1940's and 1950's, the phenomenal spread of eastern wild turkeys *(Meleagris gallopavo silvestris)* across the north-central part of the Commonwealth was current with, and attributed to, an ambitious stocking program of artificially propagated turkeys (Latham 1956, Roberts 1959).

From 1915 through 1969, over 150,000 game-farm turkeys were released by the Pennsylvania Game Commission. Over the years the program was gradually increased and, by 1950, approximately 6,000 turkeys were being stocked annually. About 3,000 of these birds were liberated in the fall before the hunting season. These were mostly juvenile toms conditioned in large enclosures, called hardening pens, for 2 months prior to liberation. Approximately 2,500 turkeys, predominately hens, were released in late winter as breeding stock. The remaining 500 hens were stocked after producing their annual egg quota for the game farm's incubators.

After the initial surge of the turkey population and the range expansion across northern Pennsylvania, problem areas began to ‘develop, especially in the old south-central range. Populations dwindled to small scattered flocks or completely disappeared (Roberts 1957). Repeated and massive infusions of game-

* Contribution from Pennsylvania Federal Aid Project W-46-R.

farm stock that appeared successful in northern Pennsylvania failed to remedy, and in some cases seemed to worsen, the situation. Growing suspicions that game-farm birds were not the restoration panacea prompted this evaluation (Wunz 1962).

Harvey A. Roberts served as project leader from 1951 to 1959. Robert L. Snyder and Burd S. McGinnes were also assigned for two short interim periods. The writer has served as project leader since 1959 and Arnold H. Hayden as assistant since 1961. The assistance of Harvey A. Roberts in reviewing this manuscript and of the many Pennsylvania Game Commission field employees who contributed to this study is appreciated.

METHODS

The objective of this investigation, conducted from 1951 to 1967, was to evaluate stocking of both game-farm and wild-trapped birds as methods for establishing and maintaining turkey populations in Pennsylvania. It involved banding 10,590 game-farm turkeys stocked throughout the state at various times of the year and intensive follow-up studies of releases of game-farm and wild-trapped birds on nine study areas, ranging in size from 25 to 275 square miles.

Perry County was selected as the initial study area in 1951, because it exemplified the problem areas of the old south-central turkey range where flocks had dwindled. Early phases of study involved inventory of the existing turkey population and the subsequent evaluation of attempts to restore it with game-farm stock. The mass banding of game-farm turkeys was initiated in 1958.

From 1960 to 1965, wild turkeys were trapped from thriving populations in north-central Pennsylvania and stocked in Perry County and on eight smaller study units. Four units, representing problem areas, were in the oak forests of the Ridge and Valley province in the original south-central range. The remainder, located in unoccupied range of the Allegheny Mountain Region of southwest Pennsylvania and on the Glaciated Allegheny Plateau of northwest and northeast sections, were forested with northern hardwoods or transitions of this type with oaks.

The population responses to releases of game-farm or wild-trapped turkeys on these areas were measured by interviews, spring gobbling counts, summer baiting and brood counts, and by track counts in the snow. The winter track census was the most reliable method under the conditions in Pennsylvania.

RESULTS

BAND RECOVERIES FROM GAME-FARM TURKEYS

The band returns from the various seasonal releases of game-farm turkeys showed that the greatest percentage of returns (12.8 percent) was from birds liberated just before the fall hunting season; the smallest percentage of returns (2.2 percent) was from poults stocked in midsummer (Table 53). Apparently, birds from winter releases survived longest; their long-term band returns (beyond one hunting season) outnumbered those from the spent breeders put out in May by 4:1 and those from the fall stocking by 2:1. No bands were recovered after the first hunting season from poults released in summer.

Nearly 98 percent of the bands recovered were returned before or during the first hunting season after release. Only 23 bands, representing 0.2 percent of 10,590 birds, were recovered after this period. Six of the 23 returns were from birds surviving beyond two hunting seasons. This paucity of long-term band recoveries indicated a short survival period for game-farm turkeys.

Table 53. Band returns from game-farm turkeys released, 1955-1966, in Pennsylvania.

Release Period	Number Banded	Percentage of Total Bands Returned	Percentage of Returns from Turkeys Surviving Beyond One Hunting Season
Winter	2,177[a]	4.5	0.4
Spring	1,183[b]	3.5	0.1
Summer	369[c]	2.2	0.0
Fall	6,861[d]	12.8	0.2
Total	10,590	9.7	0.2

[a]Mostly hens released as breeding stock.
[b]Hens released as *spent breeders.*
[c]Poults.
[d]Mostly juvenile males released prior to the fall hunting season.

Factors Influencing Band Returns from Game-Farm Turkeys

The major factors (in addition to survival of the birds) that influenced band-return rates were: time of stocking, physical condition of the birds, and hunter cooperation in reporting bands.

As noted above, the greatest percentage of band recoveries of game-farm turkeys were from birds released just prior to the fall hunting season. On a relative basis, twice as many banded birds were harvested when stocking was within 10 days of opening day as when a month had elapsed. There were progressively fewer band returns as the time span increased (Tables 53 and 54).

The influence of the physical quality of game-farm stock on band returns was vividly portrayed during 1963, when turkeys parasitized by gapeworms *(Syngamus trachea)* were noted in one field division's hardening pen. Subsequently, 3.7 percent of the birds from this pen died during transport to release sites and only 7.5 percent were reported harvested. Turkeys from another field division, where these internal parasites were not evident among the birds in the enclosure, showed a loss of 0.6 percent in transit and a return of 13.7 percent from hunters.

Hunter apathy can be the most important single factor influencing band returns. Based upon the greater percentage of returns generated through periodic intensive field checks of hunters and greater publicity given to some releases

Table 54. Percentage of game-farm turkeys reported shot in relation to the amount of time released prior to the opening date of the fall hunting season in Pennsylvania.

Time of Release Before Fall Hunting Season (days)	Number Released	Percent Reported Shot
0-10[a]	1,208	16.6
11-20[a]	2,529	12.7
21-30[a]	1,256	12.3
31-40[a]	1,528	8.2
41-60[a]	340	7.4
61-120[a]	369	1.9
121-300	3,360 (adults)	2.5

[a]Most were juvenile males. All turkeys released from 0 to 120 days prior to the fall hunting season were juveniles.

of banded turkeys, it was found that only about half of the gunners who bag marked birds regularly submit bands. On this basis, hunter harvest of the game-farm turkeys was double the band return indicated in Table 53. Thus, the average harvest of game-farm turkeys released in fall was nearly 25 percent of the population. On some heavily hunted and limited ranges, nearly half of the game-farm birds stocked immediately before the season were harvested.

Behavior of Released Game-Farm Turkeys

Postrelease behavior of game-farm turkeys usually followed a standard pattern. They remained near the release sites for 1 week or longer, calling frequently and appearing to be in a state of unrest; aimless wandering, sometimes to considerable distances, followed. Extreme movements of up to 40 miles were recorded. They seemed to prefer roads and cleared rights-of-way for their travels. Some game-farm birds eventually established home ranges near farmsteads or rural communities.

The conduct of one flock of 30 marked birds, part of a large midwinter release in a remote mountain study area, was typical. This flock remained near a feeding station for 2 months before starting a 20-mile trek down a rural road and across open farmland. During the flocks l-week journey, when the turkeys were observed frequently, there was a loss of five birds. By spring, this flock had decreased to 21, and there was still no noticeable increase in wildness.

Neither the ages of the game-farm birds when released nor their conditioning prior to release appeared to influence wildness significantly. Although artificially propagated turkeys seemed to exhibit their greatest degree of wildness at approximately 8 weeks of age, after 2 months in the wild some poults permitted humans to approach within 6 feet before showing alarm. Even birds conditioned in forested hardening pens failed to show significantly greater wildness than those taken directly from the game-farm rearing fields.

Reproductive Success and Poult Survival of Game-Farm Turkeys

Observations of identifiable game-farm birds in various sections of the state revealed that their reproduction was comparatively poor. Results from one study in Perry County, which involved a release of 109 color-banded game-farm turkeys in the spring of 1956, showed that their broods averaged 2.5 fewer poults than those of resident stock. Although the number of newly liberated turkeys equaled the resident breeding population, and broods of game-farm origin were more easily and frequently seen than those of wild hens, only 28 percent of the total number of broods observed were accompanied by marked game-farm hens.

Intensive follow-up studies of poult survival during a 3-year period in Perry County showed that the long-range reproductive success of game-farm turkeys was even less than the study of the 1956 release indicated. As shown in Table 55, an over-the-summer loss of eight poults per brood occurred in 1953 after an outbreak of blackhead *(Histomonas meleagridis)* that was probably introduced through the spring liberation. In 1954, when no game-farm turkeys were released during the spring, no mortality that was caused by disease was reported. Although broods were small, poult losses through the summer were normal. A high loss of six poults per brood was recorded in 1955, when liberations of game-farm birds resumed.

Mortality data for poults hatched by game-farm hens were substantiated by other evidence of poor reproductive success in Perry County. In 1952, a mass release of 261 game-farm hens was made in the spring, followed by a fall libera-

Table 55. The relationship of game-farm turkey stocking to poult loss, 1953-1955, in Perry County, Pennsylvania.

Month	Average Number of Poults per Brood		
	1953[a] (64)[b]	1954[a] (64)	1955[a] (79)
June	11.6	7.8	9.8
July	6.5	6.1	7.2
August	4.3	5.5	5.3
September	3.3	5.7	3.9

[a]Game-farm turkeys were released in 1953 and 1955, but not in 1954.
[b]Number of broods observed is shown in parentheses.

tion of 60 birds. The estimated fall population, including native stock, was 11 birds less than the 321 liberated. During the other years of the 10-year study of game-farm bird stocking in Perry County, autumn turkey populations were seldom much greater than the number released each year. Even closing hunting seasons for 2 years failed to improve densities that averaged less than one turkey per square mile in the fall.

Mortality of Game-Farm Turkeys

Necropsies showed that blackhead was responsible for excessive mortalities among adults, as well as their poults, shortly after they were released in Perry County during 1953.

There were indications that predators caused losses among the progeny of newly liberated game-farm turkeys. In view of the relatively tame behavior displayed by this stock, it was surprising that predation was not more severe. The turkey's size, which apparently discouraged most animal predators, attracted poachers. The tendency for game-farm stock to trust man made them highly susceptible to illegal hunting. The relative impacts of poaching and predation were impossible to measure.

The lack of fear of man and his activities was reflected in abnormally high accident rates, Most mortalities caused by automobiles and haymowing were traced to birds of game-farm origin. Open-field nesting, common where large numbers of game-farm turkeys were released, rarely occurred among the wild populations of north-central Pennsylvania, where comparatively few game-farm turkeys had been stocked.

Trapping and Transferring Wild Stock

During the study of reestablishment attempts with game-farm turkeys, the companion study involving wild-trapped stock was started in 1956. Large winter concentrations of native birds at artificial feeding stations in north-central Pennsylvania at first seemed to offer an easily obtained supply of turkeys for experimental restocking, but initial efforts to catch these birds were largely unsuccessful due to their wariness. They proved reluctant to enter drop-door traps even when constructed of fine nylon gill netting. Not until the more easily camouflaged cannon nets were used and summer trapping was initiated in 1960 were significant numbers captured. Subsequently, 75 to 100 turkeys were trapped and transferred annually through a winter and summer trapping program. By April 1965, a total of 434 trapped turkeys had been transferred to nine study areas.

Comparative Costs of Game-Farm and Wild-Trapped Turkeys

The average expense for each turkey trapped and transferred was $36.88 during summer and $43.41 during winter operations. Biologists' salaries, which accounted for 60 percent of the trapping expense, and the experimental nature of the program inflated costs above those of an experienced and adequately equipped trapping crew.

The minimum cost for raising each game-farm bird to 20 weeks of age for fall release was $10.00. Birds held over winter for spring release cost at least $18.00 each. These costs are based on the annual operating budget and do not include annual amortization of the game farm and of the hardening pens.

Wild turkeys were trapped and transferred for only $20.63 each during one winter of the research study, indicating that production costs of an efficient trapping program were competitive with those of the game farm. This comparison of costs does not include the relative merits of the two types of stock.

Comparative Survival of Game-Farm and Wild-Trapped Turkeys

The band-recovery rate (nearly all from hunters) from trapped and transplanted turkeys was 17.3 percent for summer releases and 9.8 percent for winter liberations. The recovery rates indicated that survival beyond the first hunting season was similar for the two groups: 2.5 percent for summer releases and 2.7 percent for winter releases.

Table 56. Band returns for wild-trapped and game-farm turkeys in Pennsylvania.

Time of Release	Type of Stock	Percentage Recovered	Percentage Recovered Beyond First Hunting Season	Ratio of Long-Term Returns, Wild-Trapped to Game-Farm Stock
Winter and	Wild-trapped	9.8	2.7	9:1
Spring	Game-farm	4.2	0.3	
Summer and	Wild-trapped	17.3	2.5	15:1
Fall	Game-farm	12.3	0.2	

Band recoveries showed that appreciably more wild birds survived than game-farm turkeys (Table 56). Even more significant were the differences in longevity (indicated by band returns beyond one hunting season) between the two types of stock. For winter liberations, the long-term band recoveries were nine times greater for wild birds than for game-farm turkeys. For summer releases, long-term returns for wild birds were 15 times greater. Evidence of mortality among transplanted wild stock, other than from hunting, was negligible.

Relative Behavior

After being transferred to new territory, game-farm birds were frequently observed, but wild birds were seldom seen, and it was suspected that they had not survived or had left the area. More thorough observations occurring after releases in the Licking Creek study area demonstrated that the sightings were misinterpreted because of deceptive behavioral differences between the two types of stock, After the liberation of game-farm birds there in 1962 and 1963, frequent reports of turkey sightings suggested that this stocking was successful. But winter track counts showed that there were few surviving birds and that they remained close to forest roads where they were easily and repeatedly seen.

Wild turkeys that were released on the same area in 1965, on the other hand, were seldom seen. Few broods were reported, and a paucity of winter sightings suggested that this establishment attempt might have failed. A follow-up winter track census, however, showed a threefold increase in the size of the population and revealed that the reason for the infrequency of observations was that the turkeys had shunned roadsides and other areas frequented by humans.

The scarcity of turkey sightings was also deceptive on another study area where only five wild-trapped hens were released. However, a track census in the snow after two breeding seasons showed that phenomenal reproduction had occurred.

Unlike game-farm birds, wild turkeys adapted readily to a new environment, with no apparent aimless wandering.

Results of the Turkey Releases on the Study Areas

Five of the nine study areas contained few or no resident turkeys before wild stock was liberated. The remaining four areas, located in the original south-central range, supported low, static populations of native turkeys and residuals from recent releases of pen-raised birds. Intensive studies of released game-farm birds had been conducted on the two largest areas, Perry County and Licking Creek, before wild-trapped turkeys were released. Prior to a population decline in the 1940's, both areas were noted for their excellent turkey hunting.

Perry County. -During the period of 1951-1960, 1,636 pen-raised turkeys were liberated and studied in Perry County's 275 square miles of turkey range. Despite an annual release rate that sometimes exceeded one game-farm turkey per square mile of range, no favorable population response was detected.

When it became obvious that stocking game-farm birds was not a remedy for this area's dwindling turkey population, releases were terminated in 1960. Wild-trapped birds were then substituted and by 1962 a total of 235 turkeys had been transferred to Perry County. Since that time, survival, reproduction, and populations have increased without additional stocking.

Broods of the wild birds stocked in Perry County showed essentially no loss of poults during the summer and averaged three more poults per brood than their game-farm counterparts (Table 57). After the introduction of wild stock, the overwintering turkey density in Perry County has more than doubled to equal the predecline density of 1940.

Table 57. Comparison of average number of game-farm poults and wild-trapped poults per brood in Perry County, Pennsylvania.

	Poults per Brood	
	Game-Farm Turkeys 1956-1960 (56)[a]	Wild-Trapped Turkeys 1961-1966 (54)
June observations	8.57	9.11
August observations	5.68	9.08
Total	6.64	9.46

[a]Number of broods observed is shown in parentheses.

Licking Creek. -Because of similarity and proximity of the two areas, the 110-square-mile Licking Creek study area served as an ideal control unit where game-farm turkey releases could be studied simultaneously with liberations of wild birds on the Perry County area. A total of 204 adult game-farm birds were released during the spring of 1962 and 1963, but the winter track censuses during and for 2 years after the last release showed no increase in the low turkey population.

The failures of the turkey populations to respond favorably to releases of game-farm birds in Licking Creek and Perry County were repeated in other sections of Pennsylvania in which large numbers of game-farm birds were stocked in areas with low densities of native birds. Elsewhere in the state where fewer game-farm turkeys were stocked in relation to the population levels of native birds, the residual populations usually recovered soon after stocking was terminated. These recoveries suggested that mass releases of pen-raised turkeys may have *genetically overwhelmed* with inferior survival traits the low native populations.

During the winter of 1965, 51 wild-trapped turkeys were stocked in Licking Creek. The turkey density had tripled by the next winter and quadrupled by the second year. Figure 44 graphically presents population trends of wild turkeys on both the Perry County and Licking Creek areas. Present (1969) estimates place the winter turkey densities of Perry County and Licking Creek at two to three turkeys per square mile.

Other study areas. -Before receiving releases varying from 6 to 38 wild-trapped birds (Table 58), the remaining seven areas, which ranged from 25 to 50 square miles in size, also had histories of failures of game-farm stock to establish turkeys. Wild stock has established populations on four of these areas, on three of which the populations were spectacularly successful. The turkeys are at least holding their own on the remaining three areas, where deficiencies

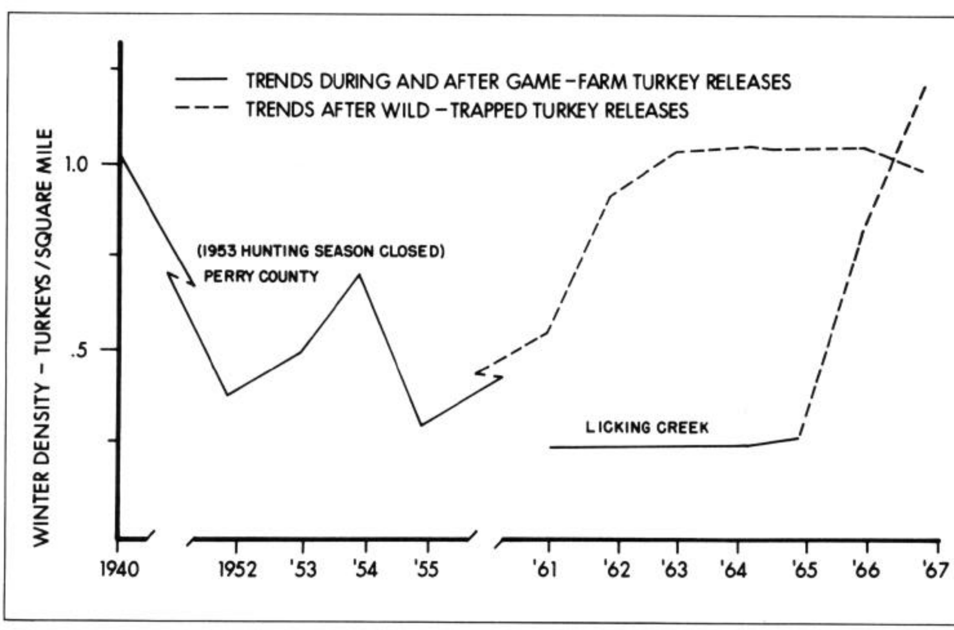


Figure 44. Population trends of turkeys on Perry County and Licking Creek study areas, based primarily on winter track censuses in Licking Creek from 1964 to 1967 and secondarily on records of the turkey project leaders and local game protectors.

Table 58. Population data for nine study areas on which wild-trapped turkeys were released in Pennsylvania.

Area and Region	Square Miles of Turkey Range on Area	Number of Turkeys Released	Time of Release	Number of Breeding Seasons from Completion of Releases to 1967	Winter Density Before Release (turkeys/sq mile)	Winter Density, 1967 (turkeys/sq mile)
Perry County (SC)	275	235	Summer and Winter	5	0.4	0.9
Oregon Valley (SC)	36	38	Summer	4	0.3	1.3
SGL[a] No. 104 (SC)	30	6	Winter	4	0.7[b]	1.3[b]
Mt. Davis (SW)	50	34	Summer	3	None known	0.4
SGL No. 51 (SW)	50	18	Winter	3	0.1[b]	0.5[b]
SGL No. 143 (NW)	30	10	Winter	3	None found in complete census[b]	(2.4 in 1966)[b] 1.5[b]
SGL No. 183 (NE)	30	31	Summer	2	None known	0.5[b]
SGL No. 70 (NE)	25	11	Summer	2	None known	0.4[b]
Licking Creek (SC)	110	51	Winter	2	0.3[b]	1.2[b]

[a]SC-south-central.
SW-southwest.
NW-northwest.
NE-northeast.
SGL- state game lands.
[b]Based on track census; other densities based on records of local game protectors and turkey-project leaders.

in the habitat or the small numbers of birds released appear responsible for the relatively poor response of the population. None of the nine study areas was closed to turkey hunting during or after the releases of wild-trapped birds.

DISCUSSION

The necessity of using wild stock for turkey restoration was clearly shown by this study and by the experiences of other states (Leopold 1944, Cantner 1955, Hardy 1959, Sickles 1959, Bailey 1963). Pennsylvania still maintains a turkey farm, but nearly all other states have abandoned artificial propagation as expensive and ineffective for restoring turkeys.

There are exceptions-Wisconsin (Smith 1965), Michigan (Wilson and Lewis 1959), and the Catskill region of New York (Mason 1964)-where large releases of game-farm stock of Pennsylvania origin have been successful in establishing turkey populations. These are not like the vigorous, rapidly growing populations of Oklahoma (Jacobs 1964), Nebraska (Suetsugu and Menzel 1963), Montana (Eng 1959), Wyoming (Wyoming Game and Fish Commission 1947), and other states that started with a small number of wild-trapped birds and now have populations numbering in the thousands. Based on Pennsylvania's experience, it is doubtful if these populations derived from game-farm birds would survive without greatly restricted hunting and a sympathetic public. The Catskill flock has not reverted to a truly wild temperament after more than 10 generations in the wild, and its population has decreased greatly even under controlled hunting (L. DeGraff and J. Whalen, personal communication, 1970).

Despite the magnitude of contrary evidence from our studies and from other states, many Pennsylvania sportsmen retain the notion that game-farm turkeys are a restoration panacea. This notion arose because pen-raised turkeys were being stocked when our turkey population and range expanded from south-central across north-central Pennsylvania into western New York State. Sportsmen have credited this expansion to game-farm birds, but the evidence suggests strongly that other factors were involved.

First, the south-to-north spread occurred along a fairly solid front. This is contrary to what would be expected to happen from the releases of game-farm birds made simultaneously in all northern counties. Had the many releases of game-farm turkeys been successful, the pattern of spread would have been from pockets of establishment throughout the range to fill in the gaps. Instead, this front advanced northward at about 5 miles per year through the contiguous forests of Pennsylvania (Figure 45). This rate of natural range expansion is continuing across western New York without any stocking (H. Bobseine, personal communication, 1968).

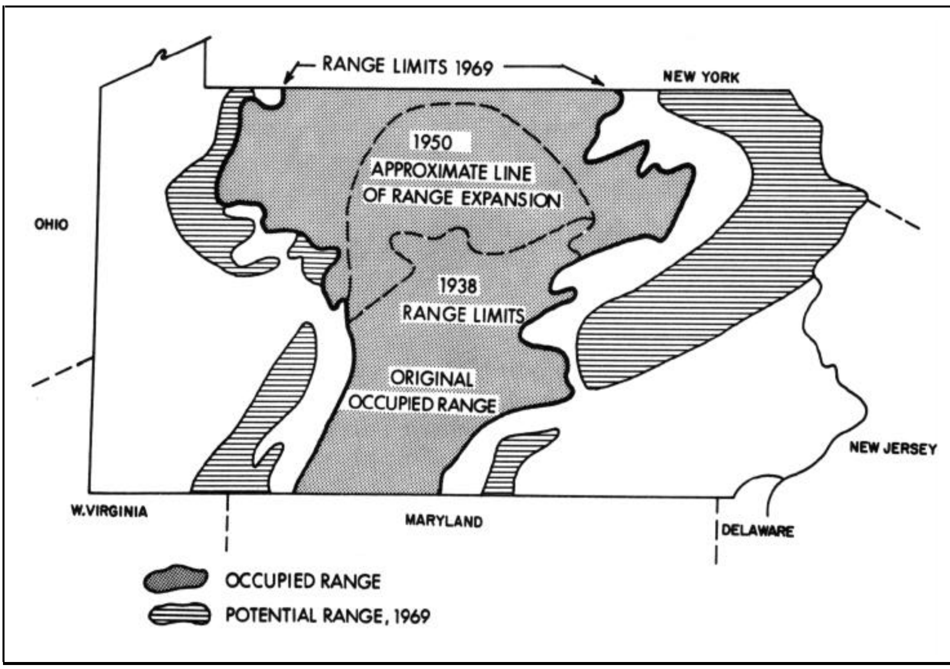


Figure 45. Expansion of turkey range in Pennsylvania.

This spread was retarded by rivers, like the West Branch of the Susquehanna and, later, the Allegheny. A long, narrow projection from the main northern range and the habitat on the northwest side of the Allegheny River have been occupied only since 1965, despite 20 years of stocking with game-farm birds (Wunz and Hayden 1967).

Second, the advance was stopped by breaks or constrictions in continuous forest, as would be expected with natural movement. Only three populations have been established in adequate range beyond these expansive agricultural and urban barriers, despite the annual liberation of thousands of game-farm turkeys. It is not known whether these three populations are truly established, or whether they are maintained because releases of game-farm turkeys continue,

Third, turkeys in our north-central range and adjacent western New York are noticeably wilder than the birds of game-farm origin in New York's

Catskill flock and in Pennsylvania's few isolated populations. Wildness in turkeys is inherent, and acquiring it is an extremely slow process (Leopold 1944).

Thus, the pattern of range expansion in northern Pennsylvania, the general failures of game-farm turkeys to establish lasting flocks where range was discontinuous, and the inherent deficiencies in wildness among populations of game-farm origin cast doubt on even the original role of pen-reared stock in north-central Pennsylvania's successful turkey restoration.

CONCLUSIONS

This study demonstrated that artificially propagated turkeys were ineffective in establishing and maintaining turkey populations in Pennsylvania. The findings were even more conclusive that wild-trapped stock was effective. There was evidence that disease may be carried by game-farm turkeys, and there were indications that pen-raised stock mixed with existing populations of wild birds was genetically polluting the resulting offspring with traits for tameness that detracted from their ability to survive.

Even if there were no evidence linking game-farm turkey stocking with detrimental effects upon existing populations, and even if their effects were only neutral, this practice has been harmful to a progressive turkey program in Pennsylvania by delaying initiation of a practical method of restoration. As a result of this study, however, the Pennsylvania Game Commission has adopted a wild-trap and transfer program to establish turkeys in new range and has relegated game-farm turkey releases to unoccupied range away from areas where wild populations exist.

This page has been intentionally left blank to preserve the continuity of the original document.

25

QUANTITATIVE EVALUATION OF WINTER ROOST SITES OF THE RIO GRANDE TURKEY IN NORTH-CENTRAL OKLAHOMA

Ben C. Crockett

ABSTRACT

This study was conducted to find and measure characteristics of winter roost sites of the Rio Grande turkey *(Meleagris gallopavo intermedia* Sennett), which has been successful in establishing itself in its new habitat. Roost sites were compared with control plots to determine differences in roost and nonroost areas. All roost sites measured were similar with respect to basal area, tree height, and tree density. Trees in roost areas tended to be taller and larger in diameter at breast height (dbh) than trees in nonroost areas. Mature American elms *(Ulmus americana)* were the most frequently used roost trees. Other species of large trees, such as sycamore *(Platanus occidentalis),* eastern cottonwood *(Populus deltoides),* bur oak *(Quercus macrocarpa),* and sugar hackberry *(Celtis laevigata),* were used to a lesser extent. Land surrounding roost sites was predominately open pasture, with smaller amounts in upland timber, cropland, and bottomland forests.

Roost sites are a basic habitat requirement for wild turkeys, and the quality of the roost site is particularly important in the winter months, when turkeys are subject to the most adverse environmental conditions. Winter roost sites must provide concealment and shelter during this critical period of the year. Bottomland forests, which provide a source of food as well as concealment and shelter, provide good winter roost sites for turkeys in north-central Oklahoma.

This study was conducted during the winter of 1967-68 to measure vegetation found within winter roost sites of Rio Grande turkeys released east of their original range. Data were analyzed statistically to determine whether significant differences existed among winter roost sites on different drainages. Information gained from this study should be useful in the selection of areas for future releases of winter-trapped turkeys in north-central Oklahoma.

Most studies, reported in the literature, of wild turkeys during the winter months, have been concerned with activities or movements and have given only qualitative descriptions of roost sites (Glover 1948, Lewis 1963, Thomas et al. 1966, and Buikstra 1968). Recent studies by Hoffman (1968) and Boeker and Scott (1969) described quantitatively both winter roost sites in Colorado and summer roost sites in Arizona of the Merriam's turkey.

Thomas et al. (1966) reported that, barring disturbance or habitat change, Rio Grande turkeys in the Trans-Pecos region of Texas will return to the same winter range and roost sites year after year. I have found that Rio Grande turkeys in north-central Oklahoma return to the same winter range, although the same roost site may not be used repeatedly.

In southern Texas several bottomland tree species serve not only as roost trees but also as sources of food. These are live oak *(Quercus virginiana),* pecan

(Caqa illinoenis), cedar elm *(Ulmus crassifolia),* American elm, and sugar hackberry (Walker 1951a and Glazener 1963). In northern and western Texas northeastern New Mexico, and western Oklahoma, eastern cottonwood becomes increasingly important as a roost tree. Roost sites in these states consist of groves of eastern cottonwood with both dead and live trees. In many localities in these states, cottonwood, which occurs entirely adjacent to streams, may be the only species available for roosting. In north-central Oklahoma many other species are available for roost trees.

I thank Dr. Robert I. Smith for his assistance during this study and the Oklahoma Cooperative Wildlife Research Unit for financial support.

STUDY AREA

The area in which Rio Grande turkeys have been released and in which the search for winter roosts was conducted includes portions of Payne, Pawnee, and Noble counties (Figure 46).

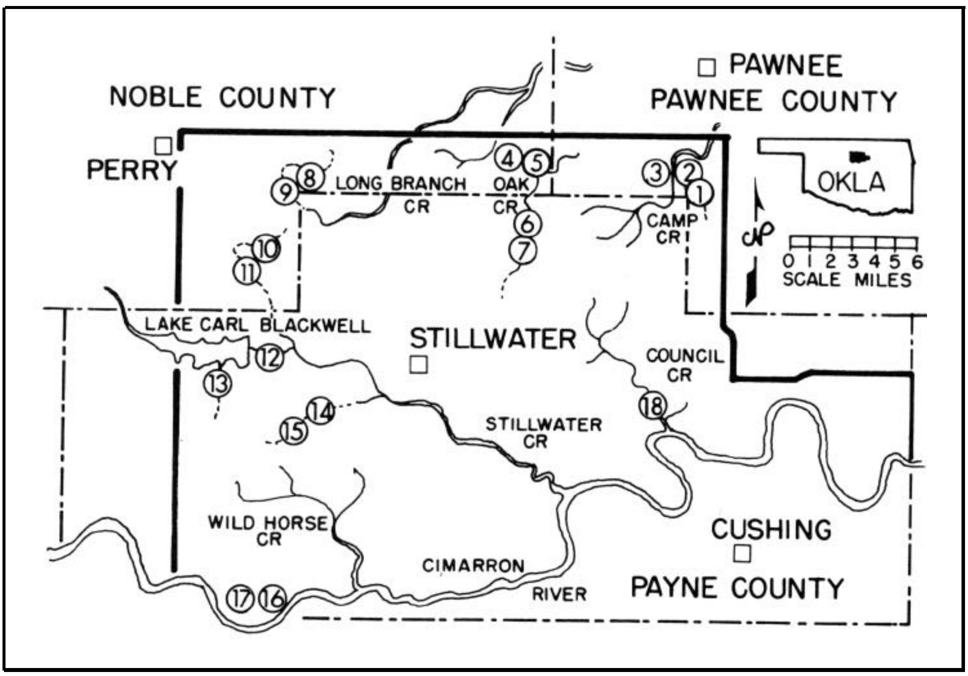


Figure 46. Map of study area in Oklahoma. Numbers refer to roost sites (see Table 59).

The area contains two physiographic regions: the Sandstone Hills region, which occupies the eastern portion, and the Redbed Plains region, which forms the largest portion of the area (Bruner 1931).

The Pennsylvania shales of the Sandstone Hills region have weathered, leaving the more resistant sandstone remaining as rough, low hills. Upland forests, predominantly scrubby post oaks *(Q. stellata)* and blackjack oaks *(Q. marilandica),* cover much of the area, but grassy areas are also abundant.

The Redbed Plains region is made up of gently rolling plains composed of weathered red Permian clays and shales. The area is well suited for the grasses that dominate the region. Upland forests are found on sandy soils.

Bottomland forests of both the Redbed Plains and Sandstone Hills regions are found in narrow bands along the streams. These forests are dominated by American elm; western and sugar hackberry, green ash *(Fraxinus pennsylvanica),* and pecan are other important trees (Rice 1965). Dominant trees of the upland forests are post oak and blackjack oak, with black oak *(Q. velutina)* occurring in the eastern part of the study area (Rice and Penfound 1959).

The principal agricultural crops of the area are wheat *(Triticum aestivum),* prairie hay, and alfalfa *(Medicago* sativa) hay. Other small grains such as barley *(Hordeum vulgare),* oats *(Avena sativa),* and sorghum *(Sorghum vulgare)* are of lesser importance. The wheat fields are used as pasture during the fall and winter months.

METHODS AND PROCEDURES

Winter roosts were located by a thorough search along streams and adjacent areas for signs of turkeys or their roosts, or by arriving before sunrise at an area where turkeys were suspected to be and listening for them before they departed from the roosts.

A total of 18 winter roosts used by 10 different flocks were located on 10 drainages. Location and sex composition were used to differentiate the flocks (Table 59). Each flock retained its identity from late November until mid-March, with gobblers and hens using the same roost site.

Table 59. Size and sex composition of turkey flocks using winter roost sites in north-central Oklahoma.

Roost Site Number[a]	Number of Birds Using Roost	Toms	Hens
1, 2, 3[b]	10	4	6
4, 5	26	10	16
6, 7	73	29	44
8, 9	11	3	8
10,11	43	19	24
12	21	8	13
13	23	5	18
14,15	19	7	12
16, 17	13	6	7
18	12	4	8

[a]See Figure 47.
[b]There were 18 roost sites on 10 drainages. For example, Roost Sites 1, 2, and 3 were located on the same drainage.

A plot that surrounded each winter roost was chosen for study. Each plot extended 145.2 feet on each side of, and perpendicular to, the stream and 147 feet along the stream on each side of the approximate center of the roost. The plots were sampled using the arms-length rectangle method. Vegetation within roost sites was measured to determine dbh (diameter at breast height), height, frequency, and density of tree species.

Sampling of each plot involved 10 arms-length rectangles 6 by 145.2 feet, spaced at intervals of 66 feet, 5 rectangles on each side of the stream. These rectangles extended at right angles from the stream and were divided into near and far halves of 0.01 acre each for comparing vegetation near the stream with that farther away.

Plots of equal size 220 yards upstream and 220 yards downstream from the roost site(s) were sampled as controls for comparing vegetation of the same drainage. On the eight drainages that had two roost sites each, the two control plots on each drainage were located only upstream and downstream from the roosts, not between them. Thus, 20 control plots (2 for each drainage) and 18 roost sites were sampled, making a total of 38 plots sampled.

Variances of vegetation within drainages and among roost sites and drainages were analyzed using the randomized complete-block design (Steel and Torrie 1960). This design was chosen in order to differentiate between vegetation near to and far from the drainages. Treatments consisted of individual roost sites or control plots.

Stems of 3.0 inches or more in dbh were considered trees; those less than 3.0 inches but greater than 1.0 inch were considered saplings; and those less than 1.0 inch were considered seedlings and understory vegetation. Importance values were calculated for each tree species appearing in the transects taken at the roost sites. These values are based on sums of three percentages: relative basal area, relative density, and relative frequency. The values rank the importance of each tree species sampled in the community (Curtis and McIntosh 1951). Tree species with importance values greater than 75 were considered to be dominant and those with importance values between 40 and 75 were considered important. Seedlings and understory vegetation and saplings were sampled for frequency and density only.

These data were analyzed statistically to ascertain whether there were significant differences in basal area, height, and density of vegetation among roost sites. Statistical tests were also made to determine whether there were significant differences in vegetation among drainage areas in which roosts were located. Data from roost sites plus data computed from measurements made in control plots were used in these tests,

Height, dbh, distance to stream, height of perches, and azimuth of perches were measured and recorded for each roost tree. Perch diameter was estimated with the aid of binoculars.

Importance values of tree species in roost sites and in control plots were calculated. The number of times a species appeared as a dominant or important tree in the control plots was then compared with the number of times it appeared as a dominant or important tree in the roost sites. The number of roost sites in which the species was used as a roost tree was also noted.

An area of 4 square miles surrounding each roost was analyzed to determine the number of acres in bottomland timber, upland timber, cropland, pasture, farmsteads, ponds, and other uses. The area of each was measured with a polar planimeter on aerial photographs obtained from the Soil Conservation Service. Visual inspection in the field determined any changes in land use that occurred after the photographs were made.

RESULTS AND DISCUSSION

ANALYSIS OF THE VEGETATION

Data computed from measurements made in the roost sites are presented in Table 60. The F values obtained for testing the hypothesis of no differences in vegetation among the 18 roost sites showed no significant differences in the categories of basal area, height, and tree density. However, there was a significant difference in sapling density and understory density. Among the 10 drainage areas there were significant differences in all categories except tree density. These differences indicate that tree density does not seem to be a factor in roost selection, but basal area and height are important.

Table 60. Values computed from measurements of trees within roost sites in north-central Oklahoma.

Roost Number	Basal Area (sq ft/acre) Near	Far	Height (mean feet) Near	Far	Tree Density (trees/acre) Near	Far	Sapling Density (saplings/acre) Near	Far	Understory Density (stems/acre) Near	Far
1	10.1	5.1	22	19	270	200	90	120	1,380	1,060
2	6.5	3.9	21	16	300	340	370	420	1,740	460
3	26.2	7.2	26	19	230	190	240	130	1,850	1,880
4	12.5	6.7	28	22	230	180	330	140	2,040	920
5	5.3	6.9	26	23	230	220	280	300	1,980	1,240
6	19.4	5.2	32	28	290	220	710	700	2,690	1,160
7	12.0	2.4	29	20	270	150	330	540	1,730	2,180
8	4.6	16.7	24	18	210	230	310	640	2,810	2,800
9	14.6	3.9	23	21	190	190	760	620	2,520	1,640
10	8.7	7.5	26	23	230	220	440	460	690	840
11	14.3	5.4	27	23	250	200	370	410	750	600
12	14.0	17.6	25	31	280	150	430	250	540	690
13	13.3	2.6	25	20	260	140	230	430	4,210	2,040
14	5.9	11.1	24	24	200	290	110	250	1,280	1,660
15	12.1	6.2	23	22	180	170	110	230	2,030	2,280
16	13.5	4.9	24	18	280	200	120	140	670	250
17	8.0	7.3	22	22	200	290	340	290	1,280	500
18	17.9	14.9	30	26	230	300	190	180	830	1,210
Mean	12.2	7.5	25	22	241	216	320	353	1,723	1,301

Tests were made for differences between vegetation in the half-plots adjacent to the streams and vegetation in the half-plots away from the streams. Expected differences existed in basal area, height, and density of trees. The values for these measurements were larger in the rectangles near the drainage, except in roost sites 8, 12, and 14. There was no significant difference in the density of saplings and understory vegetation.

American elm and bur oak appeared as a dominant species more often in roost sites than in control areas (Table 61). American elm was the most frequently used roost tree.

Measurements of Roost Trees

Among the 58 roost trees examined, 28 were American elm, 8 black willow *(Salix nigra),* 6 sycamore, and 5 cottonwood. Measurements of roost trees are listed in Table 62.

Roost trees were not always beside a stream, but were usually within the 72.6 feet included in the near rectangle. The average distance from the stream to the roost was 25.4 feet. Trees used for roosting were usually mature, with spreading horizontal branches. Average dbh was 22.6 inches, with a range of 8.1 to 45.4 inches. Mean perch height was 36 feet, with a range of 26 to 47 feet. Average estimated diameter of perches was 1.5 to 2.0 inches. Branches of this size were probably chosen because they were comfortable and supported the weight of the turkey. The average height of roost trees was 44.2 feet. Sixty-four percent of the perch limbs extended in an east or west direction, thus allowing the turkey to face into northerly and southerly winds. Most birds faced the wind when observed on their perches whether it was blowing from the north or south. The largest number of turkeys observed roosting in one tree was 24 in an American elm.

Table 61. Comparison of the number of times a species of tree was dominant or important in all roost areas and control plots to the number of times where the species was used for roosting in north-central Oklahoma.

Tree Species	Roost Sites (18) Dominant	Roost Sites (18) Important	Control Plots Dominant	Control Plots Important	Roost Sites Where Species Was Used
Box elder *(Acer negundo)*	–	3	1	1	–
False buckthorn *(Bumelia lanuginosa)*	–	2	–	2	–
Pecan *(Carya illinoensis)*	1	–	–	1	1
Mocker nut hickory *(Carya tomentosa)*	1	2	1	2	–
Hackberry *(Celtis* spp.)	4	5	7	4	2
Redbud *(Cercis canadensis)*	1	1	–	–	–
Red ash *(Fraxinus pennsylvanica)*	–	1	3	–	–
Black walnut *(Juglans nigra)*	1	2	–	1	1
Eastern red cedar *(Juniperus virginiana)*	2	–	2	–	–
Red mulberry *(Morus rubra)*	–	2	–	1	–
Sycamore *(Platanus occidentalis)*	1	–	–	2	3
Eastern cottonwood *(Populus deltoides)*	–	3	–	1	2
Bur oak *(Quercus macrocarpa)*	2	3	1	–	2
Blackjack oak *(Quercus marilandica)*	–	–	–	1	–
Chinquapin oak *(Quercus muhlenbergii)*	3	4	3	2	–
Post oak *(Quercus stellata)*	4	4	7	3	–
Black oak *(Quercus velutina)*	1	2	2	–	–
Black willow *(Salix nigra)*	1	–	–	–	1
Soapberry *(Sapindus drummondi)*	–	1	–	2	1
American elm *(Ulmus americana)*	12	5	9	8	14

Table 62. Measurements of roost trees in north-central Oklahoma.

Tree Species	Number	Percent	DBH (inches) Mean	DBH (inches) Range	Height (feet) Mean	Height (feet) Range	Distance to Stream (feet) Mean	Distance to Stream (feet) Raw
Pecan *(Carya illinoensis)*	1	2	27.0	-	49	–	32	–
Hackberry *(Celtis occidentalis)*	3	5	15.9	9.4-20.5	44	41-51	51	21-66
Black walnut *(Juglans nigra)*	1	2	19.1	-	40	–	13	–
Sycamore *(Platanus occidentalis)*	6	10	23.2	11.2-35.2	50	45-57	6	1-23
Eastern cottonwood *(Populus deltoides)*	5	9	30.6	21.3-40.0	55	52-61	2	1-3
Bur oak *(Quercus macrocarpa)*	3	5	20.6	15.6-28.3	46	44-48	22	8-34
Black willow *(Salix nigra)*	8	14	11.9	8.1-17.0	41	36-43	11	1-26
Soapberry *(Sapindus drummondi)*	3	5	11.2	8.9-15.5	42	41-43	42	24-52
American elm *(Ulmus americana)*	28	48	26.4	9.0-45.4	42	32-55	34	1-117
Total	58	100	22.6	8.1-45.4	44.2	32-61	25.4	1-117

	Perch Height (feet) Mean	Perch Height (feet) Range	Perch Diameter (inches)	Perch Azimuth (relative percentage) N-S	E-W	NE-SW	NW-SE
Carya illinoensis	41	40-42	2.0	1			
Celtis occidentalis	35	31-41	1.5		2		
Juglans nigra	32	30-34	1.5	1			
Platanus occidentalis	39	36-44	2.0		11	2	2
Populus deltoides	43	41-45	1.5		2	6	
Quercus macrocarpa	34	32-36	2.0		4		
Salix nigra	31	26-35	1.5	1	9	2	
Sapindus drummondi	39	38-41	1.0	1	1	1	2
Ulmus americana	33	27-47	1.5	8	35	4	4
Total	36	26-47	1.5	12	64	15	8

Analysis of Land Use

Land use surrounding roost sites is given in Table 63. Areas were analyzed in order to compare the percentage of each composed of bottomland timber, upland timber, cropland, and pasture. The only significant differences that existed among areas surrounding roost sites were in acres of upland timber and cropland.

Korschgen (1967) and Walker (1951a) found that because of habitat preference, agricultural crops comprise a small percentage of the wild turkey's diet. The turkey is not found in open agricultural lands with high human populations, but tolerates an interspersion of cultivated crops and forests.

The present study found that compared with land use throughout the entire study area (Table 64), turkeys were located in areas where a smaller percentage of the land was used for crops, and a greater percentage was timbered or pasture.

Table 63. Land use on a 4-square-mile area surrounding the roost sites on each of 10 drainages studied in north-central Oklahoma.

Roost Site Number(s)	Number of Acres						
	Bottomland Forest	Upland Forest	Cropland	Pasture	Ponds	Farmsteads	Other
1, 2, 3	201	188	210	1,927	8	26	0
4, 5	149	559	228	1,603	12	9	0
6, 7	118	88	169	2,029	19	19	118
8, 9	132	84	362	1,931	16	21	14
10, 11	110	336	100	1,963	12	9	30
12	156	252	248	1,280	3	27	594
13	186	435	25	1,816	4	7	87
14,15	119	557	29	1,737	21	22	75
16, 17	109	186	230	1,896	6	15	118
18	149	90	214	2,078	10	19	0
Mean[a]	143	278	182	1,826	11	17	103
Percentage	5.6	10.8	7.1	71.3	0.4	0.7	4.1

[a]Mean number of acres per drainage. There were 18 roost sites but only 10 drainages.

Table 64. Comparison of land use in the three-county study area and in the 4-square-mile area surrounding roost sites studied in north-central Oklahoma.

Land Use	Payne, Pawnee, and Noble Counties		Four-Square-Mile Area Surrounding Roost Sites	
	Acreage	Percentage	Mean Acreage	Percentage
Timber	128,227	10.9	421	16.4
Cropland	370,162	31.8	182	7.1
Pasture	648,079	55.6	1,826	71.3
Ponds	9,239	0.8	11	0.4
Farmsteads	10,438	0.9	17	0.7
Other	-	-	103	4.1

CONCLUSIONS

All roost sites measured were characterized by similar basal areas and tree heights. Areas selected as roost sites had a greater number of tall trees with a larger dbh than other areas. Tree density was uniform at roost sites but was similar on the control plots, indicating that density of trees was not a factor of importance in roost-site selection by turkeys on the study area.

Mature American elms were the most frequently used roost trees, probably because they had spreading horizontal branches suitable for roosting, and they were the most abundant large tree. Other species of large trees such as sycamore, eastern cottonwood, bur oak, and hackberry, with similar forms, were used to a lesser extent. Large trees that were used for roosts were usually located near streams; however, in some areas, large trees in the half-plots away from the streams were used as roosts. Water is not a direct factor in the selection of a roost site, but since it is an important factor in the growth of the trees used by the turkeys, the frequent occurrence of roost trees on or near streams is explained.

Land surrounding roost sites was predominately open pasture, with smaller amounts in upland timber, cropland, and bottomland forests.

26

CAPTURING TURKEYS WITH ORAL DRUGS*

Lovett E. Williams, Jr., David H. Austin, Tommie E. Peoples, and Robert W. Phillips

ABSTRACT

One technique to capture free-ranging wild turkeys *(Meleagris gallopavo)* is to treat baits with alpha-chloralose, methoxymol, or tribromoethanol. In this study approximately 1,600 turkeys were captured with alpha-chloralose with 9.0 percent mortality; 113 were captured with methoxymol with a mortality rate of 6.3 percent; and 209 were captured with tribromoethanol with a mortality rate of 2.4 percent. Turkeys could be captured approximately 15 minutes after beginning to feed on bait treated with tribromoethanol, and they usually recovered within 10 hours. Alpha-chloralose produced narcosis much more slowly, and its effects often continued more than 40 hours. The narcotic characteristics of methoxymol and tribromoethanol were similar, but methoxymol was difficult to procure in sufficient quantities and turkeys often refused to eat it because of its taste.

The success of wild turkey management in the United States has been almost directly proportional to the success game managers have achieved in capturing wild turkeys for restocking and research purposes. The extreme wildness of the turkey has offered a special challenge to its capture and handling.

Trapping methods that have been successful are the old-fashioned pole trap (Ligon 1946, Wheeler 1948), a roll-front trap (Baldwin 1947); drop nets (Glazener et al. 1964), and a walk-in drop-door wire pen (Powell 1965). Drop nets have been effective in the Southwest for capturing *M. g. intermedia,* but the cannon net (Dill and Thornsberry 1950) has been much more widely used in the eastern parts of the turkey's range (Holbrook 1958, Austin 1966). The literature contains many descriptions of variations of these basic techniques.

Conventional capture techniques have two serious drawbacks when used for the wild turkey: (1) they require physical contact for restraint, which nearly always results in at least some physical injury or defeathering of the turkeys, and (2) the presence of trapping devices at the capture site reduces trapping success because of the turkey's wariness. The purpose of this paper is to describe the use of orally administered drugs, a relatively new and versatile method of capturing turkeys, that requires no traps and calls for little forced restraint.

Although *tranquilizer* techniques promise to be more effective than mechanical traps for capturing some species of wary animals, they also have shortcomings and are not necessarily substitutes for trapping skill. Technicians who have little success capturing animals with conventional methods will probably do no better with drugs, with the likelihood of much more spectacular failure.

Orally administered narcotizing agents have been tested extensively on captive and domestic animals, but relatively few have been used to capture

*This is a contribution of Florida Federal Aid to Wildlife Restoration Program, Pittman-Robertson Project W-41-17.

wild birds or mammals. Murton (1962) and Murton et al. (1963, 1965) used alpha-chloralose on wood pigeons *(Columba palumbus)* and other pest birds. Borg (1955) compared the effects of alpha-chloralose and beta-chloralose on crows *(Corvus corone),* magpies *(Pica pica),* pigeons *(C. livia)* and pheasants *(Phasianus colchicus), geese (Anser anser, A. erythropus),* and gulls *(Larus argentatus).* Canada geese *(Branta canadensis)* and several species of ducks have been captured with alpha-chloralose and with alpha-chloralose mixed with diazepam (Crider and McDaniel 1967, 1969, and Crider et al. 1969). Murry and Dennett (1965) and Murry (1966) used diazepam to capture and handle three species of deer *(Ceruus nippon, Dama dama,* and *Odocoileus virginianus).* Austin and Peoples (1968) reported on alpha-chloralose administered orally to feral hogs *(Sus scrofa)* in southern Florida, and Martin (1968) compared methoxymol, alpha-chloralose, secobarbital sodium, and methohexital sodium (Brevane) for capturing mourning doves *(Zenaidura macroura)* at bait stations. Mosby and Cantner (1956) were the first to suggest an oral narcotic-like drug to capture turkeys and reported the capture of five turkeys with tribromoethanol.

We were unaware of the work of Mosby and Cantner (1956), before we had undertaken similar research with alpha-chloralose (Williams 1966). After a satisfactory procedure for capturing turkeys was developed with alpha-chloralose (Williams et al. 1967), we tested a new compound called methoxymol and found it to be faster acting and safer than alpha-chloralose or tribromoethanol on penned wild turkeys. When methoxymol proved to be distasteful to turkeys under field conditions (Williams 1968) and difficult to obtain in sufficient quantities for adequate testing, we turned to tribromoethanol. Tribromoethanol proved to be palatable to turkeys, could be purchased in sufficient quantities, and approached methoxymol in narcotic characteristics in turkeys. It was definitely superior to alpha-chloralose, because it was faster acting and caused a shorter period of narcosis and a lower mortality rate.

Sources of supply and technical data on alpha-chloralose and methoxymol are in our earlier reports (Williams 1966, Williams et al. 1967, Williams 1968) and in references listed in them. This report reviews the procedure we developed for capturing turkeys with drugs, and it presents data on the dosage of tribromoethanol.

We thank Lykes Brothers, Inc. and Owens-Illinois, Inc. for making their properties available for our field studies on turkeys. Many personnel of the Game and Fresh Water Fish Commission assisted with the field testing of drugs to capture turkeys. We particularly acknowledge the assistance of James E. Brogdon, Jerry H. Peoples, C. T. Lee, Larry L. Martin, John L. Daniel, and M. J. Fogarty. Dr. Aaron Addelston of Winthrop Laboratories helped us to obtain tribromoethanol when supplies were short. Brevane was generously supplied without cost by Corvel Laboratories, a division of Eli Lilly and Company. Methoxymol was supplied by three companies: McNeil Laboratories; Janssen Pharmaceutics of Beerse, Belgium; and Vetco, a company affiliated with Johnson and Johnson. E. B. Chamberlain made a number of helpful suggestions during the preparation of this paper.

METHODS

Tribromoethanol ($CBr_3 \cdot CH_2OH$) is a water-soluble, whitish crystalline powder with a taste that is pungent to humans. The powdered form is said to be unstable (Beckman 1961), especially at high temperatures in the presence of sunlight and air (Mosby and Cantner 1956). We have not measured its stability under field conditions but have experienced no serious deterioration of the compound. Tribromoethanol used in our studies was obtained at a cost of $20.00 to $30.00 per pound from Winthrop Laboratories, 90 Park Avenue, New York, New York.

Initial dosages of each drug were tested on penned wild and domestic turkeys to establish a general dosage range, then tried in the field under varied circumstances and adjusted as necessary to establish the heaviest dosage that could be used without undue mortality. Alpha-chloralose was used at ten trap areas in 1966 and through 1968, tribromoethanol was used on four study areas in 1969, and methoxymol was tried only occasionally on one study area, primarily in 1967 and 1968.

The technique described here was developed gradually by a process of trial and error, and very little quantitative data were collected that can be tabulated. Our work has only scratched the surface, and considerable improvements in this method are expected.

RESULTS AND DISCUSSION

PREBAITING

The following procedures for site selections and prebaiting are applicable to other methods of capturing wild turkeys and are familiar to turkey trappers. Their proper execution is important for the efficient application of orally administered drugs.

Bait sites should be comparatively open, with few trees or other ground-level obstructions within approximately 200 feet, so that turkeys can be easily observed. Nearby fences should be avoided, because they are especially hazardous when lightly narcotized turkeys attempt to fly for short distances, as they sometimes do if startled.

Other hazards associated with site location include: danger of drowning of narcotized turkeys if sites are near water; disturbance by people who are not associated with the trapping operation; and harassment of narcotized turkeys by predators, livestock, and unnarcotized turkeys.

Bait sites should be located close enough to roost sites to enhance the probability that the turkeys will visit the bait in early morning when they are hungry. However, the bait site should be far enough away to preclude undue disturbance of turkeys at the roost area during prebaiting operations.

Turkeys should be baited to the capture site until they are using it every day. Bait should be presented in piles of about one-quarter cup (for tribromoethanol and methoxymol) and one-half cup (for alpha-chloralose). Coarsely cracked yellow corn *(Zea mays)* is recommended for bait, if turkeys will accept it, and should be used in the final stages of prebaiting. Other baits may be satisfactory, if turkeys will accept them. Bait piles should be spaced far enough apart to minimize antagonism among unsociable turkeys. Three-foot intervals proved satisfactory for us in most situations, but greater spacing was desirable when separate social groups used the bait area together.

Observation blinds were erected that completely concealed the trapper and afforded a good view of the bait area and surroundings. We used small canvas tents or tractor umbrellas draped with double layers of insect-proof netting and furnished with chairs. Occasionally, blinds were constructed with natural vegetation. Long hours in the blind are often necessary, so the observer should be comfortable enough to operate efficiently and without distraction. The blind should be at least 100 feet from the bait.

Prebaiting should be done, at least in its final stages, by the individual who intends to catch the turkeys, or by someone using identical baiting techniques. No changes should be made in the site or in the prebaiting procedures for at least 3 days preceding the capture attempt.

Bait Preparations and Dosages

We tested several methods of mixing drugs and baits, including adhesive compounds: granulated sugar dissolved in water, methocel (Dow Chemical Co.), plain water, and others. Ethanol, acetone, and water have been used as solvents and carriers; of these, plain water worked best for preparing baits with alpha-chloralose, methoxymol, or tribromoethanol.

Preparing the bait-drug mixtures in advance to permit time for drying before use has been attempted, and mixtures have been presented at bait sites in varying degrees of dampness, So many factors have been involved that effects of differences among mixing procedures have been difficult to assess, but there has appeared no obvious advantage in mixing baits in advance of the time they are to be presented in the field. To the contrary, if mixed with water alone and permitted to dry, the surface coatings of drugs on the bait tend to flake off when handled. This results in the administration of a lighter dosage than intended.

Dry bait was measured in standard measuring cups, wetted in a pail of water, and permitted to soak for about 1 minute; then the excess water was drained off. After standing for another minute or two to permit the remaining water to soak into the bait, the powdered drug was stirred in thoroughly.

The most satisfactory dosage for alpha-chloralose has been 2.0 grams per cup of cracked corn when mixed with water and administered slightly damp. Dosages less than 1.5 grams per cup of bait were tested in field trials but too often resulted in subeffective narcosis. At dosages greater than 2.0 grams per cup, the overdosage rate exceeded 10 percent. A small loss of alpha-chloralose from the bait surface is inevitable when a sticking compound is not used; thus, when mixed with water alone, the dose actually administered is less than 2.0 grams per cup of bait. Dosage mixtures in the range 1.5 to 1.75 grams per cup of bait are indicated when an effective sticking compound is used.

Of the methoxymol dosages tested (between 1 and 12 grams per cup of

Table 65. Dosage, reaction time, and duration time for three drugs used for capturing turkeys.

Drug	Recommended Dosage per cup of Cracked Corn (grams)	Total Number Captured[a]	Mortality[a] (percent)	Usual Number Captured per Cup of Bait	Average Knockdown (minutes)[b]	Approximate Narcotic Duration (hours)[c]
Tribromoethanol	10-11	209	2.4	3-5	10-20	4-10
Methoxymol	4	113	6.3	3-5	7-10	3-4
Alpha-chloralose	2	1,600[d]	9.0[d]	1-3	30-70	20-40

[a]All dosages tested, including tests of dosages greater than those that ultimately proved to be optimum.

[b]Interval between time of beginning to feed and time birds could be captured with long-handled nets.

[c]For birds reaching Stage III (Table 66).

[d]Because alpha-chloralose has been widely used for routine trapping, these figures are estimates from incomplete data.

bait), 4 grams per cup proved to be the most satisfactory. Methoxymol is very soluble in water and is distasteful to turkeys when the bait mixture is damp.

The best dosage of tribromoethanol was found to be 10 grams per cup of cracked corn.

The numbers of turkeys captured with each drug, recommended dosage rates, and other data are presented in Table 65.

DISPENSING TREATED BAIT

Before treated bait is set out, untreated bait remaining at the bait site should be removed. Drug and bait should be mixed shortly before they are presented. For best results, tribromoethanol should be mixed with dampened' bait immediately before being placed on the ground at the bait site. Mixing and placing the bait can be done with a large metal mixing spoon.

NARCOSIS

The four stages of hypnosis through which turkeys progress under the influence of drugs are given in Table 66. Table 65 shows dosage and response-time delay to narcotic induction for turkeys feeding normally on baits treated with each of the three drugs. Onset and duration of hypnosis are different for each drug; the variations are especially distinct in the middle stages. Alpha-chloralose produces a gradual and fairly constant rate of induction from Stage I through Stage IV (Figure 47). With methoxymol, Stages I and II are very brief and sometimes pass almost unnoticed before the narcotized turkeys suddenly begin to stumble backwards as they enter Stage III. Tribromoethanol produces narcotic symptoms more like methoxymol than alpha-chloralose, but it is peculiar in the way that turkeys tend to doze in Stages II and III and still be easily aroused, possibly exhibiting excellent muscular and mental coordination for brief periods before relapsing into shallow sleep. The symptoms of Stage IV are similar for the three drugs.

Table 66. Hypnotic stages defined for turkeys.

Stage	Depth of Hypnosis	Posture	Coordination	Escape Response
I	Barely evident	Standing or walking (Figure 48A)	Good, able to fly	Unwary until approached, cannot be captured
II	Sluggish	Standing, walking, or squatting (Figure 48B)	Noticeably impaired	Difficult to capture[a]
III	Shallow anesthesia	Not standing or walking (Figure 48C)	Very poor	Can usually be picked up by hand
IV	Deep anesthesia	Prostrate (Figure 48D)	None	None

[a]Turkeys can be captured with a long-handled dip net in Stage II if approached with extreme caution.

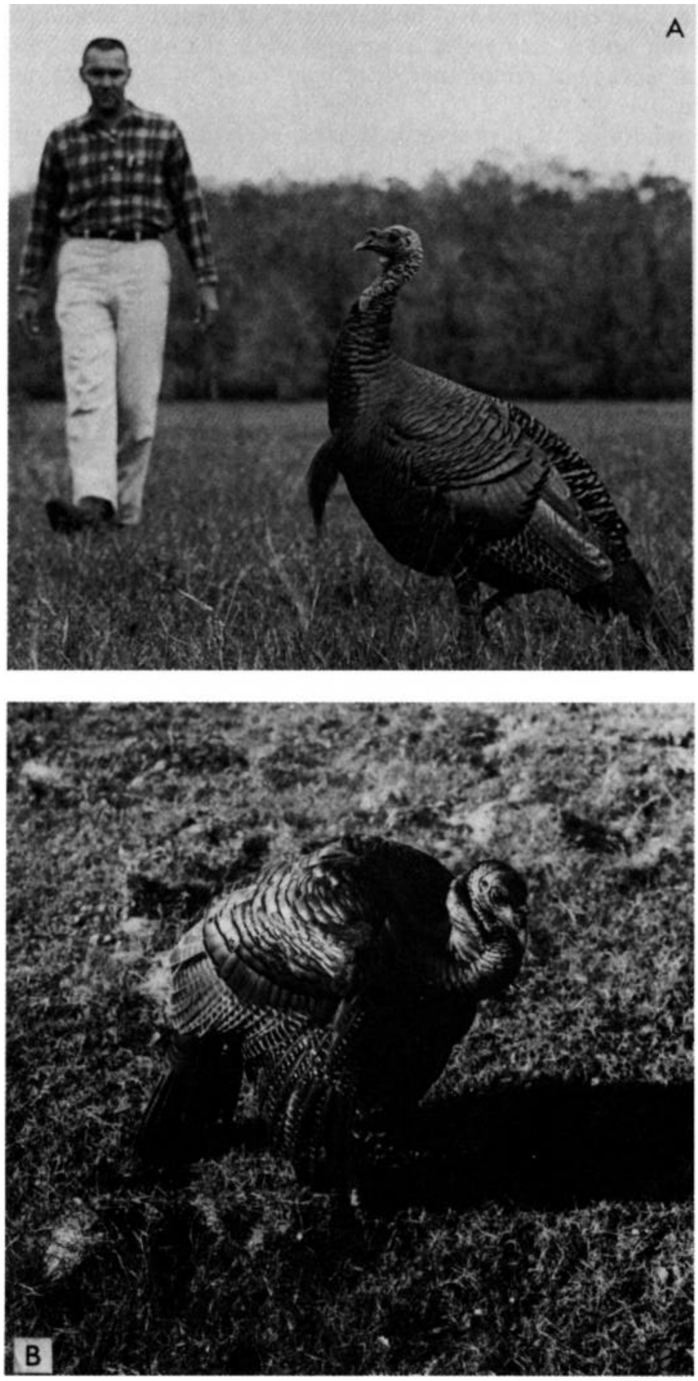
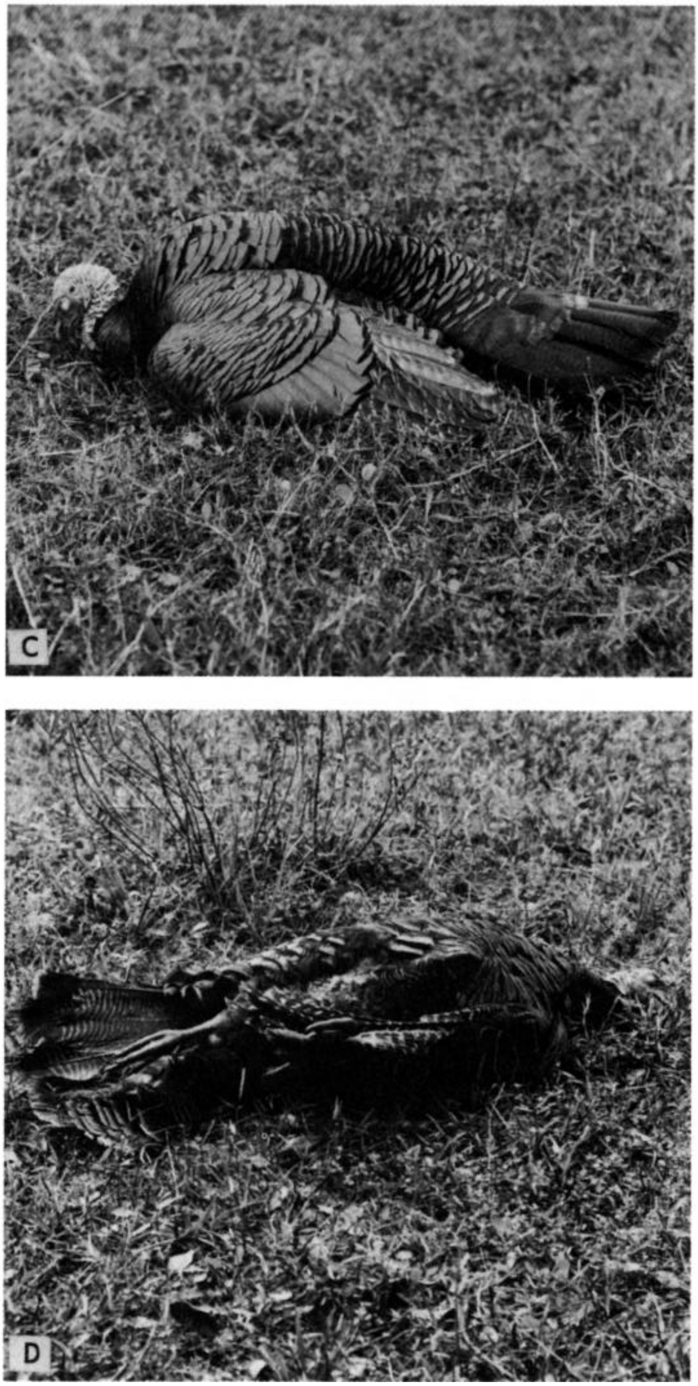


Figure 47. Wild turkeys in four stages of narcosis. A. In Stage I, turkeys are unwary of danger at a distance but cannot be approached closely enough to be captured. B. In Stage II, they show alternating degrees of alertness and usually remain standing or walk slowly in circles. They may be approached from behind and captured



with a long-handled net. C. In Stage III, birds can be easily captured with a net or by hand if approached carefully. D. In Stage IV, turkeys are in general anesthesia and may be handled and transported without physical restraint.

Capturing and Handling

As indicated in Table 65, turkeys can usually be captured with dip nets as early as Stage II, although they will normally progress into deeper narcosis if permitted to lie undisturbed. In most capture operations with oral drugs, various stages of narcosis were evident simultaneously in a single flock. It has been our practice to permit even the least narcotized individuals to reach Stage III (or to walk away in mild narcosis) before beginning to pick up those in deeper narcosis.

Paraffin-treated cardboard boxes were used to hold the turkeys during recovery. Completely immobilizing turkeys in Stages II and III with small intramuscular injections of Brevane (a brand of sodium methohexital by Corvel) has aided in transporting and handling the birds. This procedure has been especially useful for one-man operations when the turkeys were to be weighed, banded, or examined closely.

Brevane is an extremely fast-acting and short-duration barbiturate that does not seem to prolong anesthesia unduly. This was not of particular concern in our work because anesthesia lasting at least 4 hours was desirable. Intramuscular breast injections of 25 mg per 4 pounds of body weight usually adequately anesthetized turkeys. Additional injections were sometimes made in order to obtain the desired level of anesthesia.

Approximate recovery time for turkeys not injected with Brevane is shown for each drug in Table 65. Care should be taken to insure that the turkeys have fully recovered before they are released.

Effect Upon Reproduction

Laymen have expressed concern that anesthesia may inhibit the reproductive ability of turkeys, but we know of no evidence to support this view. A simple experiment with domestic turkeys (Williams et al. 1967) revealed no adverse effects caused by alpha-chloralose, and several flourishing turkey populations have been recently established in Florida and in Alabama (D. W. Speake, personal communication) with turkeys captured with alpha-chloralose, methoxymol, or tribromoethanol. Further, in a study of nesting and productivity of turkeys in Florida (Williams et al. 1969), 17 nests of hens that had been captured with alpha-chloralose were examined. The eight that were not destroyed by predators produced 76 eggs from which 70 poults hatched and departed with the hens. Three of the six unhatched eggs were pipped but were evidently deserted when the hen departed the nest with the rest of the brood. Four hens captured with tribromoethanol on a study area in southern Florida during the spring of 1969 produced normal broods. In the same study, the nests of four other hens captured with tribromoethanol contained a normal number of eggs, but they were destroyed by predators before they could hatch.

The evidence suggests that the reproductive ability of turkeys is not altered markedly by these drugs.

Response to Drugs in Relation to Age and Sex

Turkey poults weighing less than 2 pounds and probably no more than 10 weeks of age were captured with tribromoethanol dosages of 8 and 9 grams per cup of cracked corn. The young turkeys, after feeding only briefly and ingesting relatively little of the bait, were affected more quickly by the drug, and they recovered more rapidly than older turkeys. Adult hens accompanying broods usually did not progress beyond Stage II narcosis on 8 grams of tribromoethanol per cup of bait and were difficult to capture. We do not know whether this was due to the amount of bait eaten or to some physiological or other reason. D. W. Speake (personal communication) reported success in capturing summer poults with alpha-chloralose in Alabama.

Data on dosages of tribromoethanol for adult gobblers are limited. Twelve to 14 grams of the drug per cup are thought to be optimum for them. A few gobblers have been captured on as little as 8 grams per cup of whole shelled corn, but some were insufficiently narcotized at these low dosages.

More data will be necessary to define accurately the optimum dosages for different sex and age groups, but it appears safe to recommend 10 to 11 grams per cup on adult turkeys and 8 grams per cup for poults during the summer.

Whole Corn Versus Cracked Corn and Other Baits

Effective dosages for whole and cracked corn differ. Of the five turkeys that died of overdosage of tribromoethanol, three died on relatively low dosages (8 and 5 grams per cup) of whole corn. The other two overdosage mortalities were on 12 grams of tribromoethanol per cup of cracked corn administered during a light rain. In capturing approximately 180 turkeys on cracked corn with tribromoethanol, no turkey died of overdosage at less than 12 grams per cup, and only 2 of 22 were lost at that dosage.

Baits other than corn may be used with drugs but the dosage levels may need to be altered in relation to particle size or other factors.

Weather Conditions

We have not deliberately administered drugs to turkeys while rain was falling. On a few occasions, however, rain began unexpectedly at the same time that turkeys arrived at the bait site. We found that the effectiveness of the tribromoethanol-treated bait was not diminished, and narcosis usually proceeded normally. In at least three instances, the narcotic effect of alpha-chloralose was greatly affected after the treated bait had been thoroughly rinsed in a heavy downpour of rain. The fastest time recorded for tribromoethanol to produce narcosis (4 minutes for the first turkey and 7 minutes for the last in a family flock of six) occurred in a light, early-morning drizzle of rain. It appears that the quantity of drug washed off the bait by rain is probably offset by an increase in the absorption rate.

CONCLUSIONS

Tribromoethanol has proved to be superior to alpha-chloralose, because it is faster acting and produces briefer narcosis. Tribromoethanol is superior to methoxymol, because it is more palatable to turkeys under the conditions we have used in Florida.

Individuals using these drugs on turkeys are cautioned that the U.S. Department of Health, Education, and Welfare strictly regulates the use of drugs on animals that are intended for human consumption.

This page has been intentionally left blank to preserve the continuity of the original document.

27

PROBLEMS IN WILD TURKEY MANAGEMENT AND RESEARCH*

James S. Lindzey and David D. Wanless

ABSTRACT

More data on the biological characteristics and ecological requirements of the wild turkey *(Meleagris gallopavo)* are necessary for an adequate understanding of its needs. Changing patterns of land use probably constitute the greatest threat to the wild turkey, even though the bird has adapted far more readily to changed conditions than was formerly believed possible. Competition with other species of wildlife and with domestic animals needs further study, but the effects of competition with deer and cattle may at times be less harmful than is supposed. Unfavorable weather is believed to have a substantial adverse effect on poults, but only meager data are available to support this belief. Predation is usually not a serious problem for the wild turkey. Understanding turkey behavior is a prime requirement for turkey management, and it is essential that pure strains of wild birds be maintained in the wild for purposes of research and as sources of wild stock.

This paper deals with broad problems of research and management of all subspecies of the wild turkey but refers most frequently to the eastern wild turkey *(M. g.* silvestris), with which the authors are most familiar.

PROBLEMS OF RESEARCH AND MANAGEMENT

The problems of management and research stem from the changes in the environment of the wild turkey that have been brought about by social and economic pressures and are acting in both direct and indirect ways to affect the success of wild turkey populations. It is therefore necessary that we as wildlife managers understand the impact of some of these changes on the bird. More adequate data on the ecological requirements and biological characteristics of the turkey are necessary for this understanding. In precise terms, the problems relate to: (1) determination of the carrying capacity of specific types of habitats for turkeys and the relative importance of factors affecting carrying capacity; (2) factors affecting production and poult survival; (3) movements of the birds as related to cover, food, and reproduction; (4) the impact of diseases and parasites and their relation to population levels; (5) behavioral adjustments as they affect survival and recreational value of turkeys; and (6) the extent and type of harvest desirable and capable of maintaining maximum sustained harvest and of reducing intraspecific competition and possibilities of disease.

Notwithstanding our efforts to guarantee the right of all species of wildlife to survive, the success of any species depends on how well it adapts to the

* Paper No. 141-Pennsylvania Cooperative Wildlife Research Unit.

new environment that man is creating. For example, the bison's *(Bison bison)* requirements did not permit it to adapt to the white man's world, and it is now limited to small areas. More recently, the grizzly bear *(Ursus horribilis)* has had similar problems. Fortunately, the wild turkey fits in more easily as our close neighbor than either the bison or the grizzly. Nonetheless, assuring a continued place for the wild turkey will be a challenge to the game manager.

LAND USE

Wild turkeys are adapting far better to some changes in land use than we believed possible a few years ago. Wild birds are living in woodlots on farms in western New York (Donald D. Foley, personal communication) and in approximately 300 acres of the small Presque Isle State Park in Erie, Pennsylvania (G. A. Wunz, personal communication). In spite of this adaptability, the bird that we wish to preserve has limits of tolerance, and we must meet them. In areas of formerly important range where changed conditions have exceeded these limits of tolerance, turkeys barely survive, and the *put-and-take* system of stocking game-farm turkeys has largely replaced natural survival and productivity (Roberts 1959).

Changing land use-including increasing demand for recreational use of lands, retreat cabins, camping areas, highways, industrial parks, urban and rural developments-environmental pollution, hunting pressure, predation, disease, and accidental losses are all important in affecting survival of the wild turkey. The relative importance of these factors varies widely, depending on the turkey range in question, and the subtle effects of factors like pollution can only be inferred from studies of other species. Changes in land use that increase direct human interference with traditionally wilderness birds such as the wild turkey perhaps pose the greatest immediate threat.

Populations of turkeys generally are self-sustaining where land is used least-for example, rugged forest terrain supporting low human populations. However, the extent of use of these forested areas is changing in many localities. Agricultural lands are being carved out of bottomland-hardwood areas that turkeys inhabit in the South (Stoddard 1963). Elsewhere, especially in the East, farmland is being abandoned and is reverting to forest land, providing new turkey habitat (Shaffer and Gwynn 1967).

The burgeoning recreational industry, which involves wild lands formerly subject to only light use by the public, has created a new set of problems. However, the increasing use of the out-of-doors by the general public has stimulated an increasing public willingness to support programs that protect the environment. This new attitude will operate to the advantage of wild turkey management if biologists can maintain public sympathy toward the goals of management and can develop an enlightened understanding by the public concerning the requirements of the birds. At the same time, the biologist must find ways of coping with increasing human disturbance of the birds, especially during periods of poult production in spring and summer and during periods of snowmobiling in winter.

The need for detailed biological research is intensified by competition for use of the land. The productive capabilities of the turkey under various conditions of land use must be determined. When a decision is made to give wild turkey management a high priority in an area, we should be in a position to institute highly specialized management procedures that will provide maximum production of turkeys and will dictate practices to sustain this production. We have a long way to go before understanding this level of management. However, opportunities to study practices of forest-wildlife management of benefit to wild turkeys are being expanded, but more quantitative data are needed. We do not yet know how, where, or indeed, if, we can integrate even-age timber management with good wild turkey management (Shaffer and Gwynn 1967).

COMPETITION WITH OTHER SPECIES

Competition between turkeys and other species may need further study because of the possible effects of competition on an area's carrying capacity for wild turkeys. White-tailed deer *(Odocoileus virginianus)* and turkeys both commonly use acorns and other fruits, but it has not been demonstrated that this competition has resulted in fewer turkeys or fewer deer. Even in overbrowsed deer ranges in Pennsylvania, little short-term competition seems to be present. In fact, the authors have observed that deer have often aided turkeys during deep snows by digging down to the ground, making food more available to the birds. The senior author observed that domestic livestock, through regular grazing, also helped by maintaining clearings of value to the turkeys in areas of closing forest stands. Where livestock and turkey ranges overlap, however, additional data are needed, and management techniques should be developed to integrate livestock use and wild turkey needs.

WEATHER

Unexplained fluctuations of turkey populations where habitat conditions are relatively stable continue to confound the research and management workers. We have assumed that damp, cold weather in the northeastern range during the period when poults were young or just hatching was a limiting factor (Markley 1967). This may be true, but apparently other factors sometimes assume greater significance than weather, because often we have been unable to correlate production or survival of poults with available weather data in central Pennsylvania. Perhaps our data are insufficiently accurate or complete to identify limiting factors in many cases. It is possible that weather conditions, except in extremes-as when nests are flooded or when low precipitation reduces hatching, as in Texas (Markley 1967)-are not as important as we have assumed. The great difficulty in gathering reliable data on the wild turkey and its brood at the time when these adverse conditions prevail is the reason we do not have more of the answers to the problem of poult survival. Difficulties recognized by Schultz and McDowell (1957), analyzing statewide brood counts of the eastern turkey in Virginia, and by MacDonald (1964), analyzing brood counts of Merriam's turkey *(M. g. merriami)* in specific study areas in New Mexico, indicate that our techniques for studying broods must be improved.

PREDATION

We will have pressures from some quarters to control predators, but the opportunity exists to demonstrate again that a normal population of turkeys will survive in better health with a normal population of predators than it will in the absence of predators. If predators must be controlled, as some workers (Markley 1967) have suggested, the reasons this control is necessary must be defined so that it will not be misunderstood.

BEHAVIOR

It is enigmatic that an animal so truly adapted to the wild as the turkey should be so vulnerable to the debilitating effects of the easy barnyard life and winter feeding. Our greatest challenge as wildlife managers may be to maintain a wild bird and a habitat for it at the same time. Assume for the moment that we classify all the turkeys in the country, domestic and wild, by their ability to reproduce and survive under primitive conditions. Starting with the least able, this classification would, on the one extreme, include 75-pound domestic meat breeds and, at the other extreme, birds so wild that the sight of kernels of corn in the woods would arouse suspicion. Between these extremes we would list game-farm turkeys and various strains of wild turkeys that, because of conditioning and dilution with domestic stock, have the ability to live among various forms of human interference and diverse habitat conditions without serious effects on reproduction or survival. It is probable that many ranges will maintain conditioned turkeys with *adjusted* requirements and that relatively few ranges in the future will be suitable for the *primitive wild turkey*. However, we cannot afford, and should not permit, only *adapted* stock to survive, because, if for no other reason, we need a source of original stock from which infusions of wild blood may be made if conditioned birds become too adapted to modified habitats and lose their sporting and recreational values.

CONCLUSIONS

The conclusion that must be drawn is that the demands of our society for goods, services, and recreation are creating, and will continue to create, pressure on our wildlife populations. These pressures may be particularly important in affecting the wild turkey because of the value of relatively undisturbed habitat for the welfare and productivity of the wildest strains of our wild turkeys. The increasing pressures on this important wildlife resource require that biologists obtain more exact information about the turkey, its biology, habitat requirements, and behavior under many diverse habitat situations if it is to continue to rank as *king* of our native game birds. The use of modern procedures of telemetry, refined techniques of analyzing habitat and of energy-cycling studies, a greater understanding of the importance of behavior of turkeys in management, and the availability of the computer to help synthesize data portend significant progress in developing guidelines for management. The progress now being made in research, as well as the adaptability being demonstrated by the wild turkey, provides a basis for optimism about the future of the turkey as a game bird in the United States.

V

HABITAT MANAGEMENT

John B. Lewis

The destruction of original forest cover, plus fire and unrestricted hunting, nearly eliminated the wild turkey throughout much of its ancestral range.

Today's resurgence of the wild turkey across the country is a matter of record and a tribute to modern game management. The revival of the wild turkey could not have been accomplished, however, without improved habitat conditions. Recent changes in programs of timber management have been largely responsible for the betterment of the turkey's habitat.

The seasonal food, cover, and water requirements of wild turkeys demand diversity of habitat, Most managers of wild turkeys would agree that good turkey habitat does not just happen-it is the result of careful planning.

The five papers in this section present concepts and guidelines for maintaining and improving existing wild turkey habitat on both private and public lands. These authors point out the need for a multiple-use system of inventory on public lands that will permit the identification of problem areas and opportunities to correct them. They also allude to the fact that without an economic incentive for habitat management on private land, turkeys may disappear from these areas in the future.

This page has been intentionally left blank to preserve the continuity of the original document.

28

HABITAT MANAGEMENT FOR TURKEYS IN THE OAK-HICKORY FORESTS OF MISSOURI

George P. Dellinger

ABSTRACT

Recommendations for managing the habitat of the eastern wild turkey *(Meleagris gallopavo silvestris)* and other game species in the forests of the Missouri Ozarks are presented in this report. Personnel of the Missouri Department of Conservation and of the Mark Twain and Clark national forests have based these suggestions upon available research data and field observations. Some problems of coordinating wildlife-habitat management with the management of other resources, especially timber, are reviewed in detail.

There are about 15 million acres of forests in Missouri (Ring et al. 1949). They are mainly upland oak-hickory *(Quercus-Carya)* types, with about 1 million acres of shortleaf pine *(Pinus echinata)* and oak-pine types in the southern Ozarks and a few thousand acres of bottomland hardwoods along the major drainages. Forests cover approximately 2 million acres in northern Missouri, comprising 8 to 26 percent of the acreage in the individual counties. In southern Missouri, forests cover 70 percent of the Ozark area and 30 to 50 percent of the Ozark border areas.

Most of Missouri's forests were severely cut in the late 1800's and earlier 1900's. A period of open-range grazing, frequent wildfires, and persistent high-grade logging followed. A few areas were clear-cut for charcoal, resulting in extensive even-age stands in these areas today.

Forests conditions have improved greatly during the past 22 years. An inventory of forests throughout the state in 1959 revealed that the acreage of forests in sawtimber stands doubled in most regions during the 12 years prior to 1959 (Gansner 1965). It is believed that this trend has continued since 1959.

Wild turkeys once were common throughout forested regions of Missouri, but they were extirpated from much of their range by the early 1900's. Only small, scattered populations survived in a few localities in the Ozarks (Lewis 1967).

Turkey populations have made remarkable gains during the past 15 years. Restocking of wild birds throughout the state has been generally successful. It is believed that reduction of brushlands, increase in sawtimber stands, improved control of wildfire, elimination of open range, and improved public interest are in large part responsible for the recovery of the native turkey population and the success of our restocking efforts. Improvement has been most pronounced on the public lands, where fire control and timber management were effected earliest.

This recent increase in the number of turkeys occurred during the practice of all-age silviculture. The greatest threat to continued improvement of turkey habitat has been adoption of even-age forest management (Roach and Gingrich

1968). Properly applied, even-age management (EAM) has a greater potential for improving habitat than all-age silviculture. However, if the transition from all-age to even-age silviculture is made without regard to its effect upon other resources, it can devastate habitat. Benefits and opportunities of properly coordinated EAM were aptly described by Zeedyk (1969).

Our program of restocking turkeys (Dickneite 1973) involves areas throughout Missouri, but our habitat-management program has been limited to public lands owned by the Department of Conservation and the U.S. Forest Service. These lands include approximately 200,000 acres of state forests and 1.3 million acres of national forests, mainly in the Ozarks of southern Missouri.

The Department of Conservation and the Forest Service embarked upon a cooperative program of forest-game habitat management in 1960. Efforts during the first 4 years were devoted to building water holes throughout all state and national forest districts and to developing a method of inventory to reveal deficiencies in the habitat and opportunities for management. During the next 5 years, construction of ponds was approximately 90 percent completed and coordination and the method of inventory were refined.

These public lands contain much less agricultural land and much more forest land than the average for the counties in which they are located. All lands within the administrative boundaries of the fire-protection districts are 80 to 90 percent forested. The lands in public ownership are 95 to 99 percent forested. However, 1 to 30 percent of these stands are noncommercial forest types, such as glades.

The ponds and fields on the private farmland interspersed among the public lands in each forest district contribute greatly to overall wildlife-habitat values. The principles derived in our cooperative management program on public land are also applicable to private land management and are encouraged by the Department.

RECOMMENDATIONS FOR HABITAT MANAGEMENT

Optimum turkey habitat has been described by Lewis (1967), Bailey and Rinell (1968), and others. We know that *optimum* habitat rarely occurs and that turkeys maintain good populations in areas having varied quantities and qualities of water, clearings, and forests. We can do no more than work with the conditions present in each area to provide the best possible combination of these components.

Needs of other forest game must be considered in recommendations for managing habitat for turkeys on public lands. Deer *(Odocoileus virginianus)*, fox *(Sciurus niger)*, and gray squirrels *(S. carolinensis)* could potentially provide substantially more hunting than turkeys. As a management goal, an objective was set of not fewer than 8 turkeys, 31 deer, and 300 squirrels per 1,000 acres of public forest. These populations do not represent the potential carrying capacity; they represent a compromise between populations too low to interest hunters and the maximum populations possible. Recommendations for management of forest-game habitat in Missouri are intended to provide an acceptable habitat for all forest wildlife until habitat needs of other wildlife species are better understood.

The following recommendations for habitat management were developed in Missouri by personnel of the Missouri Department of Conservation and of the Mark Twain and Clark national forests. They are value judgments by the most knowledgeable people available and are based upon available research data and personal observations. These objectives are considered desirable but not totally attainable in all areas. Evans (1968) has presented and explained them in detail, and I will summarize them briefly here.

Habitat improvements are categorized as direct and indirect. Direct habitat improvements are intensive developments in limited areas. They are expensive, primarily serve only wildlife, and are financed entirely as wildlife management. Direct habitat improvements are an integral part of habitat management but should be designed to complement the results of coordination with management of other resources. The timing, type, and extent of direct habitat improvements should be based upon demonstrated need. Indirect habitat improvements are usually effected through coordination with management of other resources. They affect large areas and benefit more than one resource.

Objectives of Direct Habitat Improvement

Water. -The objective is to provide at least one source of water per square mile. One source per 160 acres near each existing field or group of fields of at least 2 acres is desirable for maximum turkey production and is of benefit to smaller wildlife.

Openings. -The objective is to preserve all existing fields occupying a minimum of 5 percent of the management unit and to maintain these fields in a productive condition by sharecropping, grazing, or periodic controlled burning, mowing, or tilling. Where such fields have been planted to pine, they should be reclaimed at the earliest opportunity by commercial clear-cutting and then maintained as fields. Power line and other rights-of-way should be maintained in productive condition by selective clearing and maintenance. When possible, the utility company should perform this task under the terms of the easement agreement.

Forested glades and other noncommercial forest stands. -The forest cover on these sites should be managed as all-age hardwoods that will provide a maximum of mast and forage. Glades in a *savannah* condition may be kept productive by regulated grazing, periodic controlled burning, or selective applications of herbicides. The more heavily forested glades may be improved, or maintained in desirable condition, by periodic controlled burning, by selective thinning to release desirable trees, shrubs, and forage, and by the harvest of merchantable trees that are surplus to habitat needs.

Indirect Habitat Improvements

Commercial forest stands. -Since 70 to 99 percent of the public lands in each forest district are in commercial forests, the management of these stands has a paramount influence on wildlife. Timber-management activities are the primary factors manipulating forest cover and thus habitat of wildlife. Coordination of timber management and wildlife-habitat management is essential for the development and maintenance of acceptable population levels of game in public forests.

Hardwood stands on sites of site index 55 and above, and oak and/or pine on sites of site index 45 to 54 should be managed under the new silvicultural guides for EAM (Roach and Gingrich 1968). Present all-age stands should be directed toward even-age as rapidly as is practical (subject to coordination needs discussed in following sections). However, care should be taken to assure that quality of habitat will be protected both in the short-term and long-term future. Implementation of even-age silviculture represents a commitment for 80 to 100 years, and decisions made during the first period of planning can limit alternatives in future periods.

A compartment is an administrative unit of a forest district, usually 600 to 1,000 acres in size, the boundaries of which are physical features such as streams and trails. It is recommended that at least 10 percent but not more than 20 percent of the commercial forest stands in each forest compartment be regenerated to oak or converted to pine each 10-year period. These treatments will create transitory openings that will produce an abundance of forage to complement that in fields and clearings. For maximum benefit to wildlife, the type conversion of hardwoods should be distributed through three 10-year plans in each compartment.

Management of commercial forests should provide for the maintenance or development of a variety of all commercial species adapted to the various sites. This variety of species will contribute to the variety of foods produced. Also, each compartment should be managed for a balance of age-size classes in each stand type, both to achieve a sustained yield of forest products and to maintain desirable wildlife habitat. A balance of age-size classes would include 40 percent of the acreage in sawtimber, 30 percent in poles, 20 percent in saplings, and 10 percent in reproduction. The stands of various age-size classes and species should be interspersed throughout each forest compartment so that variety occurs throughout the entire range of turkeys and other wildlife.

Mast production. -In Missouri, acorns comprise an average of 32 percent of the turkey's fall and winter diet and 50 to 75 percent of the deer's annual diet in the Ozarks (Korschgen 1962, 1967). Korschgen (1962) and Crawford and Leonard (1965) reported that acorns serve as a buffer against the over-utilization of other forage by deer and that carrying capacity of the range is greatly enhanced by the availability of acorns. Segelquist et al. (1969) reported substantial mortality of deer in populations of about 21 per square mile in the Arkansas Ozark forests on three occasions when acorn production fell to 10, 15, and 23 pounds per acre. Acorns are the primary food of squirrels, and their reproduction and population levels vary directly with acorn production of the previous fall and winter (Christisen and Korschgen 1955). Projected use of acorns by the three major forest-game species and the acreage required to reproduce such quantities comprise Table 67.

Many factors could alter the projections in Table 67, but it is obvious that a substantial proportion of stands must be in mast production to maintain the carrying capacity for acceptable wildlife populations.

Because acorns are so important as a staple in the diet of all three major forest-game species, it is recommended that at least 45 percent of the forest stands be maintained in mast-producing condition. At least a third of the acorn-producing trees should be in the white oak group.

Table 67. Need of acorns of an acceptable population of deer, turkeys, and squirrels in a 1,000-acre forest compartment.

Species	Number of Animals	Daily Acorn Use (lb)	Days of Acorn Use	Acorns Needed (lb)	Acres[a] Needed
Turkeys	8	0.25	180	360	9
Deer	31	1.50	150	6,975	174
Squirrels	300	0.20	180	10,800	270
Total				18,135	453

[a]Based upon average of 40 pounds of usable acorns per acre.
Source: Evans (1968).

A mast-producing stand is defined as follows: on commercial hardwood sites, stands with 50 percent of the basal area in sawtimber and large poles, half of which is sawtimber; on all other sites, stands with at least 30 square feet of basal area of oak sawtimber and large poles. The latter group of mast-producing stands may include all-age stands on noncommercial forest sites and oak-conifer stands on commercial forest sites. The goal of 45 percent of the forest in acorn production will occur naturally where hardwoods on commercial and on noncommercial sites comprise more than 70 percent of the area and maintain a desirable balance of age-size classes. However, where more than 30 percent of the sites are adapted to pine or red cedar *(Juniperus virginiana),* a portion of these sites should be continued in hardwoods, either as pure stands or as mixtures of hardwoods and conifers, with oaks comprising at least 50 percent of the stand.

Use of EAM and all-age forest management. -The value of EAM to wildlife-habitat management was described by Zeedyk (1969), who wrote: "EAM opens the door for the biologist to take the initiative in habitat management. It offers the opportunity to manage intensively for a wide variety of species, the opportunity to control the quantity, quality and spacing of habitat components on a forest-wide scale, and the chance to pinpoint and resolve specific habitat problems."

However, EAM applied from only a silvicultural standpoint can devastate wildlife habitat. It is essential that application of EAM be coordinated between management of timber and habitat. Before considering examples of problems of coordination, I will compare the relative effects of EAM and all-age management in achieving desirable wildlife habitat.

Under EAM, only 50 to 60 percent of the forest stands produce food for wildlife. For the first 10 years of a rotation after a regeneration cut, there is usually an abundance of forage and browse, but no acorns. The last 45 years of an 80-year rotation (or 50 years of a 100-year rotation) provide large amounts of acorn mast and low to moderate quantities of fruits and forage. During the intervening 30 to 40 years, sapling and small pole size-classes are usually so dense that they preclude understory plants, but they are not yet producing acorns (Figure 48). Irregularities in the lines in Figure 49 represent responses to intermediate thinnings.

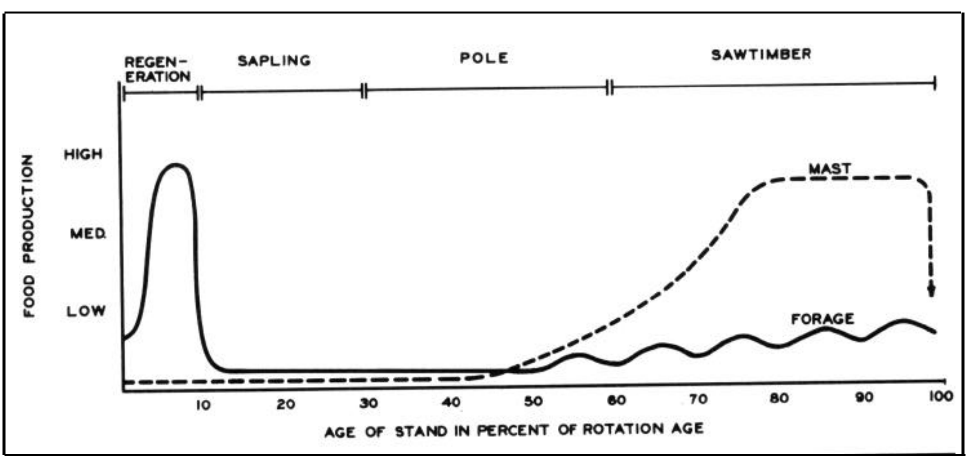


Figure 48. Relative production of acorn mast and forage through the rotation of an oak stand under even-age management.

Under all-age management, 100 percent of the forest stands produce some food (Figure 49). Forage and browse production will always be low, because the overstory is never adequately opened, but the stand will provide a moderate amount of mast from the relatively widely spaced sawtimber and large poles that constitute one- to two-thirds of the forest. Forage production by forest stands in various conditions and age-classes was reported in detail by Murphy and Crawford (1970).

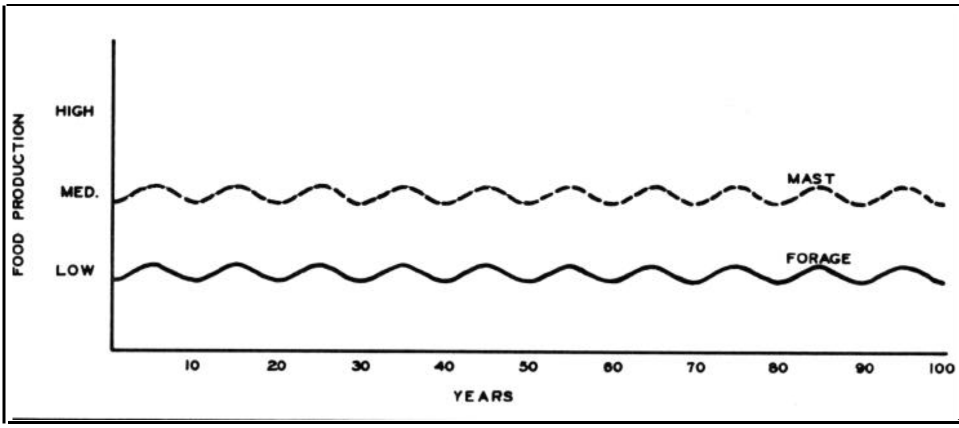


Figure 49. Relative production of acorn mast and forage in an oak stand under continuous all-age management.

COORDINATION AND PROBLEMS OF IMPLEMENTATION

During the course of the cooperative program, it was found that *good* habitat rarely occurred naturally or as a result of the routine application of timber management. Desirable habitat is a result of careful planning and execution of both direct and indirect habitat improvements. Three basic problems must be solved to permit effective coordination of forest-habitat management with timber management and other resources: (1) developing a multiple-use compartment inventory that provides sufficiently detailed information about each resource to permit identification of deficiencies and opportunities for correction, (2) increasing financing to cover the slightly increased costs of such inventory and of practicing coordination, and (3) resolving the relative economics involved when compromises are needed to achieve coordination.

INVENTORY

In the early efforts to develop coordination guides, data from the standard forest-compartment inventories were used. These inventories, conducted by timber-management personnel and financed by the timber-management function, were designed to provide data for timber management. These data were not sufficiently detailed to permit evaluation of habitat before or after silvicultural treatments.

EAM was initiated during this period. The biologist needed an inventory method, and the forester needed a new one. A method for the multiple-use compartment inventory was developed and tested in a pilot study on 11 compartments. The method and the results of the test were reported by Stout et al. (1964). The procedure provided data about the number, sire, distribution, and habitat value of the various cover types and about the species composition, rates of stocking, and quality of trees in each forest stand. These data were used to evaluate, plan, and coordinate management of forest and habitat. The data also revealed some of the dangers of applying EAM without regard for habitat. Some of these dangers are discussed in detail later.

In the following examples, the forest stands are the residual stems resulting from the abuses of high-grade cutting, wildfires, and grazing prior to their acquisition by the state or federal government; they have been managed as all-age stands since their acquisition. EAM requires adequate stocking of the site by one age-size class or two closely allied age-size classes.

Many stands were unacceptable for continued management. The prescription according to EAM guides was to sell all merchantable trees and deaden all remaining undesirable stems necessary to reduce the stand to the next smaller size-class of trees that would provide adequate stocking. The present dominant size-class of the stand, the cutting prescription, and the dominant size-class that would result from the recommended cultural treatment of the 11 pilot compartments are presented in Table 68. It became apparent that if these prescriptions were implemented, the habitat in all but compartment No. 18 would be seriously impaired for many years, with little future opportunity to correct the deficiencies. Thus, it is imperative that regeneration of many of the stands be deferred for 10, 20, or 30 years to achieve a balance of age-size classes and to retain alternatives for future harvests and manipulation of habitat.

Table 68. Effect of even-age silvicultural prescriptions on size-class distribution of hardwood timber stands in Missouri.

		Present Dominant Size-class (percent)				Types of Cut Prescribed (percent)		Future Dominant Size-class Following Cut and Postsale Treatment (percent)			
Forest Compartment Number	Acres	Saw timber	Pole	Small Tree	Reproduction	Clear-cut	Selective Cut	Saw timber	Pole	Small Tree	Reproduction
Region I											
11	579	60	18	22	0	53	20	14[a]	17[a]	35[a]	32[a]
12	226	52	48	0	0	52	14	20	14	15	51
13	866	84	8	8	0	65	12	19	12	20	49
14	449	70	14	16	0	80	5	8	8	15	69
17	616	89	5	6	0	90	5	0	4	14	82
18	824	59	19	22	0	22	59	40	22	18	20
All	3,560	72	15	13	0	60	22	19	13	20	48
Region II											
134	1,225	69	23	8	0	65	18	23	13	0	64
136	191	52	38	10	0	18	35	32	48	0	20
138	354	64	31	5	0	44	43	4	38	16	42
139	773	56	33	11	0	75	9	5	12	26	57
140	672	45	35	20	0	64	18	13	6	13	68
All	3,215	58	30	12	0	62	19	8	17	12	63

[a]This number represents the size-class distribution of all hardwood stands in the compartment.

The new method of inventory revealed not only the silvicultural prescriptions but also provided details that permitted priorities to be set for cutting or deferring cutting of each stand. These data permitted soundly based compromises to be made in applying prescriptions to maintain high-quality habitat and to preserve alternatives for subsequent timber and habitat management.

More recent inventories in many compartments, made by using a modification of this method, revealed that a great majority of compartments required special effort to retain or create a balance of age-size classes and to assure high-quality habitat. The conditions responsible for the problems in these compartments were numerous and varied. The four most common causes of problems and the special efforts required to correct them are discussed briefly.

As in the compartments in the pilot study, too many of the trees, especially the larger size-classes, were considered undesirable growing stock because of form, defect, or species-faults that resulted from the stand's early abuse. As a result, no one or two age-size classes provided adequate stocking for continued management under the principles of EAM.

Stands that were clear-cut many years ago are now extensive areas of one age-size class that are not productive habitat. If this age-size class is in sawtimber stands, some stands should be regenerated as soon as possible; additional stands should be regenerated each 10 years thereafter to create new age-classes. Some of the stands should be carried many years beyond normal rotation age to continue producing acorns until regenerated stands have grown to acorn-producing size. If the one age-size class is sapling or pole stands, some stands (the poorest) should be regenerated to create a new, younger age-class, and other stands (the best) should be thinned (crop-tree release) to speed their development into a larger size-class capable of producing acorns.

In the central Ozark pine range and the southwest Ozark cedar range, silvicultural prescriptions call for converting a large part of the hardwood stands on sites having site index below 55 to pine or cedar. If all such stands are converted, a serious deficiency of stands producing acorn mast will result. To maintain quality of habitat in these areas, it is essential that many of these stands be allowed to continue in hardwoods, either as pure stands or as mixtures of oaks and conifers.

In some compartments, deficiencies in habitat, resulting from an imbalance of age-classes, will not become evident for 20 to 40 years; by that time flexibility to correct these deficiencies may be lost. For example, compartments containing an inadequate representation of saplings and/or pole stands may be good habitat for many years. When these stands advance during the rotation to become sawtimber or regeneration stands, the mast and/or forage production will be inadequate. It is essential that an effort be made to correct the imbalance of age-size classes at the earliest practical time during the rotation. A careful look into the future is essential when analyzing compartment data.

FINANCING

This multiple-use inventory is estimated by different district personnel to cost 20 to 40 cents more per acre than the previously used forest-compartment examination. Costs vary greatly among districts and among compartments, depending upon the experience of the worker, the complexity of the stands, and coordination needs. Present district financing for examining compartments is based upon time-study records of former methods. Because we do not have time-study records for conducting the multiple-use inventory, rates of financing have not been determined. Even though the forester and the biologist agree on needs and on methods of coordination, former, inadequate rates of financing deter implementation of the new method of inventory. Sufficient experience with the multiple-use inventory is required to define the new method and to compute financing needs. This cannot be done with current financing. Some special-project funding appears necessary to break the stalemate.

Efforts to attain coordination under present financing create hardships for the district forester. With presently available financing, he cannot adequately inventory all compartments scheduled for a cut in any given year. The application of EAM criteria to forest stands calls for the cutting of so many stands in each compartment that the volume-cut goals of the district can be met by a third to half of the compartments that were scheduled for cutting. As a result, the district forester is forced to choose between making his volume-cut goals from the few compartments inventoried (and adversely affect habitat by excessive cutting) or inventorying all compartments scheduled for a cut that year and spreading his cut among all of them. By spreading his cut among all scheduled compartments, he preserves a good balance of age-size classes but exceeds his authorized funds for compartment examination.

A variety of ways to protect the habitat from excessive cutting, without resorting to the more expensive method of inventory, were tried. One method was a blanket rule that no more than X percent of the stands in a compartment could be regenerated or converted in any 10-year-plan period. This method worked in areas with a high proportion of low-grade sawtimber where large acreages would otherwise have been cut. It did not protect the compartment that had a minimal amount of sawtimber and should receive little or no cutting.

Another method of protecting the habitat from excessive cutting was a relaxation of EAM prescription standards. This relaxation reduced the number of stands receiving a clear-cut prescription in each compartment. However, this method reduced cutting in compartments where there was no problem and where the cutting of some additional stands would have been desirable. Also, it did not protect those compartments where the few sawtimber stands present did not meet even this reduced requirement.

As the solution to this problem, it is recommended that sound silvicultural criteria be developed and employed in a sufficiently detailed inventory to permit analysis and adjustment in each compartment, based upon demonstrated need and opportunity. This solution would permit both cutting and deferring of stands, based on priority of need in each compartment,

ECONOMICS

There is little disagreement between the forester and the wildlife manager regarding the need for coordination. Both approve the use of EAM and of type conversion; both desire sustained yield; both agree that a balance of age-size classes, well interspersed, is practical and desirable. Their different goals as to size of area are not serious. The forester would settle for good distribution of the various forest-stand types within an area of several thousand acres that serves his buyers, whereas the wildlife manager desires them within the annual ranges of the three major forest-game species, preferably within each compartment. However, there is frequently disagreement, not only between foresters and wildlife managers but also among foresters, concerning the economic feasibility of some of the recommended coordination practices. These disputes should not be merely argued; they should be investigated and resolved as soon as practical. Some of the disputed coordination practices are discussed here.

Maintaining an acceptable distribution of *age-size classes in compartments* *containing low-quality hardwoods.* -It is frequently necessary to defer regeneration of several understocked hardwood stands in each compartment to retain an acceptable distribution of size-class. For example: 4 million board feet are scheduled for harvesting from 12 compartments, but because of an excessive number of understocked stands in each compartment, the volume-cut goal can be harvested from 6 compartments. Questions : (a) Should all 12 compartments be inventoried, and the stands having highest priority for regeneration be cut from all 12 compartments and the stands with the lowest priority be deferred? Or (b) should only 6 compartments be inventoried and all understocked stands be cut and the other 6 compartments be deferred? Forest economics and benefits to habitat appear to justify the extra cost of administering cultural practices in all 12 compartments.

Correcting the distribution of age-size classes of extensive stands of small sawtimber. -It is desirable to regenerate segments of these immature stands now to provide forage after clear-cutting and to create a new age-class that will provide the sawtimber for mast production in 50 years. Some value would be lost by premature harvest of this young sawtimber. Near the end of the rotation, a similar question arises as to carrying segments of these stands to overmaturity to preserve mast production and alternatives for harvest until the stands that were cut first reach acorn-producing size. If the stands were initially 60 years old, some of them should be carried to age 110. If they were 80, some stands should be carried to age 130. Some value would be lost to mortality and to defect during this period, but these procedures will direct such areas toward a better balance of age-size classes. Do the values of improved habitat for wildlife and a good balance of age-size classes justify the loss of value in forest products? In many cases, they do.

Capitalizing on benefits and minimizing losses to habitat quality by type conversion. -Where more than 30 percent of an area is classed as pine sites, wildlife managers recommend that some of these sites be maintained in oak or oak-pine stands to retain the mast-producing potential for wildlife. Questions: (a) is it economically feasible to convert low-quality hardwoods to pine by planting, especially on sites capable of producing commercial (even if low value) hardwood products? And (b) might hardwoods managed by periodic harvest of merchantable trees, with little investment in other cultural treatments, provide the greatest income from such sites presently occupied by commercial species of hardwoods? Many factors are involved in determining the answers to these two questions. However, it appears that in many cases, the answer to *(a)* is “No” (Brinkman and Smith 1968) and to (b) is "Yes” (Herrick and Morse 1968).

CONCLUSIONS

I wish to emphasize that these recommendations for wildlife habitat management represent our best judgment based upon present knowledge. We are confident that habitat so managed will support acceptable populations of all forest game. However, more information is needed about the requirements for wildlife habitat and the effects of various silvicultural practices (especially EAM) on habitat quality. We also recognize that new knowledge may reveal the need to revise these recommendations. It is essential that all resource managers continue their cooperation in seeking needed information and in refining the management of all resources.

29

MANAGEMENT OF WILD TURKEY HABITAT IN SOUTHERN FOREST TYPES

H. L. Holbrook

ABSTRACT

The 12 million acres of national forests in the South provide much of the remaining opportunity for the public to hunt wild turkeys *(Meleagris gallopavo).* Good habitat for turkeys in these areas consists of mixed hardwoods and groups of conifers with open understories, openings, water, and freedom from disturbance. The basic goal for turkey management is 10 birds per square mile, plus other forest wildlife, in habitats of longleaf pine-slash pine *(Pinus palustris-P. caribaea)* and oak-pine *(Quercus-Pinus)* types managed as evenage silviculture. Management practices recommended for use in the longleaf pine-slash pine type include prescribed burning, mast production in key areas, improvement of wildlife stands to enhance food production, manipulating sizes and distribution of stands, site preparation, and reforestation. Management practices recommended for use in the oak-pine type include production of mast by high-quality stands of hardwoods and production of mast in commercial stands of hardwoods if rotations occur at intervals of more than 80 years and are not managed by burning. If stands are burned or rotations are shorter, mast should be produced in key areas. Care must be taken that improvement of timber stands does not adversely affect their composition or reduce the number of soft, mast-producing species to an unacceptable level.

In the Southeast, wild turkeys require extensive forest lands. Timber-management practices on these lands govern quality of habitat and are just as important to the future of turkey hunting as adequate protection of turkeys and the use of wild-trapped birds for restocking.

The U.S. Forest Service is particularly concerned with management of turkey habitat, because the 12 million acres of national forests in the Southern Region provide much of the remaining opportunity for public hunting of this fine game bird. The following comments are excerpts from a handbook, not yet complete, concerning wildlife input into this region's procedure for evenage timber management (EAM) and turkey-habitat management. It will provide direction for management to forest supervisors when they plan to feature a game species in a specific timber type under the Forest Service's multiple-use program. The handbook will provide comparable guidelines for squirrels *(Sciurus niger* and *S. carolinensis),* white-tailed deer *(Odocoileus virginianus),* ruffed grouse *(Bonasa umbellus),* quail *(Colinus virginianus),* mourning doves *(Zenaidura macroura),* waterfowl, and black bears *(Ursus americanus).*

This paper was adapted from the handbook style and therefore does not cite authorities. The basic reference was Hewitt (1967).

The purpose of this paper is to review the habitat needs of wild turkeys; summarize the food requirements by season and source; generalize on population objectives, recruitment, and hunting pressure; and provide the standards for habitat management in two timber types-longleaf pine-slash pine and oak-pine.

HABITAT DESCRIPTION

Good turkey habitat contains stands of mixed hardwoods, groups of conifers, relatively open understories, scattered clearings, and well-distributed water; additional requisites are reasonable freedom from disturbance and adequate area. Mixed hardwoods produce mast (fruits of oak; beech, *Fagus grandifolia;* gum, *Nyssa* spp.; cherry, *Prunus* spp.; and dogwood, *Cornus* spp.), which is the primary winter food of turkeys. A combination of hardwood timber species is necessary to compensate for the variable nature of mast production. Conifers afford roost sites and protection during adverse weather. Open understories permit optimum use of the turkey's remarkable eyesight in detecting and escaping enemies. Clearings provide the food needed during the warm months (grass seed, insects, fruit, and forage) and areas for breeding, nesting, and brooding. When planted, clearings supplement native food supplies throughout the year. Even though the turkey's demands for water are not understood, they readily use open streams, ponds, and prepared water holes.

Frequent and sustained disturbances by free-running dogs or by man may cause turkeys to forsake portions of their territory. The daily range of turkeys varies greatly, depending upon season, food supplies, and disturbances. The essentials for food, cover, water, and reproduction should be provided within a square-mile unit area.

The above description of habitat requirements shows that the future of the wild turkey is inalterably coupled to timber-management practices.

General food habits of turkeys and the sources of foods are shown in Table 69.

POPULATION OBJECTIVES, RECRUITMENT, AND HUNTING PRESSURE

Estimates of fall turkey populations within the region where we have hunting programs have varied from 1.5 birds per square mile to 32 birds per square mile. Our objective, where turkeys are to be featured, is 10 birds per square mile, and the guidelines for providing mast are based upon this level. The needs of other wildlife for mast that must be met on a turkey range are determined by assuming populations of 20 deer and 300 squirrels per square mile, and sufficient numbers of crows *(Corvus* spp.), blue jays *(Cyanocitta cristata),* woodpeckers (Picidae), chipmunks *(Tamias striatus),* wood rats *(Neotoma floridana),* and other small animals to have a total consumption of food comparable to that of squirrels.

On the basis of an average yield of 3.5 pounds of mast per square foot of basal area, a good turkey range needs about 8,800 square feet of basal area (about 125 acres where mast trees predominate) per square mile to meet food requirements for the assumed populations of wildlife.

The permissible take by either-sex hunting in fall is about one-third of the population. Gobbler hunting in spring affects less than 10 percent of the birds and has no appreciable impact on productivity if hens receive the protection that they need at this season.

Normal annual recruitment to the turkey population is from 40 to 70 percent, but in years with cold, wet springs it can drop nearly to zero.

The extensive survey of habitat in national forests, now being conducted in the South, identifies compartments where we feature turkeys. When locating opportunities for restoration, we consider 5,000 acres to be a suitable unit.

Table 69. Seasonal food habits and sources of food of wild turkeys in the Southeast.

Foods	Fall	Winter	Spring	Summer
Primary	Grass and weed seeds Mast	Mast Forage	Mast Forage	Forage Insects
Other	Forage Soft mast Insects	Soft mast Seeds	Grain Insects	Fruit Grass and weed seeds Mast

Foods and Type Species	Sources
Grass and weed seeds *Paspalum* spp. *Panicum* spp. Native legumes	Openings, open woodlands, transitions, log roads, thinnings, prescribed burns, and regeneration areas up to 3 or 4 years of age.
Mast Acorns Beechnuts Pecans	Hardwood stands over 25 years of age-10 years for turkey oak and bear oak *(Q. ilicifolia)* and 15 years for water oak. Highest production occurs in stands 50 to 100 years of age.
Forage Clovers Grasses Sedges	Openings, prescribed burns, open woodlands, log roads, bottomlands, and open-grown understory vegetation.
Soft mast Dogwood Grapes Cherries	Both pine and hardwood sites under conditions ranging from openings to fully stocked stands. Greatest fruit production occurs under open growing conditions.
Seeds Sweet gum *(Liquidambar styraciflua)* Longleaf pine	Both pine and hardwood stands. Highest yields associated with vigorous growth.
Insects and snails Grasshoppers Millipedes Insect larvae	Snails are associated with moist sites, and high insect populations with low-growing vegetation in open aspects. Insect larvae are most abundant in fields and moist accumulations of hardwood litter.
Fruit Blackberries and dewberries Huckleberries Strawberries *(Fragaria* spp.)	Both pine and hardwood stands. Usually associated with disturbance of litter layer and open growing conditions.
Grain Oats *(Avena sativa)* Corn *(Zea mays)*	Available when woodland and agricultural acreage intermingle. Turkeys use open fields readily unless disturbances prevent it.

LONGLEAF PINE-SLASH PINE TYPE

COMPOSITION, DISTRIBUTION, AND IMPORTANCE FOR TURKEYS

This type occurs throughout the Southern Coastal Plains. Important associated species of trees include turkey *(Q. catesbaei),* bluejack *(Q. cinerea),* post *(Q. stellata),* southern red *(Q. rubra),* and live oaks *(Q. virginiana)* on dry sites; and water *(Q. nigra), willow (Q. phellos),* and laurel oaks *(Q. laurifolia),* with crab apple *(Malus* spp.), highbush huckleberry *(Gaylussacia* spp.), and dogwood understories on moist sites. The wild turkey is an important game bird within this type.

Foods produced in the understory of longleaf and slash stands are primarily grass and weed seeds, forage, and insects. Turkeys readily eat the pine seeds when available. Both species of pine provide excellent roost cover. The open understories of lightly stocked stands of timber are used as nest and brood cover. The associated species of timber provide a variety of food supplies and largely determine the quality of the range for turkeys.

MANAGEMENT

Prescribed burning. -Since both longleaf pine and slash pine are resistant to fire, they offer an excellent opportunity for prescribed burning when they occur in pure stands under EAM. Burning improves the palatability and the nutritional quality of understory plants. Turkeys eagerly consume the fresh growth of forbs, grasses, and browse, especially in late winter and early spring. Open understories of mature stands burned regularly by winter fires also produce rich crops of insects for food during summer and fall. Burn rotations of 3 to 4 years remove much of the *rough* that suppresses desirable undergrowth, maintain legumes, and reduce large sprouts to new growth. More frequent burning limits supplies of understory fruit and mast. Burning should be scheduled to miss nest and brood seasons in March, April, May, and June. Winter burns best fulfill the requirements of turkey management. Summer burns encourage grasses at the expense of forbs. Initial burns in longleaf pine should be made when the stands are in the grass stage; those in slash pine should be made after stands are 8 to 10 years old.

Valuable transitional zones between pine uplands and gum swamps, containing oaks, magnolia *(Magnolia* spp.), and black gum *(Nyssa sylvatica),* must be protected from fire, because repeated burning will convert these zones to pine. In stands of longleaf pine-scrub oak, an important subtype because the scrub oaks *(Q. catesbaei, Q. margaretta, Q. marilandica,* and *Q. cinerea)* often provide mast when other species fail, unburned key areas should be maintained for mast production.

Key areas. -These are units of land managed primarily for wildlife food and cover or water. Key areas supplement the nearby forest-management types and enable them to meet the habitat requirements of the featured game species at the desired population level within the unit area. Key areas can be stand-sized or smaller and can be managed through timber sales and cultural treatments or through improvement of wildlife stands so that they can successfully fulfill their purpose.

In the longleaf pine-slash pine type, where prescribed burning and rotations of less than 80 years prevail, adequate mast cannot be produced by scattered hardwoods within a pine stand. Needs for mast should be met by keeping 125 acres per square mile in oak, hickory *(Carya),* and beech for food production. If available, the key areas retained for mast should be in stand sizes (20 acres plus) so that they can be mapped and managed. If not available, suitable sites should be selected and developed as key areas.

One of the most beneficial projects we can undertake in key areas for mast is wildlife stand improvement (WSI) to groom them for improved food production. For example, live oak hammocks should be released from over-topping pine; chinquapins *(Castanea* spp.), thorn apples *(Crataegus* spp.), and lowbush acorns *(Q. pumila)* should be released from competing shrubs and sprouts; sweet gums that tend to replace water oaks in the transition between pine uplands and gum swamps should be removed; and fruit or nut trees at old homesites should be released, pruned, and fertilized.

When portions of key areas are regenerated, the composition in the associated tree species should be retained. New stands should be prepared by lop ping all remaining whips and sprouts after merchantable timber is removed. Foliar herbicides should not be applied because they reduce the variety of understory plants. A follow-up weeding with injectors may be needed after 5 to 6 years to release desirable stems. Since mast and fruit are the critical food items to be supplied, key areas should have half or more of the dominant and codominant basal area in oaks and beech.

Silviculture. -Regeneration under EAM in the longleaf pine-slash pine type is by clear-cuts or seed-tree cuts. Under an 80-year rotation, 10 to 15 percent of this type will be regenerated each lo-year interval. Larger percentages must be clear-cut under short rotations. In the Southern Region, cuts vary in size from 20 to 200 acres. Cuts should be distributed so that not more than one-third of a 1,000-acre compartment is regenerated in a 20-year period. Clear-cuts provide excellent nest and brood habitat for turkeys for the first 3 or 4 years.

Thinnings stimulate growth and encourage a variety of species in the understory when made at 8- to 10-year intervals.

Short rotations reduce the quality of the range for turkeys, because a large proportion of the area will be in pine stands 5 to 30 years old. Our experience indicates that these sapling and young pole stands are of little value to turkeys except as escape cover.

Reforestation and timber stand improvement. -The first step in reforestation after regeneration is chopping, blading, and burning, or aerial application of herbicides. Planting follows if necessary. Wide spacing should be sought to encourage understory vegetation. There is an excellent opportunity during reforestation to seed species of food in the understory as well as pine. Precommercial treatments after about 5 years provide growing room for the crop trees and expedite full use of the site for the new crop of timber. Because of the need for a variety of food plants in the understory, herbicides should not be used on valuable understory species during precommercial treatments. Mechanical row-thinning is adequate to release the growing stock of trees.

Timber stand improvement (TSI) is the release or the improvement of composition in a stand. After a stand progresses to small poles and is under a prescribed-burn rotation, it is no longer necessary to use successive TSI treatments to remove understory plants needed for turkeys.

HABITAT IMPROVEMENTS

Openings in the longleaf pine-slash pine type are needed for nest and brood sites, forage (clover, *Trifolium),* starchy food (chufas, *Cyperus* spp.), and fruiting shrubs (blackberries, *Rubus* spp.). The openings are particularly important where stands of midrotation age predominate. Distribution of openings should be about one per quarter Section and from 1 to 5 acres in size.

Water holes are necessary if open water is not available within 0.5 mile. This frequency of occurrence enables turkeys to have some option in meeting their needs for water.

Hunter access is not a problem in the longleaf pine-slash pine type. The country is flat and timber operations provide what access is needed.

OAK-PINE TYPE

COMPOSITION, DISTRIBUTION, AND IMPORTANCE FOR TURKEYS

This group includes the following types:

1. Loblolly pine *(Pinus taeda)* -hardwood. There are important associated species such as northern red oak *(Q. borealis),* southern red oak, black gum, water oak, post oak, and dogwood in the understory. This type occurs in the Southern Coastal Plain, Coastal Plain, and the Piedmont.

2. Shortleaf pine *(P. echinata)-oak.* There are important associated species such as scarlet oak *(Q. coccinea),* black oak *(Q. velutina*), blackjack oak *(Q. marilandica),* black gum, and dogwood in the understory. This type occurs in the Appalachians, the Cumberland Plateau, the Ozarks, the Ouachitas, and the Piedmont.

3. Virginia pine *(P. virginiana)* -southern red oak. There are important associated species including chestnut oak (*Q. montana),* red oak, white oak, and dogwood in the understory. This type occurs in the Appalachians and the Piedmont.

4. White pine *(P. strobus)* -northern red oak. There are associated species including white oak, white ash *(Fraxinus americana),* yellow poplar *(Liriodendron tulipifera),* and dogwood and grape *(Vitis* spp.) in the understory. This type occurs in the Appalachians and the Cumberland Plateau.

These types extend throughout much of the region and are among the most important for turkeys. Many estimates of fall populations in these types are about 10 turkeys per square mile. However, if these types are to reach their potential for turkeys, the stands of oak for winter food and the stands of pine for cover must be interspersed liberally within the square-mile unit of a wild turkey's range. Our objective in managing the habitat of the turkey is to maintain this essential mixture.

MANAGEMENT

Mast is the essential food element most affected by forest practices in these types. Production varies among species, sites, aspects, elevations, and years. As an example, on the Francis Marion National Forest, which is in the Coastal Plain, the food supply, in any one year, may be restricted largely to willow oaks and water oaks; to southern red, turkey, and post oaks; or to live oaks. Management should favor species suitable to the site, but, if possible, variety should be sought.

Guidelines for management of sites where turkeys are to be featured include the following :

1. Sites suitable for high-quality hardwoods should be managed for them, and at least half of the basal area should be maintained in oak, hickory, and beech.

2. On sites that can produce commercially important hardwoods, mast

species should be grown as a substantial part of each stand (20 to 50 percent of the basal area in the case of trees with dominant or codominant crowns) if rotations are 80 years or more and the stands are not managed by prescribed burning. If rotations are less than 80 years or are under a burn program, mast should be produced in unburned key areas.

3. On sites unsuitable for hardwoods, at least 125 acres per square mile should be left in mast-producing species to serve as key areas.

Generally, mast trees begin production at about 25 years of age. Mast production increases with the size of the trees and is greatest in stands 50 years old or older. Assuming a balance of age-classes of mast trees, any shortening of the length of rotation-for example, from 80 to 60 years-reduces mast production of the unit of land, whereas rotations of 100 years increase yields.

In loblolly pine-hardwood and shortleaf pine-oak, age-classes should be distributed and small stand sizes (20 to 100 acres) should be emphasized, with not more than 200 acres per section regenerated in any 20-year period. This practice will distribute fruit production and reduce the impact of large units of coppice growth.

Virginia pine-southern red oak is a unique type, in that the pine should be grown on a short rotation (50 years) whereas the mast components need long rotations. In such stands, key areas provide the only feasible way to retain mast components.

The white pine-northern red oak type is important for both food and cover. A balanced distribution of age-classes, with emphasis on small-sized stands, should be maintained. Key areas of grape often occur in this type; they are extremely important to turkeys and should be retained. Some control may be needed when vines damage young, valuable timber. Winter-cutting with an axe does not kill the root crown of the vines, but it does eliminate the problem. No control should be used on grapes on trees that are suppressed or of low value. In turn, WSI can be used to encourage grapevines by daylighting.

Key areas and transitions. -Key areas provide an excellent way to maintain mast-producing components. They can be retained unaltered, undergo improvement cuttings, be regenerated by clear-cutting, or later be absorbed into surrounding stands, depending upon need. The objective in maintaining key areas, which is to enhance food production during the various seasons of the year, should be met through each of these alternatives. Key areas provide a practical way to lengthen rotations.

Bottomland hardwoods that occur along scattered streams should be designated as key areas.

Wildlife stand improvement. -WSI and selling timber are the cultural methods for treating key areas to insure that they produce a sufficient quantity and variety of foods. When portions of key areas need to be regenerated to make them more productive, all stems 2 or more inches in diameter should be lopped, except for possible hardwood seed trees. Though herbicides may be valuable in some instances if there is a large composition of undesirable plants, they should be used discriminately.

Timber stand improvement. -TSI is used to control composition after a stand is established. When an even-age stand reaches the size for thinning cuts, additional TSI is unnecessary. In good turkey range, TSI treatments must not be permitted to reduce understory species that provide fruit or soft mast, nor should the variety of species be reduced just prior to regeneration. Root crowns of dogwood, viburnum *(Viburnum* spp.), thorn apple, crab apple, grape, and chinquapin should not be poisoned.

Prescribed burning.-Prescribed burning is practical for preparing sites and for improving forage in pure pine stands. It has no practical application in management of hardwoods, except possibly for preparing sites after regeneration cuts and for maintenance of glades. In other words, fire should be excluded from hardwood stands, key areas of hardwoods, and transitions where hardwoods are important. Prescribed burning of hardwoods saps their vigor and introduces fungus and insect infestations.

Clearings in these types should be managed for production of forage, fruits, and insects. These foods are the product of openings and are not found in adequate supply under canopies of fully stocked timber stands. Both sod and natural clearings (1 to 5 acres each) should be distributed at a minimum of one per quarter section. Legumes, grasses, and fruiting shrubs should be favored. Planting, mowing, fertilizing, discing, and burning are all practical means of maintaining openings and should be applied as needed to meet the above objective.

Water holes are important in some portions of the southern Appalachians, the Cumberland Plateau, the Ozarks, and the Gulf Coastal Plain. Where necessary, two water holes should be provided for each square mile of wild turkey range. They must be deep enough to be serviceable under drought conditions.

Access roads resulting from the sale of timber are generally adequate to meet the needs of hunters. Where this is not the case, suitably distributed roads and trails should be provided so that access routes are not more than 2 miles apart.

Coordination guides for the remainder of the timber types or type groups include loblolly pine-shortleaf pine, white pine-yellow popular-hemlock *(Tsuga canadensis),* oak-hickory, beech-birch *(Betula* spp.)-maple (Acer spp.), and oak-gum-cypress *(Taxodium distichum).*

CONCLUSION

This is our first attempt to provide guidelines for management according to game species and specific timber types. We have had enough experience to know that we cannot return to coordination guides in the future.

30

LAND-USE PRACTICES AND RIO GRANDE TURKEYS IN TEXAS*

Horace G. Gore

ABSTRACT

Populations of Rio Grande turkeys *(Meleagris gallopavo intermedia) in* Texas are now closely correlated with areas of least human activity located where mean annual rainfall is 16 to 32 inches. Turkey range and populations are further restricted by overgrazing, human occupation and disturbances, and destruction of habitat. In general, turkeys have declined in direct proportion to the increase in human occupation of the land. Most lands in Texas are privately owned with no restrictions on use. Both Rio Grande and eastern turkeys *(M. g. silvestris)* were abundant in Texas in 1870 when the population of 818,500 Texans owned 4.5 million head of livestock. Today's 12 million people and activities associated with production of 19 million head of livestock (including 3.5 million goats and 4.0 million sheep) have made inroads into turkey habitat that cannot be readily corrected. Vegetative associations that once produced an abundance of food for turkeys have been subjected to brush-control programs or have been replaced by various invader species of limited value to turkeys. The economic importance of livestock points to even greater decreases in turkey habitat as human populations and demands increase. Removal of brush and timber is not the only reason that the number of turkeys has decreased, because properly managed open range is extensively utilized by turkeys for nesting and feeding. It is destruction of winter roost sites and large-scale removal of mast-producing species that presently cause remnant flocks to change their ranges-changes that more often than not result in conditions that make the survival of turkeys impossible. Transplanting of wild-trapped birds to ancestral ranges is credited with increasing the number of turkeys within their present range. Widespread precipitation and improved range conditions following periods of drought have also increased local turkey populations. The future of the Rio Grande turkey hinges on whether limited habitat can be maintained or improved under the present system of agricultural economics. Land-use practices that presently promote increases in the number of turkeys are rotated grazing systems, decreases in numbers of goats and sheep, planting of small grains in winter food plots, minimal human disturbance, and supplement feeding during critical periods of drought.

The range of Rio Grande turkeys in Texas has declined in direct proportion to human occupation of the land. Prior to the European conquest of North America, Texas probably had no less than 1.5 million turkeys of the Rio Grande strain (Schorger 1966). They flourished along the Canadian River in the Panhandle, the forks of the Brazos River on the Rolling Plains, the spring-fed creeks and rivers of the Edwards Plateau, and the oak savannahs of the Rio Grande Plains (Figure 50).

* This study is a contribution of Texas Pittman-Robertson Project FW-14-C.

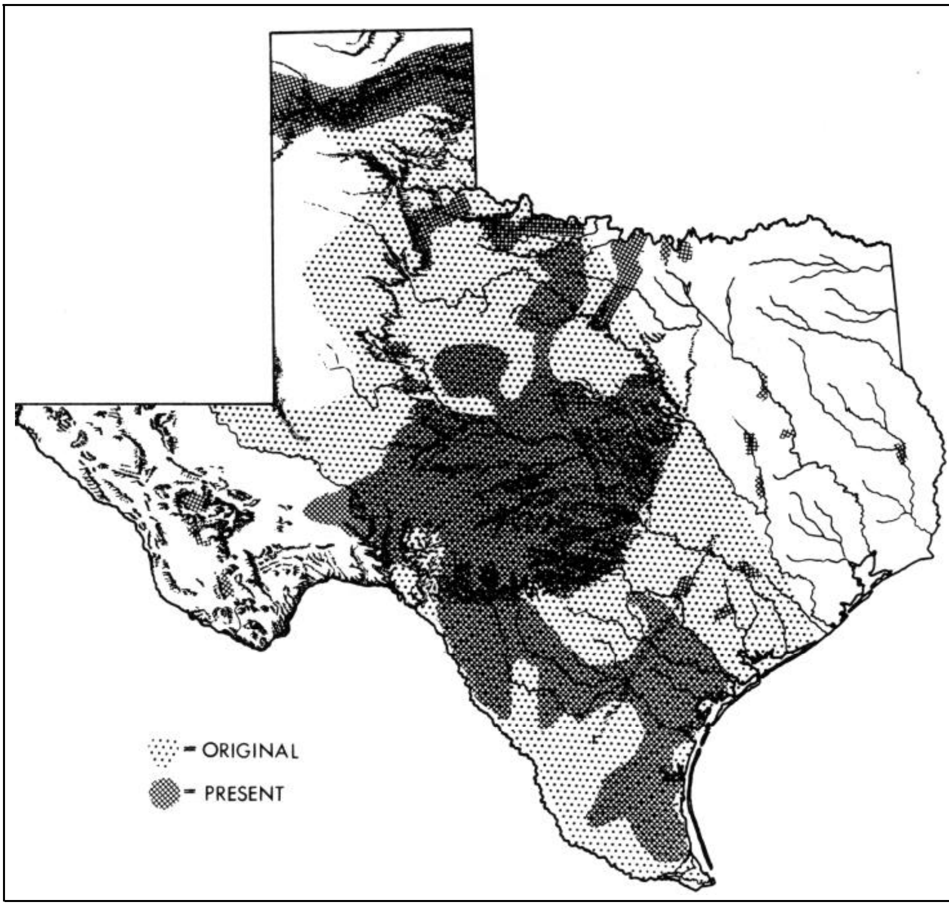


Figure 50. Extent of the original range of the Rio Grande turkey in Texas, compared with the extent of the present range.

The extent of turkey habitat today, when compared with the original, is reduced to a few small, scattered areas and a few fairly large areas in the regions of the best remaining habitat. Much of the original range is now devoid of turkeys. The major causes for the depletion of the habitat of the Rio Grande turkey that involve land use are overgrazing, human occupation and disturbances, and general destruction of habitat.

LAND USE AFFECTING TURKEYS

OVERGRAZING

Bertha Name best described the early years in Texas, which have some bearing on a discussion of land use. Her famous verse

> "Other states were carved or born:
> Texas grew from hide and horn"

fully portrays the advent of the livestock industry. Overgrazed cattle ranges were prevalent by 1890 (Dallas Morning News 1966), but cattle alone did not affect turkeys as severely as the introduction of sheep and goats. Walker

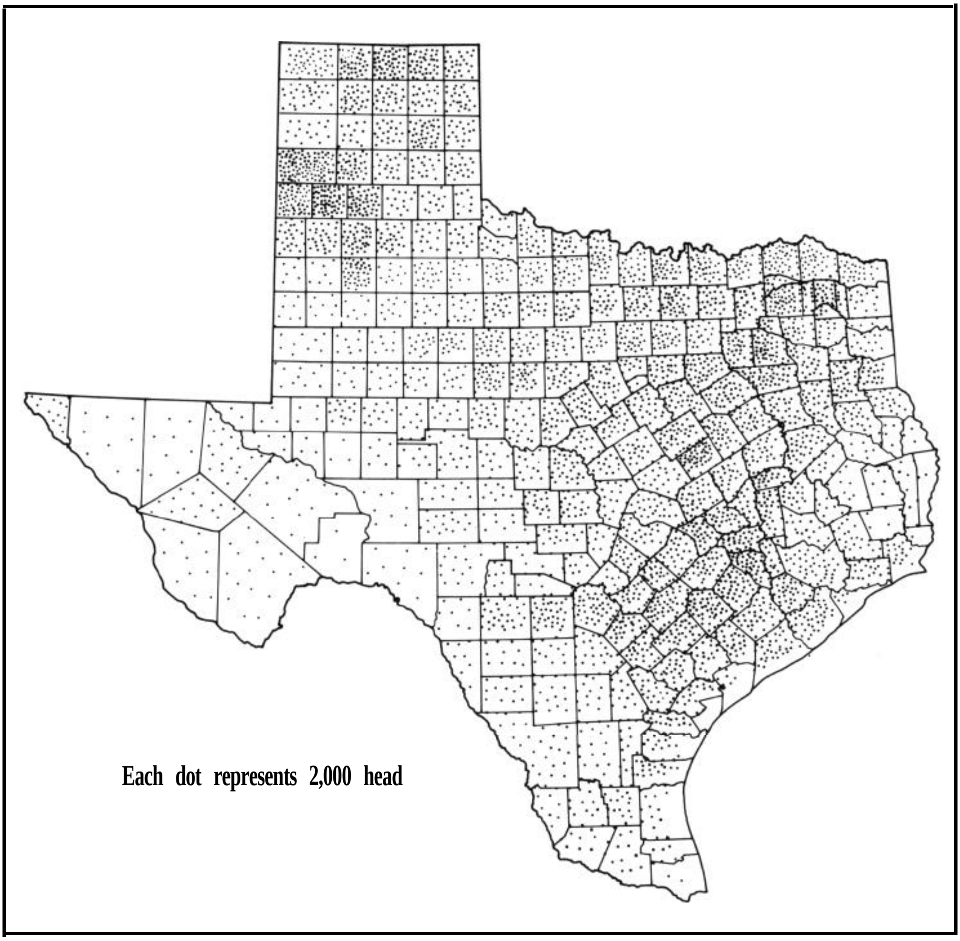


Figure 51. Cattle production in Texas-1969.

(1951b) reported that sheep, goats, and white-tailed deer *(Odocoileus virginianus)* competed directly with turkeys for food and cover as early as 1920, at which time turkey populations were declining. Texas presently leads the nation in production of cattle, sheep, and angora goats (Texas Department of Agriculture 1969, Figures 51, 52, and 53). Table 70 (Dallas Morning News 1970) shows trends in livestock production in Texas, which also reflects use of vegetation on ranges associated with turkey habitat.

HUMAN OCCUPATION AND DISTURBANCE

In replies to a questionnaire on turkey habitat, a cross section of wildlife biologists familiar with populations of the Rio Grande turkey in Texas indicated that human disturbance is a key factor influencing wild populations of turkeys. The word *wild* is used here to differentiate between game-farm stock and the widely dispersed native stock, which is prevalent over most areas of turkey range. As the quality of their habitat continues to decline, size of ranches, as well as the degree of human disturbance in general, is becoming increasingly important in holding established flocks of turkeys. Most wildlife biologists use the simple term "the bigger the better" when referring to size of ranches in

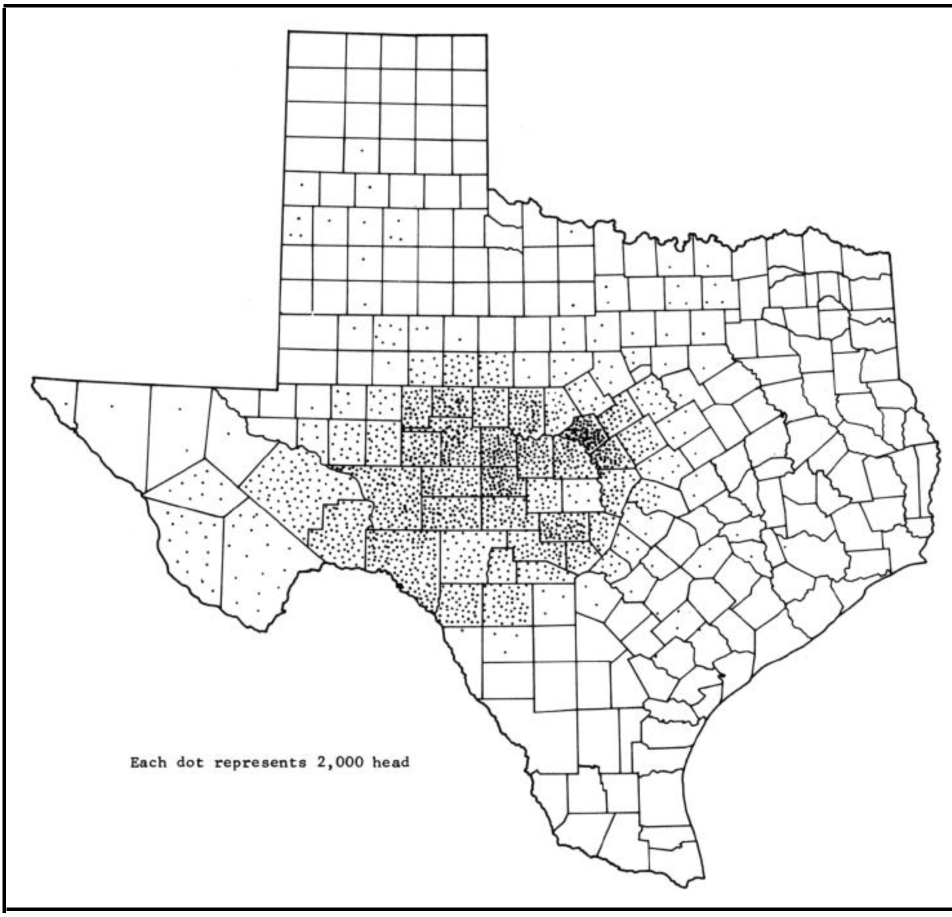


Figure 52. Sheep production in Texas-1969.

relation to turkey management. Since turkey habitat occurs on lands that are privately owned, and these lands are operated to the best economic advantage of landowners, it is difficult to correlate turkey management and present trends in land economics. More often than not, turkeys are given no consideration under modern intensive land use.

General Habitat Destruction

Habitat destruction is a term widely used by game managers. As discussed here, it denotes the alteration of vegetation or soils to achieve a definite purpose and the resultant failure of the altered habitat to provide the biotic demands of a species. Brush control is a common form of turkey-habitat destruction but there are others. Bottomlands are being cleared for improved pasture and also are being inundated to form large impoundments of water that severely deplete the winter range of turkeys. For example, flocks that are only holding their own on marginal range can be permanently excluded by the removal of a roost site. Landowners may or may not be concerned about the complete disappearance of a flock of turkeys on marginal range, for they may see turkeys only on rare occasions. However, the gradual removal of choice sites for turkeys will either

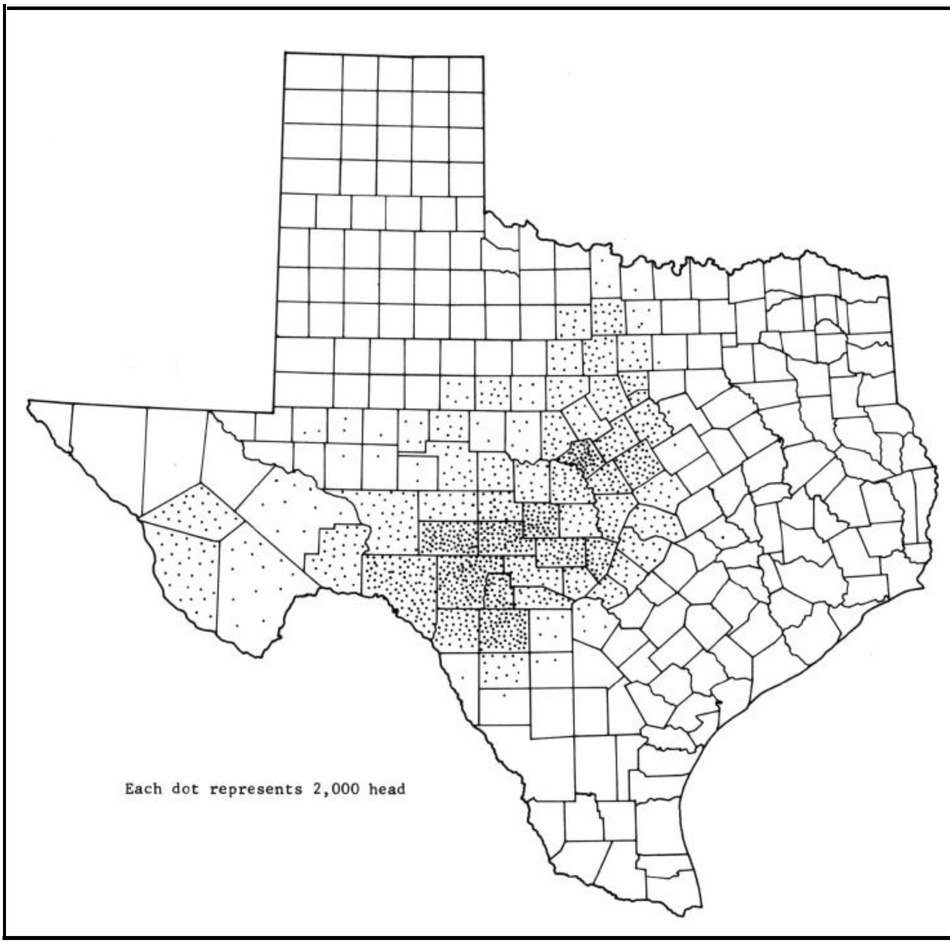


Figure 53. Angora goat production in Texas-1969.

Table 70. Numbers of livestock, 1870-1968, in Texas.

Year	Beef Cattle	Sheep	Goats
1870	2,933,888	1,223,000	
1880	4,072,000	6,024,000	
1890	7,168,000	4,752,000	
1900	4,353,000	2,416,000	627,333
1910	7,131,000	1,909,000	1,135,000
1920	6,870,000	3,360,000	1,753,000
1930	5,298,000	6,304,000	2,965,000
1940	5,528,000	10,069,000	3,300,000
1950	6,995,000	6,756,000	2,295,000
1960	8,457,000	5,938,000	3,339,000
1967	10,338,000	4,802,000	4,053,000
1968	10,972,000	4,228,000	3,572,000

Source: Texas Almanac and State Industrial Guide (Dallas Morning News 1970).

eliminate them or drive them to less suitable range. The Soil Conservation Service (SCS) reports that brush is the number one problem on Texas grasslands. Personnel of the SCS estimated that 30 to 35 million acres of brush in Texas had been treated by 1964, and 15 million acres of brush had been controlled (Smith and Rechenthin 1964:13). Bulldozing, chaining, railing, chopping, discing, mowing, shredding, and root-plowing are mechanical control methods used. Chemical controls include oils, ammate, hormone herbicides (sprayed by air or used in basal treatment), pelletized materials, and MPC amine acid. Heavy use of browse by goats is often recommended for brush control after various treatments. Controls are necessary for restoring pasture in many areas where invading brush has completely overcome forage production. However, an excerpt from SCS literature (Rechenthin et al. 1964:29) shows the frustrations connected with controlling brush and wildlife habitat:

> Woody plants are important . . . for many species of wildlife as sources of food, nesting and roosting sites, dens, and for cover.
>
> Oak acorns, for example, are an important food for many wild species of birds and animals. . . .
>
> The fruit of wild plums, persimmon, berries, cactus, agarita, hackberry, sumac and numerous other woody plants are important food sources. . . .
>
> Many kinds of wildlife use woody plants as escape cover from predators, and cover is essential to the survival of the young. . . .
>
> Most of the wildlife species (such as deer, turkey, doves, quail, javelina, and squirrels) of particular interest to ranchers because of recreational or income possibilities, adapt themselves to wide variations in environment, though some are more limited than others. . . . Turkeys must have roosting trees, but can use open grassland as well as woods for foraging.
>
> It seldom is desirable to remove all the woody plants. . . .
>
> Leaving some of the brush plants also leaves a source of seed for reinfestation. The landowner has to make a decision in planning his brush control based on the importance of wildlife to him in his operations-what affect *[sic]* removal will have, what and how many of the plants to retain-and then plan for maintenance to control reinfestation.
>
> There is too little specific information regarding minimum requirements for cover and food plants by various wildlife species. Experience and field observations by biologists, ranchers, and conservation technicians do give some worthwhile information that can be used as a guide in planning brush control where wildlife is a definite part of the operations.

These statements deserve careful scrutiny when related to controlling brush and managing turkeys. Controlling brush is an economic improvement aimed at reducing nonforage species while increasing forage species that supposedly allow the landowner more monetary return from his operation. But on turkey range, how much brush can be cleared before some habitat is destroyed? Walker and Springs (1952) concluded from a study of transplanted turkeys in the post oak belt that a minimum of 30 percent open terrain is needed for acceptable turkey habitat and 50 percent of well-spaced open country is more desirable. This requirement conflicts with the clearing of entire pastures or ranches involving thousands of acres.

Are the majority of landowners qualified to judge the quality of turkey habitat and its significance to local flocks? With sedentary wildlife, such as white-tailed deer, quail *(Colinus virginianus),* and squirrels *(Sciurus* sp.), landowners may be able to weigh habitat requirements and monetary potentials and relate these to brush control. With species as mobile as turkeys, which range over 20,000 acres or more during the year (Blakey 1944), an individual landowner can easily place too little emphasis on the needs that his acreage may supply to local flocks of turkeys. Turkeys may depend on an acreage for nest cover, for roost sites, for surface water, or for other requirements of livelihood, but if the landowner receives no income from turkeys, as is often the case on marginal range, he is likely to discount turkeys in the operations of his ranch.

A comparison of distribution of woody vegetation and density of turkey populations indicates that a variety of mast-producing species is necessary to sustain their production and carry-over of turkey populations. The Edwards Plateau produces and maintains the highest population of Rio Grande turkeys in Texas. Wildlife biologists estimated that there were 151,477 birds within a 22-county area in 1968 (Robinett 1970). This area also supports the most abundant variety of woody vegetation in the state, indicating a direct correlation between production and distribution of turkeys and the density of mast-producing species. Figures 54 and 55 show the occurrence of mesquite *(Prosopis chilensis), live* oak *(Quercus virginiana),* shin oak *(Q. breviloba),* and juniper *(Juniperus* sp.). The Edwards Plateau would not be productive habitat for wild turkeys if these species of brush were absent or drastically depleted, a situation that exists over much ancestral turkey range in Texas.

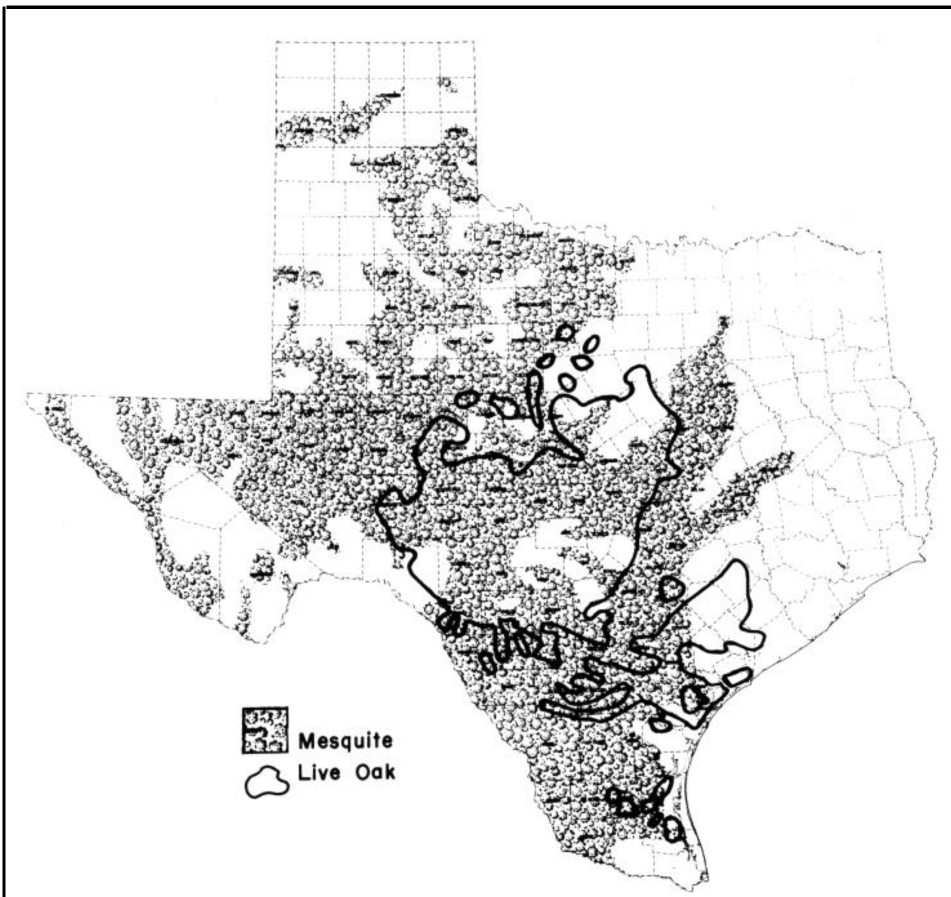


Figure 54. Distribution of mesquite and live oak on Texas rangelands.

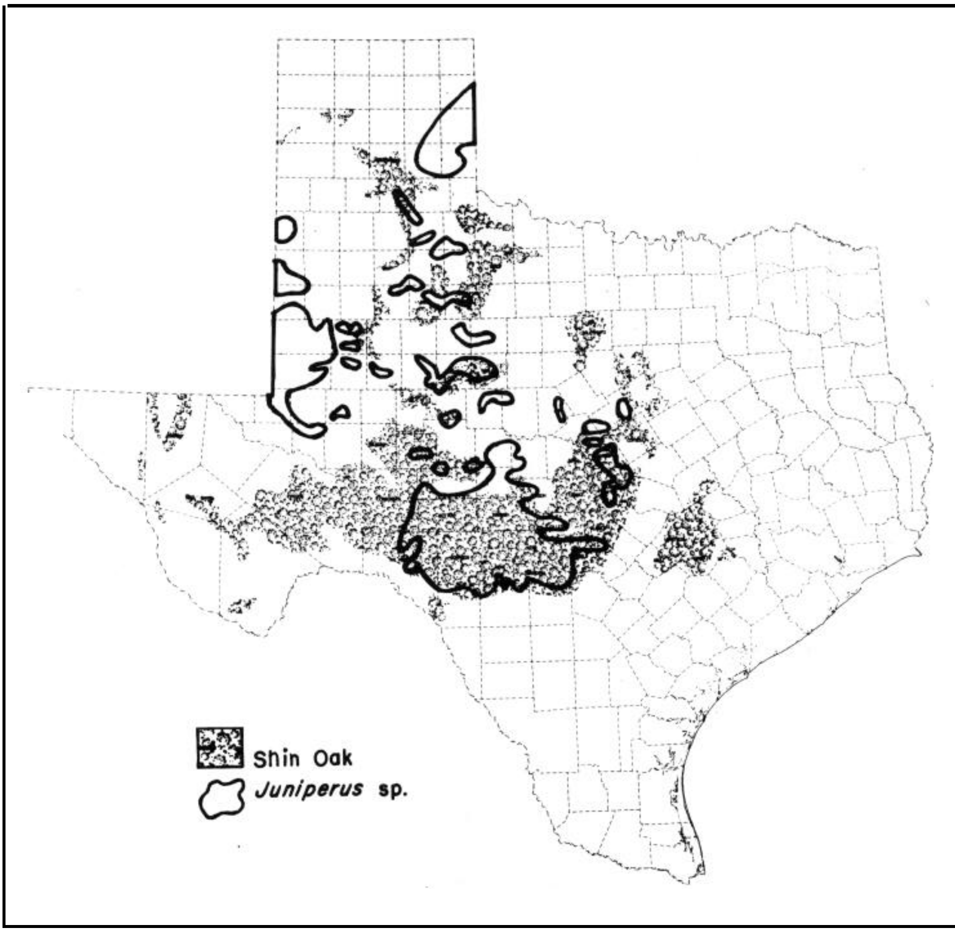


Figure 55. Distribution of *Juniperus* sp. and shin oak on Texas rangelands.

DISCUSSION

Turkey populations are presently higher in Texas than at any time during the last 40 years (Gore 1969). Transplanting of wild-trapped birds to ancestral ranges, increased availability of surface water (for livestock), and optimum climatic conditions, rather than changes in land use, are credited for the increases in population. Efforts to restore turkeys have resulted in the placement of wild-trapped broodstock where available habitat will support turkeys. Increases and decreases in the population occur as regularly as do changes in the quality of habitat. Widespread precipitation and improved conditions on the range after the severe drought of the 1950's promoted statewide increases in numbers of turkeys, and populations have continued to expand. The statewide estimates in 1968 totaled 575 thousand birds (Cook 1968). Landowners and field personnel of the Game Department reported isolated flocks where few or no turkeys had previously been observed. However, there is little chance that these high populations will be sustained.

Many flocks of wild turkeys have also been supplemented with pen-raised birds of pure wild origin by well-meaning landowners and sportsmen. Some of the highest turkey populations in the Edwards Plateau are composed of birds that appear, for the most part, to be domesticated. These turkeys seem to thrive on overgrazed ranges when given supplemental feed. Although they lack wildness, they survive and are available to the gun, which pleases most hunters. There is some speculation that future demands for turkey hunting will call for an increase in husbandry activities associated with pen-raised, semi-wild birds. Their tolerance of human activity allows them to be fed and protected, yet their instinctive wildness prevents their complete domestication, This semi-wild behavior in turkeys is prevalent in many areas of Rio Grande turkey range. The value of supplemental feeding in order to support wild turkeys is questionable except during severe drought. However, some biologists point to the fact that most large concentrations are supplementally fed and would not otherwise occur. Landowners who buy turkey feed are usually more protective of the birds than landowners who do not.

CONCLUSIONS

The future of the Rio Grande turkey hinges on whether limited habitat can be maintained under the present system of agriculture and social demands. The original range of the species in Texas covered well over 100 million acres (Schorger 1966:46), but land use is turning prime turkey habitat to uses that provide monetary gain. More than 25 million of these acres are in crops from which farmers receive 292 million dollars in government subsidies (Texas Agricultural and Stabilization Committee 1968). Fifty-four million additional acres of rangeland that are infested with brush and earmarked for control (Smith and Rechenthin 1964). Major reservoirs will total approximately 22.5 million acre-feet of water on bottomlands within the limits of Rio Grande turkey range by the year 2010 (U.S. Study Commission 1962).

Livestock production on smaller farms and ranches continues to rely on heavy grazing in summer and feeding in the winter. In contrast, turkeys respond well to rotated grazing systems and deferred pastures (Walker 1951b), practices that are mostly associated with ownership of larger areas where grazing is generally lighter than it is on smaller ranches (Texas Game, Fish and Oyster Commission 1945). Large ranches are also in a better economic position than small ranches to maintain habitat. If large ranches in turkey range are divided by heirs in coming generations, even more habitat will be destroyed. Smaller ownerships, in these days of high-priced land, high costs of operations, and available government subsidies, demand intensive use in order to sustain a paying business.

The general concensus of Texas wildlife biologists is that landowners are anxious to participate in restocking programs, protection from illegal hunting, and some supplemental feeding, but these three efforts appear to be the extent of their efforts to manage turkeys. Landowners destroy the turkey habitat but wonder at the scarcity of the birds. Many owners of small ranches cannot afford the luxury of turkeys. Practices that presently promote increases in number of turkeys are rotated grazing systems; moderate to light grazing with cattle, sheep, goats, and deer; plantings of small grains as winter food plots; minimal human disturbance; adequate mast-producing cover and roost sites; and occasional supplemental feeding. These practices are not common to the average ranch in much of the marginal turkey range. Quality of game habitat is secondary to operational efficiency, because the inefficient operation is usually short-lived. The trends in brush control, livestock production, use of insecticides, and rural and urban developments indicate that unless wild turkeys also gain adequate economic importance, they will eventually succumb to man's lucrative pursuits. More lenient and diversified harvest regulations would enable landowners to profit economically by the presence of Rio Grande turkeys (Thomas et al. 1973a). This, in turn, could change the landowners' attitudes toward providing adequate habitat. A statement of consequence was expressed by Aldo Leopold (1933:403-404). He said: "Experience with game has shown, however, that a determination to conserve, even when supported by public sentiment, protective legislation, and a few public reservations or parks, is an insufficient conservation program. Notwithstanding these safeguards, nongame wild life is year by year being decimated in numbers and restricted in distribution by the identical economic trends-such as clean farming, close grazing, and drainage-which are decimating and restricting game. The fact that game is legally shot while other wild life is only illegally shot in no wise alters the deadly truth of the principle that it cannot nest in a cornstalk."

31

SOME EFFECTS OF WEATHER AND TIMBER MANAGEMENT ON MERRIAM'S TURKEYS IN COLORADO*

Donald M. Hoffman

ABSTRACT

The climate of the range occupied by Merriam's turkey *(Meleagris gallopavo merriami)* in Colorado is usually not severe, because flocks move from high summer range to preferred winter range at lower elevations. Measurements of snowfall and precipitation within two preferred winter areas are listed. Occasionally, as in the 6-week period from early February 1964 to mid-March 1964, frequent heavy snows and high winds result in unusual winter stress on turkeys, unless food conditions are exceptionally good. Methods of harvesting timber affect selection of roost sites and the establishment and maintenance of forest openings. Selective cutting that removed approximately half of the old growth in stands of uneven-age ponderosa pine *(Pinus ponderosa)* on two summer roost sites did not appear to deter turkeys from using these sites for roosting. There were 17 other roost sites (9 winter and 8 summer sites) in unlogged tracts of old-growth timber. No roost sites were found in second-growth timber after clear-cutting operations.

Major changes in habitat have occurred within Colorado's wild turkey ranges since historical days, particularly within winter ranges. These changes have mostly resulted from man-induced practices, such as cultivation, timber operations, raising livestock, and recreation. Most aspects of these changes have not been evaluated.

Merriam's wild turkey is native to Colorado and has survived periods of extended drought, as well as periods of high snowfall and other severe conditions. Climate is an important factor directly influencing habitat. Measurements of temperature, precipitation, and snowfall have been secured for some winter areas.

THE STUDY AREA

The study area (Figure 56) lies in western Huerfano and Las Animas counties in south-central Colorado where Merriam's populations of turkeys are thought to be representative of the populations on the better historical ranges in the state. The range of Merriam's turkey (Figure 57), according to my check of its distribution from December 1, 1963, through October 13, 1968, is mostly limited to the area between 7,000 feet and 11,000 feet in elevation and approximates 900 square miles. The area between the 7,000-foot and 8,600-foot contours is considered primarily winter range and approximates 560 square miles. The area between the 8,600-foot and 11,000-foot contours (or between the 8,600-foot contour and the top of the Sangre de Cristo Range, where the

* A contribution from Federal Aid in Wildlife Restoration Project W-37-R.

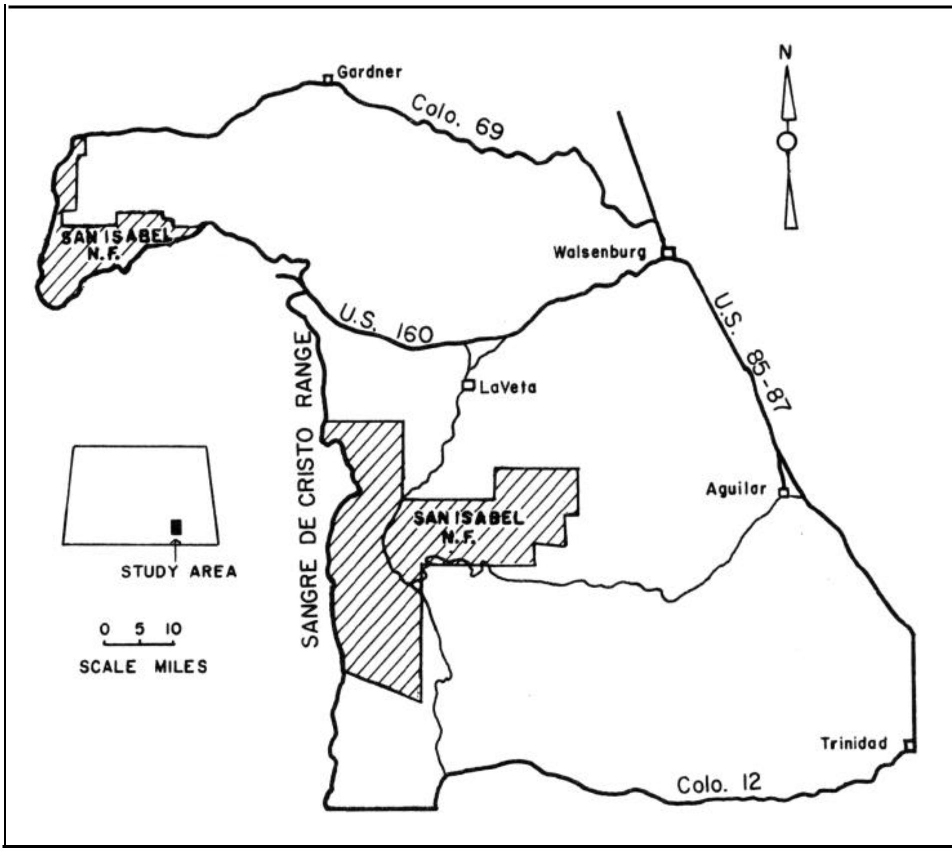


Figure 56. Map of the study area.

elevation is less than 11,000 feet) is primarily summer range and approximates 340 square miles.

Figure 57 shows long-time patterns of mean annual precipitation within the study area and is adapted from a map prepared by the Colorado State Planning Division, with information from the U. S. Weather Bureau.

The topography is almost entirely mountainous, varying from foothills to several peaks above timberline. Cattle raising is the main occupation in the study area, and several privately owned sawmills have been in operation for many years. Distinct vegetative types found within Merriam's turkey range include piñon *(Pinus edulis)* -juniper *(Juniperus* spp.), ponderosa pine, and spruce *(Picea* spp.)-fir *(Abies* spp.) (Table 71).

METHODS

Populations of turkeys were determined annually through counts of birds on winter areas, searches to locate new wintering flocks, and reports believed to be reliable from various individuals. Supplemental feeding stations using baled oat *(Avena sativa)* hay and whole grain were placed in 6 of the 16 winter areas (Figure 57, Nos. 3, 4, 5, 6, 8, and 10) during the winter periods of 1964-65 through 1967-68, and a 5-acre cultivated oat food plot was established in one winter area (Figure 57, No. 10) in the spring of 1966. These were

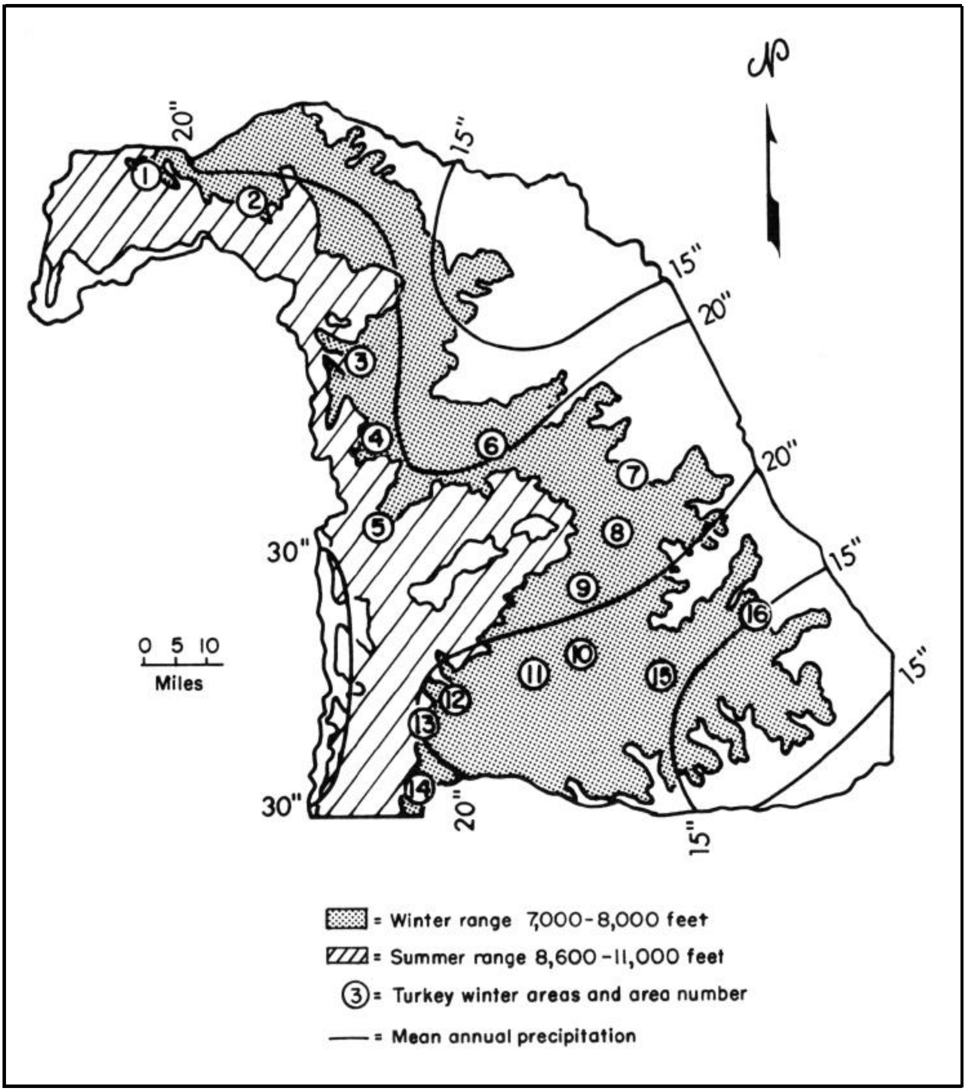


Figure 57. Locations of turkey winter areas on the study area in Colorado in relation to summer and winter ranges and annual precipitation patterns.

helpful in stabilizing wintering populations and aided in securing winter counts. Counts were made during the period December 1 through March 31 each winter. The maximum count after the population appeared to become stabilized was used for the population index.

Spring, summer, and early-fall distribution of turkeys within the study area was obtained for the period early May through late September each year. Records were kept of locations and elevations of spring and fall open-season kills, nest sites (harem flocks or droppings of incubating hens), brood-rearing sites (hens with young), field-sign locations (tracks, shed feathers, scratchings, or droppings), or sites where adult birds were observed. Late-fall and winter distribution of turkeys was secured for the period December 1 through March 15 by keeping records of locations and elevations of adult birds observed.

Table 71. Approximate elevations of vegetational zones and communities within the study area, based on altimeter readings secured along five routes in Colorado.

Vegetational Zone	Vegetational Community	Range in Elevations (feet)[a]
Piñon-juniper		Below 6,000 to 8,600
	Piñon-juniper-Gambel oak *(Quercus gambellii)*	7,100 to 8,600
Ponderosa pine		7,200 to 9,500
	Ponderosa pine-Gambel oak	7,200 to 9,500
	Ponderosa pine-aspen *(Populus tremuloides)*	8,000 to 9,500
	Ponderosa pine-Douglas fir *(Pseudotsuga* taxifolia)-white fir *(Abies concolor)*	7,500 to 9,500
Spruce-fir		8,200 to timberline
	Blue spruce *(Picea pungens)* -aspen	8,200 to 10,000
	Lodgepole pine *(Pinus contorta)* (limited areas only)	9,600 to 10,000
	Engelmann spruce *(P. engelmanni)*-alpine fir (A. lasiocarpa)-aspen	10,000 to timberline
	Bristlecone pine *(P. aristata)* (limited areas only)	9,400 to 11,000
Alpine		11.500 and above

[a]Elevations were found to vary as much as 1,000 feet according to how wet or dry the sites were; therefore, average elevations are listed.

Weather factors, including precipitation and temperature, were measured in two winter areas (Figure 57, Nos. 4 and 10) from May 1965 through August 1968, using standard weather stations consisting of precipitation gauges, maximum-minimum thermometers, and shelters. Measurements of snowfall were obtained for four winters (1964-65 through 1967-68) in one winter area (Figure 57, No. 4) and for one winter (1964-65) in two other winter areas (Figure 57, Nos. 8 and 10), using either a ruler or a yardstick.

Roost sites were located by searching areas where turkeys were known to range, interviewing landowners, and by tracking flocks of turkeys after snowfalls. The presence of fresh turkey droppings indicated active roost trees. The roost sites were classified as winter or summer sites. Winter sites were normally used during the late fall and winter while birds were concentrated on winter grounds, although some winter sites were used during the summer. Summer sites were those normally used during the spring and summer.

POPULATIONS

Figure 57 shows the locations of 16 known turkey winter areas within the study area. Specific winter areas were assigned arbitrary numbers (Figure 57). Table 72 lists wild turkey wintering populations by area and period. One or more of the 16 winter areas were not utilized by turkeys each winter during the 5-year study period. Movement between some of the winter areas was evident, but no birds were marked or instrumented as proof.

The 1963-64 winter population totaled 309 birds in 15 winter areas, or 0.55 bird per square mile of winter range. Populations were also determined during four successive winters, as shown in Table 72, but numbers and winter

Table 72. Wild turkey wintering populations, 1963-1968, in the study area in Colorado.

Area Number	Number of Turkeys During Winter Period				
	1963-64	1964-65	1965-66	1966-67	1967-68
1. Huerfano River	10	18	14	12	13
2. Pass Creek	4	0	7	7	2
3. Middle Creek	20	13	20	15	56
4. East Indian Creek	30	60	70	32	25
5. Cucharas River	14	0	0	12	0
6. Wahatoya Canyon	11	9	45	26	24
7. Santa Clara Creek	11	10	0	0	0
8. North Trujillo Creek	20	31	11	44	45
9. Apishapa River	13	8	0	0	8
10. Sarcillo Canyon	16	107	0	76	73
11. Wet Canyon	0	0	10	0	0
12. North Fork	17	0	7	0	0
13. Whiskey Creek	17	10	0	9	16
14. Abbotts Creek	50	62	63	60	50
15. Burro Canyon	14	0	0	0	0
16. Del Aqua Canyon	62	13	120	102	70
Total	309	341	367	395	382
Birds per square mile of winter range	0.55	0.61	0.66	0.71	0.68

distribution may have been influenced by the establishment of supplemental feeding stations in six areas after the period of 1963-64. Supplemental feeding practices were not conducted during 1963-64 except on a limited basis to facilitate counts of turkeys.

DISTRIBUTION

Approximate elevations of vegetational zones and communities within the study area, based upon altimeter readings secured along five routes, are listed in Table 71. The ponderosa pine zone ranging from 7,200 feet to 9,500 feet elevation is considered to be the most important for turkeys and includes both winter and summer range.

A summary of observations made at elevations where spring and fall open-season kills were made; at possible nest-site, brood-rearing, and turkey field-sign locations; and at locations where adult birds were observed is included in Table 73. These indicate that considerable nesting and brood-rearing activities occur within winter range (7,000 feet to 8,600 feet). The numbers of adult birds observed as well as field signs found in the higher summer range show that most of the turkeys spend considerable time at higher elevations during the summer months.

The majority of the known kills during the fall hunting season held annually in early October also occurred on winter range. I believe this is due largely to accessibility of these lower areas, but there also may be a trend toward movement to lower ranges early in the fall. Accessibility is also believed to be an important factor in hunter success during the spring gobbler season.

A summary of elevations of all observations of turkeys from December 1 through March 15, by period, is included in Table 74. All mean elevations

Table 73. Summary of spring, summer, and early fall locations of Merriam's turkeys, 1964-1968, in the study area in Colorado.[a]

Year	Number of Observations	Type of Observation	Elevation Range (feet)	Elevation Mean (feet)
1964	5	Spring gobbler season kills (May 2-12)	7,800- 9,500	8,650
	2	Nest sites[b]	9,250- 9,800	9,550
	27	Brood-rearing sites[c]	7,200-10,200	8,400
	4	Grown birds observed	8,100- 9,300	8,950
	19	Field signs[d]	7,900-10,050	8,850
	3	Fall season kills (October 3-11)	7,200- 7,800	7,600
				8,650[e]
1965	2	Spring gobbler season kills (April 10-18)	7,800- 8,050	7,950
	3	Nest sites	8,700- 9,300	8,900
	17	Brood-rearing sites	7,500- 9,500	8,200
	11	Grown birds observed	7,700-10,500	8,200
	49	Field signs	7,700-10,500	8,750
	5	Fall season kills (October 2-10)	7,200- 9,200	8,100
				8,550[e]
1966		No spring gobbler season held in 1966		
	2	Nest sites	8,800-10,500	9,650
	25	Brood-rearing sites	7,400-10,050	8,200
	15	Grown birds observed	7,500-10,400	8,050
	33	Field signs	7,200-11,100	8,900
	4	Fall season kills (October 1-9)	7,200- 9,200	8,200
				8,600[e]
1967	3	Spring gobbler season kills (April 29-May 7)	7,900- 9,200	8,550
	4	Nest sites	7,000- 8,250	7,750
	17	Brood-rearing sites	7,200- 8,600	7,950
	11	Grown birds observed	7,300- 9,400	8,500
	18	Field signs	7,400-10,300	8,600
	4	Fall season kills (October 7-15)	7,300- 9,400	8,050
				8,250[e]
1968	6	Spring gobbler season kills (April 27-May 5)	7,600- 9,200	8,200
	3	Nest sites	7,500- 8,000	7,750
	19	Brood-rearing sites	7,500-10,300	8,250
	9	Grown birds observed	7,700-10,000	8,900
	7	Field signs	7,800- 9,200	8,800
	5	Fall season kills (October 5-13)	7,300- 9,350	8,100
				8,400[e]

[a]The period of observation was from early May to late September except for open seasons where dates are listed.
[b]Harem flocks observed or nesting-hen field signs observed.
[c]Broods observed or reported.
[d]Observations of droppings, tracks, shed feathers, scratchings, or reports.
[e]Mean of the samples taken for the respective year.

Table 74. Summary of late-fall and winter locations of Merriam's turkeys, December 1 to March 15, 1963-1968, in the study area in Colorado.

Period	Number of Observations	Elevation Range (feet)	Elevation Mean (feet)
1963-64	25	7,200 to 8,600	7,900
1964-65	21	7,200 to 8,700	8,050
1965-66	16	7,200 to 8,500	8,050
1966-67	13	7,200 to 8,700	8,100
1967-68	14	7,250 to 8,700	8,000
5-year average	18	7,200 to 8,700	8,000

are within winter-range elevational limits, Higher summer areas were checked at that time without finding birds.

A seasonal altitudinal movement of birds was indicated from the various winter grounds toward the intermediate and summer ranges in the spring and the return in the fall. Weather and food were the apparent controlling factors in this movement. Green grass was usually observed to be available in most winter areas by mid-February, and the spring dispersal of wintering concentrations usually occurred by late March.

WEATHER FACTORS

The winter range of Merriam's turkey in Colorado is characterized by moderate climate in most years. Amounts of snowfall (Table 75) on one winter area (Figure 57, No. 4) varied from 54 to 169 inches and averaged 109 inches during the four winters of this study. When above-normal snowfall occurs, the birds are forced to move to lower elevations, often below preferred winter range. Higher elevations normally receive heavier snowfall, as would be expected, Differences in the amounts of snowfall and annual precipitation within the winter areas are probably due to site.

The total snowfall during the winters of 1963-64 and 1967-68 was much above average on all winter areas. Winter areas were covered with deep drifts by heavy snows and high winds from early February to mid-March 1964, and from early December 1967 to mid-January 1968.

Severe weather conditions in the form of deep snows, high winds, and low temperatures during the period early February through mid-March 1964, combined with poor production of natural food in 1963, apparently caused concentrations of turkeys in four winter areas (Figure 57, Nos. 1, 3, 4, and 8)

Table 75. Amount of snowfall, in inches, from September 1 through March 31, 1964-1968, on the study area in Colorado.

	Area and Elevation		
	East Indian Creek (Wintering Area No. 4)	North Trujillo Creek (Wintering Area No. 8)	Sarcillo Canyon (Wintering Area No. 10)
Period	8,000 feet	7,800 feet	7,900 feet
1964-65	111	81	56
1965-66	54	Not measured	
1966-67	104	Not measured	
1967-68	169	Not measured	
Average	109		

Table 76. Precipitation, dates of killing frosts, and days between killing frosts, 1965-1968, East Indian Creek winter area, elevation 8,000 feet (Figure 57, No. 4).

Year	Precipitation (inches of moisture)				Dates of Killing Frost and Temperature[a]		Days Between Killing Frosts
	Jan.-April	May-Aug.	Sept.-Dec.	Total	Last	First	
1965	Installed May 3	10.56	5.00		June 2-9 26 F	Sept. 24 23 F	122
1966	3.99	8.35	3.19	15.53	May 23-31 25 F	Sept. 16 27 F	122
1967	4.27	14.80	5.46	24.53	May 15-22 22 F	Sept. 12 23 F	122
1968	5.58	11.09			May 27-June 3 15 F	Sept. 16 18 F	121
Average	4.61	11.20	4.55	20.03	Late May	Mid-Sept.	122

[a]Killing frost is considered to be 27° F or less.

to break up into small groups of two to eight birds each, move down the mountains and valleys, and show symptoms of winter stress. In contrast, flocks in three winter areas (Figure 57, Nos. 10, 14, and 16), where supplemental feed was provided by ranchers during the periods of deep snow cover, remained on their winter grounds and did not show symptoms of abnormal winter stress.

Similar severe weather conditions occurred during the 6-week period from early December 1967 through mid-January 1968. Mast production was spotty during 1967. Supplemental feeding stations were provided in six winter areas (Figure 57, Nos. 3, 4, 5, 6, 8, and 10) by the Colorado Division of Game, Fish and Parks and in two winter areas (Figure 57, Nos. 14, and 16) by ranchers. Turkeys on all these winter areas remained on their normal winter grounds and evidenced no symptoms of abnormal winter stress. Populations in four winter areas (Figure 57, Nos. 1, 2, 9, and 13) were not followed closely, because many secondary roads were blocked and travel was difficult, so it is not known how these populations fared. No turkeys are thought to have wintered on the remaining four winter areas (Figure 57, Nos. 7, 11, 12, and 15).

Table 76 lists general weather information for the East Indian Creek winter area (Figure 57, No. 4), located at 8,000 feet elevation, northwest of the Spanish Peaks; Table 77 lists similar information for the Sarcillo Canyon

Table 77. Precipitation, dates of killing frosts, and days between killing frosts, 1965-1968, Sarcillo Canyon winter area, elevation 7,900 feet (Figure 57, No. 10).

Year	Precipitation (inches of moisture)				Dates of Killing Frost and Temperature[a]		Days Between Killing Frosts
	Jan-April	May-Aug.	Sept.-Dec.	Total	Last	First	
1965	Installed May 6	12.67	3.03		June 3-10 26 F	Sept. 7-21 25 F	107
1966	2.63	15.47	1.46	19.56	May 10-16 22 F	Oct. 1 25 F	137
1967	2.67	17.43	3.51	23.61	May 15-22 22 F	Oct. 2-12 27 F	140
1968	3.43	9.99			May 20-27 24 F	Sept. 16 23 F	128
Average	2.91	13.89	2.66	21.58	Mid-May	Late Sept.	128

[a]Killing frost is considered to be 27° F or less.

winter area (Figure 57, No. 10), located at 7,900 feet, southeast of the Spanish Peaks. Most of the annual precipitation for both areas comes in the form of rain during the late-spring and summer periods.

TIMBER OPERATIONS AND ROOST SITES

The study area included 9 winter and 10 summer roost sites (Hoffman 1968). The 9 winter roost sites were found in 7 of the 16 winter areas. The remaining 9 winter areas undoubtedly contained one or more roost sites, but they were never located. Tall, overmature ponderosa pines were preferred for winter roost sites. Old-growth Douglas fir, white fir, and narrowleaf cottonwood *(Populus angustifolia)* were also used on winter sites. Summer sites, while similar to the winter sites, were usually located at higher elevations, smaller in area, and contained fewer roost trees. Overmature ponderosa pines were most often used on the summer sites; old-growth Engelmann spruce, narrowleaf cottonwood, and white fir were also used.

All 9 winter roost sites and 8 of the 10 summer roost sites were in unlogged tracts of old-growth timber, either in areas where surrounding timber had never been logged, or as islands of uncut timber left because of inaccessibility or for aesthetic reasons. The smallest island of uncut timber used by turkeys for roosting was a group, of three large ponderosa pines on approximately 0.25 acre on a summer roost site.

No roost sites were found in second-growth tracts. Trees 8 inches in diameter at breast height and larger, on eight unlogged summer roost sites, averaged 64 trees per acre (range 24 to 108). On two logged summer roost sites, the average was 30 trees per acre (range 26 to 34). Before being logged, these two sites had an average of 61 trees per acre, as determined by counting stumps. It is not known if these sites were used for roosting prior to logging. Selective cutting that removed approximately half of the old-growth, uneven-aged ponderosa pine did not appear to deter turkeys from using these sites for roosting.

This page has been intentionally left blank to preserve the continuity of the original document.

32

EVEN-AGE MANAGEMENT TURKEYS AND TURKEY HUNTERS A NEW STUDY*

Jack Ward Thomas, James C. Pack, John D. Gill, and R. Wayne Bailey

ABSTRACT

Methods for coordinating even-aged hardwood management and turkey-habitat management are being studied in West Virginia. The study utilizes a 20,000-acre area (10,000 acres in control); 1,620 acres are treated as clear-cuts and 840 are of intermediate cut. Effects of the treatment on eastern turkeys *(Meleagris gallopavo silvestris),* white-tailed deer *(Odocoileus virginianus),* squirrels *(Sciurus* spp.), ruffed grouse *(Bonasa umbellus),* and on attitudes and behavior of hunters are being determined. Three techniques are used to measure wildlife populations. Some 1,200 to 1,400 hunters are interviewed annually.

THE PRESSING PROBLEM

When the wildlife-habitat project of the U.S. Forest Service was begun at Morgantown, West Virginia, in 1967, advice about needs for research was solicited from outstanding biologists and administrators in Kentucky, Ohio, Pennsylvania, Virginia, and West Virginia. Most of these authorities reported that the most pressing need for research is to determine how even-age timber management affects wildlife, particularly turkeys and gray squirrels *(Sciurus carolinensis).*

A large-scale study was activated 3 years ago, and timber cutting is due on the study area. Although the study is too new to provide any answers, there is so much interest in this problem that a preliminary report on the effects of even-age management (EAM) on turkeys and turkey hunters is in order.

Silvicultural research by the Forest Service has brought about radical changes in the concept of hardwood timber management. EAM (initial cuttings followed by one or more intermediate thinnings and concluded by clear-cutting when timber reaches the age for rotation) is now considered more practical than uneven-age or all-age management brought about by selective cutting. EAM nearly always yields plentiful regeneration, favors valuable intolerants, allows short rotations, and is simple to apply (Roach and Gingrich 1968).

This concept of EAM is being used increasingly on both public and private forest lands throughout the East. Unfortunately, effects on species of wildlife-particularly turkeys and squirrels (there seems to be much less concern about deer and grouse)-cannot be predicted as confidently as the effects on timber production. Because of the flexibility it offers in manipulating vegetation and vegetative patterns, EAM has been seen as a needed and valuable tool for the

* This is a cooperative study of the West Virginia Department of Natural Resources (Pittman-Robertson Project W-39-R) and the U.S. Department of Agriculture, Forest Service (Northeastern Forest Experiment Station and Monongahela National Forest).

wildlife manager (Zeedyk 1968). Other authors have predicted, more or less confidently, that the effects of EAM systems will be generally beneficial to wildlife (Schulz 1964, Doolittle 1966, U.S. Forest Service 1969).

It seems unquestionably true that regeneration cuts provide initially great increases in browse and herbaceous vegetation (Ripley and McClure 1963, Harlow et al. 1966). Regeneration cuts have also been praised as providing clearings, particularly good for brood range, that can be used by turkeys (U.S. Forest Service 1969). However, these benefits may be short-lived for deer (Harlow and Downing 1969) and for turkeys (Bailey and Rinell 1968).

In the case of turkeys, the greatest concern centers around the general effect of clear-cutting on acorn production and on turkey hunting and turkey hunters.

Korschgen (1967) reviewed the available information about food habits of the eastern wild turkey and found that acorns are the wild turkey's most important staple food. Acorns provide 25 to 66 percent of the wild turkey's diet during winter. But EAM may be a threat to acorn production, because it leads to reduction of the average age of the overstory; domination of stands by non-oak *(Quercus* spp.), shade-intolerant species; and conversion of existing oak and oak-hickory *(Carya* spp.) to stands of softwood or non-oak hardwood. The problems involved here have been pointed out by Zeedyk (1968):

> It is probably safe to say that in hardwood types under an 80- or 100-year rotation, we will have as much capability with even-aged as uneven-aged managed management, but the yields will come from fewer acres. Under uneven-aged management mast was produced on every acre, but basal areas averaged only 40-50 square feet per acre. Crowns were often thin, stunted, poor mast producers. With even-aged management, we can look for 70-80 square feet or more in vigorous, fast growing dominant and co-dominant full crowned stems.
>
> But remember, mast production does not begin until around age 30 and increases per square foot of BA with increased diameter. The years beyond 60 are best. Any shortening of rotation has a disproportionate impact on mast. With a 100-year rotation about 30-40 percent of the stands in the working group will produce little or no mast, whereas the portion older than 60 will probably produce more mast under EAM than under any other system! With a 60 year rotation you can expect token mast production on half of the area and none from the rest.

Obviously, the variables of spacing, size, and timing of regeneration and thinning cuts are extremely critical. Not enough data are available on the subject, but it would seem that forecasts of benefits, or at least minimal damage to turkey and squirrel populations, are too full of unknown factors to be comforting.

Similarly, little data are available on the effect of EAM on the turkey-hunting experience. Turkey hunting, by its nature, tends to be a highly aesthetic proposition involving stalking skill, knowledge of the prey, ability to call, and a very low success ratio. Although not many have taken this view, the production of a satisfactory hunting experience may take precedence over the production of a better crop of game. The hunter is the consumer, and his satisfaction is of paramount importance to those who produce and provide game and hunting.

So the arguments about effects on quantity of game and on quality of hunting experience continue. Adequate, accurate data on the subject are lacking-particularly information about the trade-offs between production of timber, squirrels and turkeys, deer, and grouse. Because of the imbalance between silvicultural knowledge as embodied in EAM and the knowledge of its effects on the habitat, quantity and behavior of game, and on hunters' attitudes and behavioral handicaps, the multiple-use land manager must determine the best compromises among the optimum treatments for each individual resource.

OBJECTIVES

The objective of the current study is to determine the effects of EAM on wildlife populations, as well as on harvests of game and on attitudes and behavior of the hunter.

The purpose of judging the effect on turkey populations is obvious. The purpose of studying hunters may be less obvious, but one of the ultimate concerns of game managers is the effect of any manipulation of habitat on the harvest of game and on the attitudes and behavior of the hunter. Those effects are the criteria by which success or failure is judged by the public and, generally, by game administrators. The need to include hunters and the hunting experience as an integral part of the overall study is made even more obvious by the numerous confrontations that have occurred between land managers and hunters over EAM.

To achieve its objectives, the study will determine the effects of even-age timber management on: (1) harvest of turkeys; (2) numbers of turkeys, as reflected by numbers of turkeys encountered per unit of hunting effort; (3) behavior of hunters; (4) distribution of hunters; (5) attitudes of hunters toward even-age management, as reflected by their opinions of its effect on quantity of game, the chances of killing game, and the aesthetics of the hunting experience; (6) number of turkeys, as determined by censuses; and (7) distribution of turkeys in relation to hunting.

STUDY AREA

The study area is Middle Mountain, in the Monongahela National Forest, Pocahontas and Greenbrier counties, West Virginia. The area is characterized by oak-hickory and oak-pine *(Pinus* spp.) forest types and lies in the Ridge and Valley Geological Province.

Middle Mountain, 18 miles long and 1.5 to 2.5 miles wide, comprises some 20,000 acres. The planned sale of timber (treatment) will take place on the southern half of the mountain; the northern half will serve as a control. The sale was designed and is being administered by personnel of the White Sulphur Ranger District, Monongahela National Forest. The gross sale area is 10,270 acres. Of this, 1,620 acres are marked for regeneration (clear-cutting) and 840 for intermediate cutting. The cutting will be done in 71 units, ranging in size from 3 to about 100 acres, dispersed through seven different combinations of growth involving forest type, stand condition, site index, and basal area.

As a study site, Middle Mountain has the additional advantage of being the heart of the Rimel-Neola study area used by Bailey and Rinell (Bailey and Rinell 1965, 1966, 1967a; Bailey 1957, 1959b; and Mosby 1967) for intensive studies on the dynamics of turkey populations in 1955-1965.

STUDY DESCRIPTION

EFFECTS ON WILDLIFE POPULATIONS

Methods.-We are interested in turkeys, deer, squirrels, and grouse. Because animal populations are generally low, and because we prefer not to rely completely on single indices, three separate indices are derived for each species.

This allows the acceptance of less precision in individual techniques. We also use several techniques, because the entire sampling scheme lends itself to the collection of a variety of data at little additional cost beyond that for collecting one set of data for each species,

Information on the number of deer is acquired from (1) censuses of groups of pellets, (2) counts of tracks in the snow, and (3) interviews with hunters. Squirrel population indices are derived from (1) counts of leaf nests, (2) interviews with hunters, and (3) squirrels seen per hour by project personnel. Grouse are indicated by (1) censuses of drumming grouse, (2) interviews with hunters, and (3) censuses of strips. Estimates for population and distribution of turkeys will be determined by using four separate techniques : (1) trapping and banding, (2) counting tracks in the snow, (3) records of gobbling in the spring, and (4) interviews with hunters.

Game Harvests, Hunter Attitudes, and Behavior

Methods. -During the fall turkey season in West Virginia (usually October 15 to November 19), hunters are interviewed at stations maintained at the main exit routes from the Middle Mountain area. All hunters are stopped, and Middle Mountain hunters are given intensive interviews. Check stations are maintained on a schedule that covers the peak periods of hunting activity. Our aim is to interview more than 90 percent of all turkey hunters who use the study area.

The preliminary questionnaire was composed after consultation with several experts and was pretested in 1967 on 1,353 hunters, 464 of which were turkey hunters. After the pretest we revised the questionnaire for use during the hunting season of 1968.

Data from our preview year of 1967 have been analyzed and published (Thomas and Pack 1969). Of the hunters we interviewed, 60 percent were deer hunters, 33 percent were turkey hunters, 6 percent were squirrel hunters, and less than 1 percent were grouse and rabbit *(Sylvilagus transitionalis)* hunters. Turkey hunters spent 25 hours hunting for each bird seen and 200 hours for each bird bagged.

CONCLUSION

The effects of EAM on turkeys are largely unknown, and the gathering of information on these effects is a most pressing research need. We believe this intensive long-term study will provide some of the answers. We also hope to suggest alterations or modifications in timber-management procedures for the benefit of wildlife, particularly turkeys.

V I

CENSUS TECHNIQUES AND HARVEST MANAGEMENT

John B. Lewis

The need for improved censusing of turkey populations is increasing with the increase in hunting pressure and with the growing demand for additional opportunities to hunt. Unfortunately, the techniques for conducting a census have not kept pace with the needs. The lack of adequate techniques of censusing is due primarily to the fact that wild turkeys are very mobile and secretive and occupy large isolated areas that make accurate counts difficult to obtain.

Although the problems of obtaining accurate counts of populations are acute with all subspecies, censuses of the Rio Grande and Merriam's turkeys are somewhat easier to obtain than those of the eastern turkey. Techniques involving counts of winter roosts in Texas show promise for developing excellent data on population trends. These data, plus information on spring dispersal from traditional winter areas, provide the basis for recommending changes in regulating the harvest. The roadside survey has value for establishing data on trends for Merriam's turkeys in Arizona; however, additional testing may be necessary before the technique can be accepted for widespread use.

Coupled with the need for up-to-date censuses is the need for an accurate appraisal of overall effects of hunting mortality. Although it is generally thought that current turkey populations are underharvested, there is little factual information to substantiate this belief. In one state, however, spring harvests of 43 percent of the gobblers on one area had no adverse effects on the population. Thus, it is possible that in most states, more liberal spring hunts could provide additional opportunities for hunting without damaging the resource.

The five papers in this section provide pertinent data on several aspects of the problems associated with managing the harvest of wild turkey populations and on the use of pen-reared wild turkeys on shooting preserves.

This page has been intentionally left blank to preserve the continuity of the original document.

33

A CENSUS TECHNIQUE FOR THE RIO GRANDE TURKEY*

Robert L. Cook

ABSTRACT

Winter roosts of the Rio Grande turkey *(Meleagris gallopavo intermedia)* in the Edwards Plateau of Texas were located, and landowners were asked to estimate the number of turkeys utilizing each roost throughout the winter. Counts of turkeys on sample roosts were made to determine the accuracy of landowners' estimates. Counts indicated that landowners in the western portion of the Plateau overestimated the number of turkeys by 7 percent over a 2-year period. Landowners in the eastern counties overestimated the number of turkeys by 203 percent. Roost sites in the western counties were stable and were found in specific locations, but those in the eastern counties were not. The stability of the roost site influenced the ability of landowners to estimate the number of turkeys. The interview was a satisfactory technique of censusing turkeys in the western counties, but it was unsatisfactory in the eastern counties, where roosts were unstable.

A reliable method of determining the wild turkey population of any large area has long been sought. Mosby (1967) reported that constant observation and map-plotting of field evidence was, perhaps, the most satisfactory technique currently available. He also noted the use of airplanes and helicopters, self-tripping camera sets, band-return data, and hunter-harvest indices as indicators of turkey populations.

We wanted to determine whether populations of Rio Grande turkeys could be reliably inventoried by interviews with owners of the land on which winter turkey roosts were located.

Thomas et al. (1966) theorized that turkeys in the Edwards Plateau might be successfully inventoried by this method because of their habits of congregating and roosting during the winter. Each turkey or group of turkeys consistently utilized a single specific roost site throughout the winter in the western portion of the Edwards Plateau.

METHODS

Location of Roosts

Project personnel, assisted by local game-management officers, attempted to locate all winter roosts of turkeys in the Plateau area. Records of kills kept by personnel of shooting preserves were used to locate additional roosts by noting the indications of concentrations of turkeys in areas where roost sites were unknown.

A *winter roost site* is considered the place or area where a consistent number of turkeys roost nightly during December, January, and February unless

* This study is a contribution of Texas Pittman-Robertson Project W-62-R.

the area is destroyed or the turkeys are unduly disturbed. A *winter roosting flock* is the group of turkeys that congregate and roost nightly on a specific location during winter.

Landowners with concentrations of turkeys roosting on their land during winter were interviewed to determine roost locations and numbers of turkeys present. Roost sites were plotted on county maps and pertinent data were recorded on individual forms.

Additional winter roosts are located each year, even though they may have existed many years. Therefore, it will be possible to accurately estimate the turkey population of any given portion of the Edwards Plateau by this technique only when all existing roosts on the area in question are located and censused.

Estimates of Landowners

Owners or ranchers of land supporting winter turkey roosts were asked to estimate the number of turkeys consistently utilizing each roost during the winter months. Biologists then made counts of turkeys on sample roosts to determine the disparities between estimates by landowners and the numbers of turkeys present.

Counts by Biologists

The roost sites were visited several times to determine the travel routes and the exact trees being used by the turkeys. During the winter of 1966-67, turkeys on each of 12 roosts were counted after studying the roost sites and the habits of the turkeys. Biologists made counts from concealed places, from vehicles traveling near or through the roosts, or from high cliffs adjacent to the roost sites. Counts were made during the early morning or late evening hours of December, January, and February while the turkeys were near the roost sites.

During the winter of 1967-68, biologists made counts of turkeys on 21 roosts over a cross section of the Edwards Plateau to determine the accuracy of the landowners' estimates.

RESULTS

Some landowners claimed to have turkey roosts on their land when none existed. Usually, these were roost sites used irregularly, in the fall or late summer, and located adjacent to ranches with permanent winter roosts. It was therefore necessary to observe all roosts to determine whether they were being regularly utilized by the same groups of turkeys during the winter months. Only those roost sites used regularly throughout the winter were considered permanent winter roosts to be censused annually to establish levels and trends of the population.

Winter turkey roosts in Kimble, Menard, Sutton, Schleicher, Crockett, Val Verde, Mason, McCulloch, Kerr, Bandera, Edwards, Real, and Gillespie counties (western counties) were normally found in specific locations, with little nightly movement by turkeys to different roosts. Each site was generally a group of trees along a river bank, near a steep bluff or in a shallow valley. Landowners and biologists found turkeys roosting in the same sites prior to and throughout this study in the western counties. However, we found that the locations of roosts were not always stable in the eastern counties of Llano, San Saba, Lampasas, Burnet, Blanco, Kendall, Hays, Travis, and Comal. Turkeys in this area frequently moved to different roosts and did not, characteristically, use any roost site for an extended period. Some landowners indicated that small groups of turkeys might be found roosting almost anywhere on their ranches. Biologists in this area found one flock of turkeys that roosted in two different locations over 0.5 mile apart on two successive nights. Instability of the roost sites in this area may be due to frequent disturbance of roosting turkeys by human activities and to the more intense land-use practices on the smaller ranches. Game wardens frequently receive reports of poachers killing turkeys on the roosts at night during the winter months. Some groups of turkeys have never returned to roost sites where they were attacked by poachers.

Instability of roost sites and infrequent observations caused many landowners in the eastern area to be inaccurate in their estimates of numbers of turkeys. Our direct counts were often unsuccessful because of landowners' erroneous reports of roost sites.

Ranchers having winter roost sites take precautions to care for the turkeys roosting on their land and frequently observe the roost sites if they are used regularly. No legal hunting or other unusual activity is allowed near the roosts. Most landowners maintain supplemental feeding programs if they have turkeys on their land, and frequently count the birds to determine the exact number present. The estimates given by these men are usually accurate if the locations of the roost sites are stable.

Roost Counts

Biologists made counts of turkeys on 12 roosts in Kimble, Sutton, and Mason counties (western counties) during the winter of 1966-67 (Table 78).

Table 78. Comparison of landowner estimates and roost counts, winter 1966-67, on the Edwards Plateau, Texas.

County	Roost[a]	Landowner Estimate	Count[b]	Disparity Between Landowner Estimate and Count: Number	Percentage
Kimble					
	Buck	175	226	-51	-23
	Gibson (House)	75	64	+11	+17
	Gibson (Winship)	100	99	+1	+1
	Homann	50	37	+13	+35
	Nethery	100	91	+9	+10
	Neal	100	93	+7	+8
	Reick	250	220	+30	+14
	Rembold	137	118	+19	+16
	Rust	400	385	+15	+4
Mason					
	Willmann	50	48	+2	+4
Sutton					
	T. Glasscock	32	28	+4	+14
	Vanderstucken	87	98	-11	-11
Total		1,556	1,507	+49	+3

[a]Roost named for landowner.
[b]Counts by biologists are considered to be the exact numbers of turkeys utilizing the roosts.

Table 79. Comparison of landowner estimates and roost counts, winter 1967-68, on the Edwards Plateau, Texas.

				Disparity Between Landowner Estimate and Count	
Counties	Roost	Landowner Estimate	Count	Number	Percentage
WESTERN					
Kimble					
	Buck	200	178	+22	+12
	Homann	50	41	+9	+22
	Reick	250	233	+17	+7
	Ragsdale	40	66	-16	+24
Mason					
	Martin	100	66	+34	+52
	Fleming	50	42	+8	+19
	Willmann	70	65	+5	+8
Sutton					
	Vanderstucken	90	82	+8	+10
	Sawyer	115	116	-1	-1
	Ross	200	199	+1	+1
	Wilson	90	81	+9	+11
Gillespie					
	Bean	55	55	0	0
	Roach	40	41	-1	+2
Kerr					
	Crider	45	43	+2	+5
	Fine	30	21	+9	+43
	Pinto	150	98	+52	+53
Total		1,585	1,427	+158	+11
EASTERN					
Blanco					
	Johnson	150	12	+138	+1,150
	Davis	50	33	+17	+52
	Reeves	40	25	+15	+60
Hays					
	Zimmerman	45	32	+13	+41
	Howell	200	58	+142	+245
Total		485	160	+325	+203

These counts showed that 1,507 turkeys were roosting in the 12 roosts. Landowners estimated 1,556 turkeys, overestimating the total by three percent (Table 78) .

Counts of turkeys on 21 roosts in the western counties, made by biologists during the winter of 1967-68, showed 1,427 turkeys, compared with estimates of 1,585 by landowners-an overestimation of 11 percent (Table 79). Counts of turkeys on roosts in the eastern counties showed 160 turkeys, compared with estimates of 485 by landowners, an overestimation of 203 percent.

DISCUSSION

Counts made by biologists showed that estimates made by landowners of numbers of turkeys utilizing winter roosts could be used to determine levels and trends of populations where there is little nightly movement from one roost site to another. Landowners in the western counties, with stable roost sites, overestimated the number of turkeys using the roosts by 7 percent over the 2-year period. Because turkeys in the eastern counties of Blanco and Hays do not roost regularly in specific locations, landowners overestimated the population by 203 percent in 1967-68.

The author is first to realize and point out the simplified treatment of these data and is also aware of the many variables encountered when collecting and analyzing the data. Primarily, the ability of each person to census turkeys on the roost site cannot be measured. In addition, the apparent tendency of landowners to *round off* estimates creates problems no biologist can overlook when subjecting such data to statistical analysis. Finally, neither of the above takes into account the unpredictability of the wild turkey.

Banding studies being conducted in the eastern counties should establish the consistency of each roosting flock. If roosting flocks do not mix with each other, we will then find and census each winter roosting flock in the eastern counties, regardless of where they roost.

Additional studies are necessary to determine other areas in Texas where stability of roost sites will allow use of the estimates by landowners as a technique for census.

Modifications of technique may prove useful. With additional manpower, it may be possible to census each winter roost annually, thereby eliminating the estimates made by landowners. A relatively quick and reliable estimate of the turkey population might be achieved through an annual statistical sample of the roosts. Analysis of accumulating data may provide correction factors for application to landowners' estimates from which to derive estimates of total populations. At least, such data can be analyzed for development of excellent data on population trends.

This page has been intentionally left blank to preserve the continuity of the original document.

34

THE ROADSIDE SURVEY FOR MERRIAM'S TURKEYS IN ARIZONA*

Harley G. Shaw

ABSTRACT

The summer roadside survey for Merriam's turkeys *(Meleagris gallopavo merriami* Nelson) has been used in Arizona for more than 20 years. Management personnel now tend to de-emphasize the technique as a measurement of trends and to use it only for gathering data pertaining to sex and age. Analyses of data compiled from 6 years of intensive survey on two areas renew hope that the method can serve to indicate changes in population. On the Moqui, where 3,400 miles of survey were run yearly, figures that determined trends in population varied approximately 25 percent between years and were significant at the 90 percent confidence level. The present design, using repeat runs and relatively short routes, apparently contains a serious bias. A procedure using longer runs without repeating is recommended. Noticeable differences in distribution of the turkey population between years occurred on the Moqui. Adequate distribution of effort during the survey is thus extremely important. Wet vegetation appeared to have little effect on results of the survey, but torrential afternoon thunderstorms frequently interrupted runs. Use of morning surveys only will avoid most problems due to weather. Reliability of hen:poult ratios at various sampling intensities is discussed. The data give little hope of deriving accurate tom:hen ratios from late-summer surveys.

Improved techniques of censusing are needed in turkey management and research. The most common methods used on eastern races appear to be direct plotting of flocks observed, personal interviews or questionnaires directed at reliable sources of information, and banding and recapture for use in research (Mosby and Handley 1943, Bailey and Rinell 1968). Plotting of observations and signs has been used for limited studies of the Merriam race by Hoffman (1962). In Arizona, where rural human populations are sparse and where district wildlife workers must cover large areas, the above approaches are not practical for determining turkey population indices.

Formal, late-summer roadside surveys to establish statewide trends of turkey populations in Arizona began in 1947 (Hall 1950). Cosper (1949, unpublished report, Arizona Game and Fish Department) attempted to stratify routes by quality of habitat in limited portions of the turkey range. In general, however, selection of routes has depended upon availability of suitable roads, and upon selection by individual workers acquainted with particular areas. Lengths of routes used vary from 6.5 to 26.0 miles, averaging 16.0. Additions and deletions of routes have occurred through the years as a result of changes in personnel, habitat, and use of the road. No statistical evaluation of these statewide surveys has been attempted.

* A contribution from Arizona Federal Aid Project W-78-R, Arizona Game and Fish Department.

Formal roadside surveys were originally intended to furnish two types of population data: (1) year-to-year total population indices, and (2) tom:hen: poult ratios. Due to the small number of birds seen on actual established routes, disillusionment regarding the value of formal roadside surveys, especially for determining population indices (trends), gradually developed among district management personnel.

Management personnel now de-emphasize formal surveys. In many areas, district wildlife managers rely entirely upon information gathered during routine field duty for data pertaining to sex and age, making no effort to detect changes in the number of turkeys. Where formal routes are still used, they are supplemented by off-route observations. Our game management division has also discontinued use of these data for indicating trends at the statewide level, using only sex and age data as indices of population conditions.

This paper is based on intensive roadside surveys made by research personnel in two separate areas over two separate periods of time. The data used here were gathered separately from the statewide management surveys discussed above. Between 1959 and 1961, an effort was made to evaluate the roadside technique by making intensive repeat surveys within a limited area (Smith 1962). This study led to the conclusion that surveys to detect turkey population trends at the district management level would require an impractical amount of effort. It was in part responsible for the general disillusionment with the roadside survey for turkeys. These data were never published except in federal aid reports.

During the years 1966, 1967, and 1968, intensive roadside surveys were run in a second area as part of a study on a turkey population. Although the main objective of this study was to measure effects of hunter harvest on an isolated turkey population, I later decided that these data might also serve to further evaluate the roadside count. Combined with those of the previous study, these counts yield a somewhat better insight into the value of the roadside-survey technique for measuring statewide trends of turkey populations and composition of sex and age, and better insight into factors that affect the reliability of the roadside survey.

I acknowledge Ronald H. Smith of the Arizona Game and Fish Department for allowing me to re-analyze roadside data from the White Mountains and for his help in statistical handling of the data pertaining to sex and age. Thomas N. Johnson, U.S. Department of Agriculture, Flagstaff, gave considerable advice regarding analysis of variance. Paul M. Webb, Jr. and Virginia M. Yates of the Arizona Game and Fish Department reviewed the manuscript.

STUDY AREAS

MacDonald and Jantzen (1967:485-503) give a general discussion of the range and habitat of the Merriam's turkey. The two areas discussed here represent extremes of both location and types of habitat of the range for the Merriam's turkey in Arizona (Figure 58).

THE WHITE MOUNTAINS

The portion of the White Mountain area sampled from 1959 to 1961 covers approximately 1,200 square miles. It constitutes essentially summer turkey range only and is contiguous with turkey habitat on all sides. Areas sampled vary in elevation from 7,000 to 9,000 feet. Vegetation ranges from ponderosa pine *(Pinus ponderosa)* type to upper mixed conifer. The forest types are broken

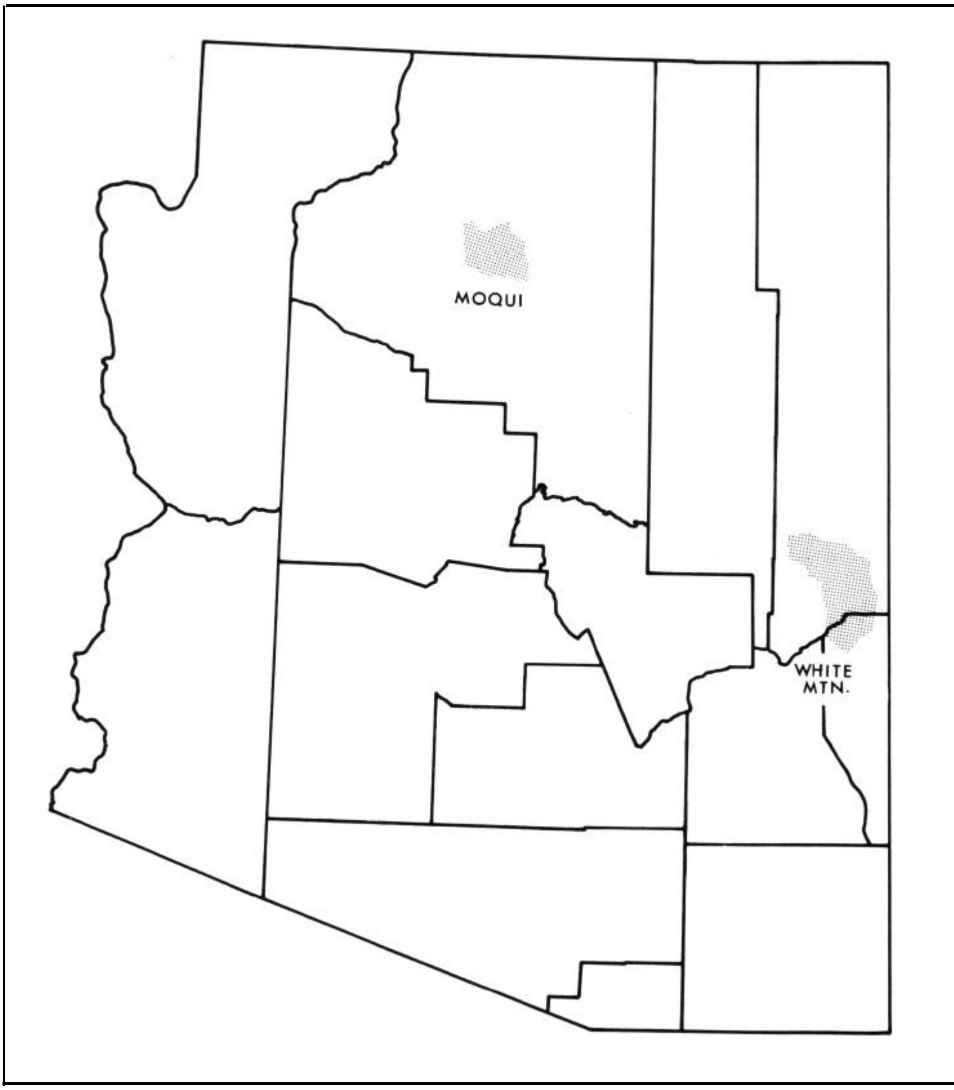


Figure 58. Outline map of Arizona showing the location of the Moqui and the White Mountain study areas where intensive roadside turkey surveys were conducted.

by large subalpine meadows. Water is abundant compared with much of Arizona's turkey range; rainfall averages 23 inches per year. Terrain varies from relatively gentle slopes at the higher elevations to rough canyons around the edge of the plateau. No estimates of densities of turkeys are available for the area, but it is considered to have one of the higher summer densities of turkeys in Arizona. The birds move to lower elevations in early fall.

THE MOQUI

The Moqui district of the Kaibab National Forest lies southward from the south rim of the Grand Canyon near the westernmost extreme of historical turkey range in the United States. Relatively isolated from other areas of turkey habitat on all sides, it encompasses approximately 500 square miles. Its highest elevation is slightly greater than 7,000 feet. Vegetation varies from ponderosa pine downward through the piñon-juniper *(Pinus* spp. -*Juniperus* spp.) woodland, blending at its lower elevations into a shortgrass prairie. A large component of shrub sagebrush *(Artemisia tridentata),* not typical of most of Arizona's turkey range, occurs throughout the forest types. Rainfall is low, averaging about 16 inches per year. There are no permanent streams such as occur in the White Mountain area. Turkeys are distributed unevenly and densities are generally low.

METHODS

Procedures followed in running routes were essentially the same in both intensive study areas and varied from methods normally used in statewide surveys (Hall 1950) only in the number of passes made over each route. White Mountain routes were each 15 miles long; those on the Moqui varied between 10 and 17 miles, averaging 12.5 miles. Surveys were each made by a single observer-driver in a pickup truck or other suitable vehicle. Routes were traversed in two directions both morning and evening for 5 days, for a total of 20 passes per route. Runs in the White Mountains were made during mid-to-late July; those on the Moqui were made in mid-September. Morning runs began at sunrise; evening runs were timed to end approximately at sunset. Ten routes were used on the White Mountains and 14 on the Moqui. Time and mileage were recorded at the beginning of the route, at each observation of turkeys, at the turn-around point, and at the end of the run. General notes were taken on weather.

To date, the greatest amount of attention has been given to evaluation of total observations as an indicator of trends. Means and variances were calculated from raw data and tested for correlation according to methods applied to roadside surveys for pheasants (Hartley et al. 1955). A highly significant correlation between means and variances was found, and the appropriate log transformation was applied to the basic data as outlined by the workers. Analysis of variance was then applied separately to each of the 3-year sets of data. No effort was made to test differences between areas, since the main consideration was the value of the roadside survey as an indicator of trends within areas. Separating areas for this analysis also eliminated the necessity of considering differences in the time of year each area was surveyed.

Methods used to classify repeat and nonrepeat observations were somewhat subjective. Observations were plotted on maps of the areas. Observations of groups of turkeys with similar composition in the same location were considered to represent one group. The group count appearing to be most complete was then tallied. Notes made by observers in the field aided greatly in identifying nonrepeat figures. It was hoped that the sources of error from including flocks already seen and excluding new flocks of similar composition to those already tallied would tend to correct each other.

Observations were also tabulated according to weather conditions and to time of day. Heavy afternoon and evening thunderstorms occur almost daily during late summer in Arizona's high country. These storms are typically local in nature and move rapidly across the landscape. Duration varies from a few minutes to an hour or more. Evaluation of effects of storms on a quantitative basis was thus difficult. Quite often, routes began in torrential rains and ended under clear skies, or vice versa. More often than not, observers simply waited for storms to pass, then resumed their surveys.

RESULTS

TREND DATA

A comparison of total and nonrepeat observations (Table 80) gives some reason to suspect that total observations are a biased indicator of population trends under the present design used for sampling. The two sets of figures are highly correlated (r = 0.98), but their relationship, in both areas, is not constant. Total counts are 3.1 times as great as nonrepeat figures at the highest density of nonrepeat observations, but they are only 1.6 times as great at the lowest density.

Table 80. Results of intensive late-summer roadside surveys of turkeys, 1959-1968, taken in two study areas in Arizona.

Area	Year	Length of Routes (miles)	Total Miles Driven	Total Observations: Number	Total Observations: Number per 10 Miles Driven	Nonrepeat Observations: Number	Ratio of Total to Nonrepeat Observations
White Mountains	1959	150	2,678	1,829	6.8	-	
	1960	150	2,909	2,232	7.7	710	3.1
	1961	150	2,863	666	2.3	290	2.3
Moqui	1966	175	3,435	361	1.1	187	1.9
	1967	175	3,476	292	0.8	186	1.6
	1968	175	3,489	389	1.1	194	2.0

If the above variation of differences between accumulated counts and nonrepeat counts at different levels of observation could be eliminated, sensitivity of the technique might be acceptable for establishing long-term trends. There was significant variation among yearly counts on the White Mountain (Table 81, item 1). Detailed breakdown shows this to be almost entirely due to the extremely low count in 1961. The 22 percent increase from 1959 to 1960 was significant only at the 0.75 level. Yearly changes of 19 and 33 percent on the Moqui were significant at the 0.90 level.

Since the ratio of densities of turkeys is not constant between repeat and nonrepeat counts, available manpower should be spent in running additional routes rather than in making repeat runs. This is further supported by the relative effects of route and run differences in the analysis. There is greater variation among the means of the routes than among the means of the day-to-day counts (Table 81, items 2 and 8). Some of this high variance in routes may be due to within-route expression of the apparent density-related bias previously discussed. Run variance, as analyzed here, includes the variation in average daily counts and the variation between morning and evening average counts. The highly significant effect of runs in the White Mountain data is due almost entirely to the large difference in counts between morning and evening. Daily averages do not differ significantly. The effect of combined runs was minor in the Moqui data, even though morning runs generally produced more observations there, too.

The recommendation to increase routes at the expense of repeat runs is further supported by the strong year-by-route interaction (Table 81, items 4 and 10). This method is a measure of differential distribution of the population

Table 81. Analysis of variance on total observations obtained during roadside surveys of turkeys, conducted 1959-1961 and 1966-1968, on two study areas in Arizona.

Source	DF[a]	SS[b]	MS[c]	F[d]	P[e]
WHITE MOUNTAINS, 1959-1961					
1. Year	2	115.09	57.55	68.23	0.005
59 + 60 versus 61	1	114.42	114.42	135.65	0.005
59 versus 60	1	1.11	1.11	1.32	0.250
2. Route	9	172.69	19.19	22.75	0.05
3. Runs	9	20.27	2.25	2.67	0.05
Morning versus evening	1	12.40	12.40	14.69	0.005
Days	4	2.54	0.63	0.75	NS
4. Year × route	18	66.07	3.67	4.35	0.05
5. Error	261	220.15	0.84		
6. Total	299	594.27			–
MOQUI, 1966-1968					
7. Year	2	3.36	1.68	2.81	0.10
8. Route	13	21.60	1.66	2.78	0.05
9. Run	9	7.03	0.78	1.20	NS
10. Year x route	26	64.16	2.47	4.13	0.01
11. Error	369	220.69	0.60		
12. Total	419	316.82			

[a]DF-degrees of freedom.
[b]SS-sum of squares.
[c]MS-mean squares.
[d]F-F value.
[e]P-P value.

on the study area from year to year. That a difference in distribution exists is demonstrated by the increasing percentage of routes with at least one observation of a turkey (Table 82) from 1966 through 1968 while population levels apparently remained unchanged on the Moqui (Table 80). Densities in the White Mountains were so high that observations were made on all routes during all years.

The most glaring lack in the present data is some measure of the sensitivity of nonrepeat observations as population indices under constant procedures of sampling. We simply have not tested them at the time of this writing. Their greatest value appears to be as a minimum estimate of the population in an area.

Reduction of the numbers of repeat runs or, ideally, eliminating repeats while increasing routes should yield acceptable data to determine trends. Elimination of repeat runs entirely, however, increases the statistical problem of handling routes where no birds have been observed. To alleviate this problem,

Table 82. Percentage of routes on which one or more turkeys were seen during roadside surveys, 1966-1968, on the Moqui study area, Arizona.

Year	Number of Routes	Percentage of Routes with Observations
1966	14	57.1
1967	14	85.7
1968	14	92.9

when the time of peak observations is considered, the best alternative to rerunning the same routes appears to be extension of morning routes. Smith (1960) noted that the midday segments, that is, returning morning and outgoing evening runs, provided the highest average number of observations. His peak observations occurred between 30 and 60 minutes after sunrise. Data from the Moqui (Figure 59) show a peak at the same time and indicate a relatively high number of observations through at least the first 3 hours of daylight. Runs between 120 and 90 minutes before sunset gave the highest

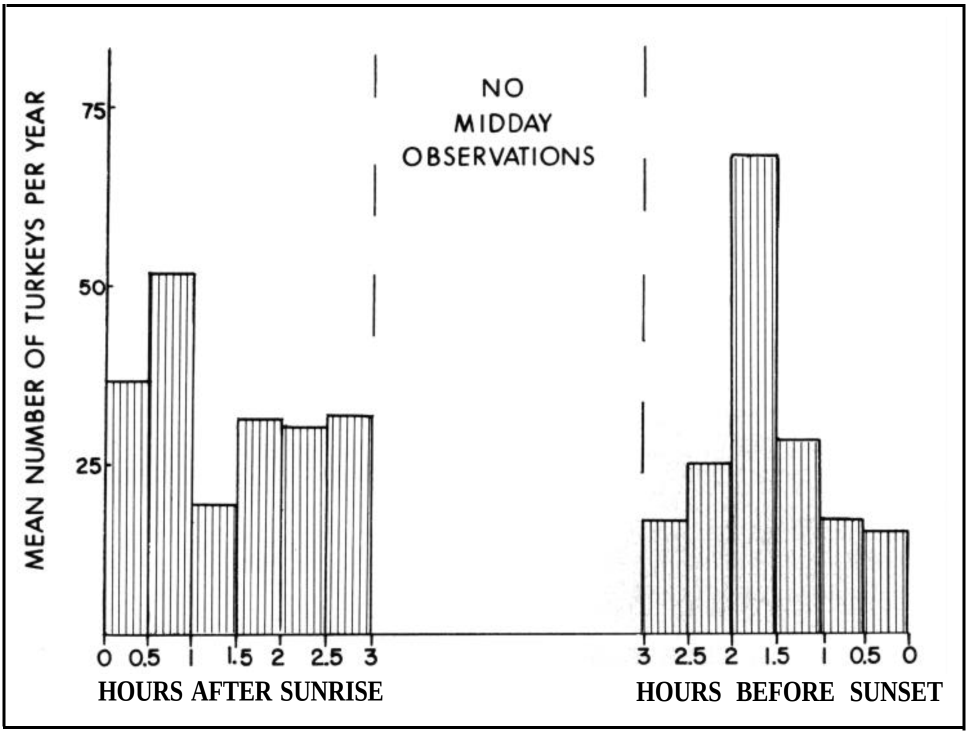


Figure 59. Time of observation of turkeys on Moqui roadside surveys, 1966-1968.

peak for the Moqui, but the highest total observations were on morning runs. Speeds for individual observers in running routes varied from 9 to 14 miles per hour with an average of 11 miles per hour. Thus, single runs over routes 40 miles in length would probably end before suitable hours for surveying turkeys ended.

Sex and Age Classification

Random, or stratified random sampling may increase the reliability of data on the age structure of a population. The improvement is probably not great enough to justify the additional effort for population composition data alone. In most areas, flocks can be classified during routine field work or other duties. As is customary, the larger the size of the sample, the narrower the confidence limits for age composition (Table 83). Smith (1962) estimated confidence limits for hen:poult ratios for various numbers of total observations using the White Mountain surveys. The same computations were used for obtaining the variance of the hen:poult ratio for the 1966-1968 Moqui data. An observation here is defined as the sighting of any combination of hens and poults together or hens or poults alone. Gobblers were excluded.

Table 83. Numbers of observations necessary to achieve certain limits of reliability, confidence limits, for poult:hen ratios on two study areas in Arizona.

Number of Observations	Confidence Limits as a Percentage of Poults-per-Hen Estimates	
	95 Percent	80 Percent
WHITE MOUNTAINS, 1959-1961		
50	56	36
100	28	18
150	18	12
200	14	9
MOQUI, 1966-1968		
50	46	30
100	22	15
150	15	10
200	11	7

Source: Smith (1962).

Data from the Moqui give little hope of deriving accurate tom:hen ratios from summer classification data (Table 84). The variation in tom:hen ratios is probably due to differential distribution of the sexes rather than to actual changes in composition of the total population. This is demonstrated when the four routes highest in elevation on the Moqui are compared with the data from all routes. Stoddard (1963) noted that toms prefer open stands of mature timber. This preference essentially describes the four upper Moqui routes. Tom:hen ratios are much higher during all 3 years on these routes than in areas at lower elevations. Considerable knowledge of habitat-use patterns and availability of habitats would be needed adequately to stratify surveys for reliable estimates of tom:hen ratios.

Table 84. Tom:hen ratios compared with overall ratios, middle to late September, 1966-1968, from four routes highest in elevation on the Moqui study area, Arizona.

Year	Ratios from Selected Routes	Overall Ratio
1966	1.4	0.8
1967	19.7	1.1
1968	16.0	1.3

Effects of Weather

Rainfall was the only weather factor of noticeable importance during the period. The major effect of weather was in interruption of surveys and inconsistency in traversing routes. Turkeys were often seen moving immediately after heavy rains and did not appear to be affected by wet vegetation.

The absence of storms early in the day may account for the generally higher total counts during morning runs. Problems due to weather could be circumvented on most days by making morning runs only.

CONCLUSIONS

The data presented here give some hope that the roadside survey may be a useful indicator of turkey population trends. The technique used appears to be capable of detecting year-to-year changes of 20 percent at the 80 percent confidence level or better.

This conclusion, however, must be tentative. Due to the bias at different densities where repeat observations are used, either the procedure for sampling must be modified to eliminate repeat observations or only nonrepeat observations should be used in the analysis. The first of these alternatives is probably preferable and can be accomplished through use of more and longer routes with no repeat runs. A 40-mile length is suggested. On smaller areas, however, repeat runs and elimination of repeat observations from the data may be the only accurate method of sampling the population. I hope that we can continue to test the data used in this paper as well as the data we have accumulated throughout the state with these possibilities in mind.

This page has been intentionally left blank to preserve the continuity of the original document.

35

MORTALITY ASSOCIATED WITH THE SPRING HUNTING OF GOBBLERS*

John B. Lewis and Gene Kelly

ABSTRACT

Harvest mortality data associated with the spring hunting of gobblers only was provided by observations and recoveries of banded gobblers during five hunting seasons, 1965-1969. Ninety-one eastern wild turkey gobblers *(Meleagris gallopavo silvestris)* were trapped, tagged with patagial wing tags, and released. Recovery rates for the first hunting season averaged 18.7 percent. The average annual rate of mortality of gobblers, based on the recovery of banded birds during the 5-year period, was 43.9 percent, whereas that based on the observation of survivors after each hunting season was 62.0 percent. The average percentage of each year class harvested during the 5-year period was 43.1 percent.

Estimates of the percentage of wild turkeys harvested range from 10 percent in states where gobblers-only hunting is permitted to about 30 percent where any-sex hunting is legal. In Virginia, Mosby and Handley (1943) estimated that 29.3 percent of the turkey population was harvested. Mosby (1959) reported an average take of 8 percent among 8 states that permitted hunting gobblers only, compared with the average take of 20 percent in 12 states where any-sex hunting was allowed. In Florida, Powell (1965) reported a harvest of 12.8 percent of the population, based on returns of 2,656 banded birds of either sex. Bailey and Rinell (1965) estimated that 24.5 percent of the population was harvested in West Virginia, based on returns of 775 banded birds of both sexes. They also reported a kill that averaged 15.9 percent of the estimated population for 7 years from 1957 to 1964.

No data are presently available on the percentage of the gobbler cohort harvested during a gobblers-only season. This paper summarizes data on mortality associated with the harvest of gobblers during the spring hunting season in Missouri over a 5-year period.

STUDY AREA

This study was conducted on a 12-square-mile area of private land in Phelps and Dent counties in south-central Missouri, near the community of Lake Springs. The topography is characterized as broad, gently rolling to moderately hilly plateaus, with elevations ranging from 900 to 1,200 feet.

The prevailing cover type is oak-hickory *(Quercus-Carya)* with post oak *(Q. stellata)* the dominant tree. Forested portions of the area have been cut

*A contribution of Federal Aid to Wildlife Restoration Project 13-R-19, Missouri Department of Conservation, and Missouri Cooperative Wildlife Research Unit, U.S. Bureau of Sport Fisheries and Wildlife.

over, and the remaining timber is of poor quality. Isolated stands of post and white oaks *(Q. alba)* have developed to sawtimber size, but most of the forest is in the pole stage of development.

The area is approximately 49 percent forested, 21 percent in old fields, 17 percent in permanent pasture, and 13 percent cultivated land (Lewis 1958). The proportion of timbered land to open land is lower than the proportion generally found on good turkey range. Turkeys, however, thrive on the area and use the open land extensively.

METHODS

The Missouri Department of Conservation, in cooperation with the Missouri Cooperative Wildlife Research Unit, initiated a mobility and annual-range study of wild turkeys at Lake Springs in January 1965. The primary objective was to obtain data on daily, seasonal, and annual movements of turkeys. Birds were trapped by cannon net, marked with patagial wing tags, and released at the points of capture. The patagial wing tags were patterned after those described by Knowlton et al. (1964). Individually marked turkeys could be identified at up to 250 yards away with binoculars and at 0.25 mile or farther with a 20-power spotting scope. All turkeys were banded with butt-end aluminum leg bands initially, but this was discontinued in 1967. Retention of leg bands was poor, especially on gobblers.

Observations and retrapping of marked birds provided data on movement reported by Ellis and Lewis (1967) and Kelly (1969). The program of observation and trapping program has continued without interruption since 1965. Data on harvest mortality were obtained from the recovery of banded birds shot during spring hunting seasons and from observation of survivors.

Missouri's turkey-hunting regulations require hunters to present their birds at a check station. The location of each bird killed is recorded on a county map. These data, with the harvest information that was furnished by landowners on the study area, provided an accurate account of harvest mortality.

For this study, estimations of rates of mortality were based on the use of composite life tables compiled from statistics of harvest (Hickey 1952: 11). In this study subadult gobblers were considered adults and age ratios were assumed to be stable during the 5 years. Calculations of the extent of mortality were obtained by two methods: Annual-the number of banded gobblers harvested each year divided by the number of banded gobblers available for harvest; and Harvest-the percentage of each year class harvested during the 5-year period.

An additional calculation of total annual mortality was based on the observations of banded gobblers known to be alive after each hunting season.

A banding year was considered to begin at the end of a hunting season and to terminate at the beginning of the next one. Hunting seasons in Missouri from 1965 to 1969 averaged 5 days in length and were held during the last 10 days in April.

RESULTS

TRAPPING AND BANDING

During the period from January 1965 to March 1969, 176 turkeys were trapped and individually marked. The captured birds included 35 adult males, 56 juvenile males, 38 adult females, and 47 juvenile females. Thirty-two of the 63 gobblers harvested during the study had been banded.

POPULATION ESTIMATES

The turkey population on the central 4,400 acres of the study area in 1957 was estimated at one bird per 25 acres (176 birds), based on observations during winter (Lewis 1958:93). Estimates of the population during the current study were made by actual counts of winter flocks. The presence of banded birds and the high degree of flock integrity facilitated the population counts.

The relatively close agreement in population estimates for 4 of the 5 years, and the population estimate of 1957, indicated that the population was relatively stable and that mortality and egress were balanced by recruitment (Table 85).

Table 85. Population estimates based on observations of winter flocks, 1964-1969, in Missouri.

Year	Hens and Juveniles	Adult Gobblers	Total Population	Total Gobblers Harvested[a]
1964-65	116	39	155	16 (10)[b]
1965-66	136	30	166	7 (4)
1966-67	85	25	110	12 (10)
1967-68	110	30	140	12 (9)
1968-69	120	35	155	16 (10)
Average	113.4	31.8	145.2	12.6 (8.7)
SD[c]	18.35	5.3	23.45	

[a]Harvest data obtained from check-station records and landowners.
[b]Percentage of total population harvested.
[c]SD-standard deviation .

HARVEST MORTALITY

The percentage of the total observed population removed annually by spring hunting ranged from 4.0 to 10.0 percent and averaged 8.7 (Table 85). These figures agree closely with reported harvest from other states hunting gobblers only (Mosby 1959).

During the 5-year period, 32 banded birds were recovered from hunting. Rates of recovery following the first hunting season after banding averaged 18.7 percent (Table 86). The average annual total mortality calculated on the basis of banded birds recovered during the 5-year period was 43.9 percent.

The percentage of each year class harvested during the 5-year period averaged 43.1 percent (Table 87). These data indicate that 43 percent of the banded gobblers are being shot and the remaining 57 percent are dying from crippling losses and natural mortality.

The overall annual mortality of gobblers, based on observation of banded gobblers after each hunting season, was approximately 62 percent (Table 88). This mortality rate is comparable to those reported from other states. Annual mortality for all turkeys in West Virginia was 76 percent (Bailey and Rinell 1965). Powell (1965) reported an annual turnover of 60 percent in Florida.

Table 86. Average annual mortality rates estimated from recovery of banded gobblers during spring hunting seasons, 1965-1969, on the study area in Missouri.

Year Banded	Number Banded	Gobblers Harvested by Season First (1965)	Second (1966)	Third (1967)	Fourth (1968)	Fifth (1969)	First Hunting Season - Recovery Rate
1965	14	6	1	0	0	1	0.4286
1965-66	24	3	5	2	1		0.1250
1966-67	15	3	2	1			0.2000
1967-68	13	2	2				0.1538
1968-69	25	3					0.1200
Total	91	17	10	3	1	1	
Average							0.1868
Banded birds available for harvest		91	66	53	38	14	
Percentage of banded birds harvested		18.7	15.2	5.7	2.6	7.1	
Percentage mortality rate by years		37.9	49.7	37.1	26.5	100.0	
Percentage index of birds alive at start of period		49.3	30.6	15.4	9.8	7.1	
				49.3/112.2 = 0.4391[a]			

[a]Average annual mortality rate = 43.9 percent.
Source: Hickey (1952:11, Table 2).

Table 87. Average of each year class harvested, 1965-1969, on the study area in Missouri.

Year Banded	Number Banded	Total of Each Year Class Harvested	Percent Harvested	Total Number Banded (cumulative)	Total Number Harvested (cumulative)
1965	14	8	57	14	8
1966	24	11	46	38	19
1967	15	6	40	53	25
1968	13	4	31	66	29
1969	25	3	12	91	32
Total	91	32	35		
Cumulative total				262	113
x[a]					43.13
SE[b]					0.0306

[a]x-mean.
[b]SE - standard error.

Table 88. Average annual mortality of gobblers, based on numbers of marked gobblers observed after each hunting season, 1965-1969, on the study area in Missouri.

Year of Banding	Number Banded	Hunting Season Survival[a]				
		1	2	3	4	5
1965	14	7	5	3	3	1
1966	24	20	12	5	2	
1967	15	9	4	2		
1968	13	8	4			
1969	25	16				
Total	91	60	25	10	5	1
Banded gobblers available for observation		91	60	25	10	5
Percentage of banded gobblers surviving		65.9	41.7	40.0	50.0	20.0
Percentage index of birds alive at start of period		217.6	151.7	110.0	70.0	20.0
			217.6/569.3 = 0.3822[b]			

[a]Known to be alive at the end of each hunting season.
[b]Average annual survival rate = 38.2 percent. Average annual mortality rate = 1 - 0.3822 = 0.6178 = 61.8 percent.

DISCUSSION

The harvest of one gobbler per square mile annually on the Lake Springs area over the last 5 years has produced no noticeable change in the gobbler population. This harvest was accomplished with an average of three hunters per square mile during a 5-day season. Hunting success ranged from 20 to 30 percent and was far above the state average of 13 percent (Lewis 1969b).

Statewide turkey-hunting data for 1969 showed a harvest of one gobbler per 17 square miles of occupied range (Lewis 1969b). The current statewide turkey population may not be capable of supporting the harvest of one gobbler per square mile, simply because population levels may never become that high. Data from the Lake Springs area, however, suggest that a potential exists for a much higher harvest of gobblers on a statewide basis than is now being realized.

The growing popularity of spring gobbler hunting brings about the need for more pertinent data on harvest mortality and its overall effects on the gobbler populations.

The basic premise of the spring gobbler season is that there are more gobblers than those needed for reproduction. The question is: What percentage of the gobblers can be harvested? Apparently, 43 percent harvested during a 5-year period had no adverse effects on the population at Lake Springs.

This page has been intentionally left blank to preserve the continuity of the original document.

36

RIO GRANDE TURKEY MIGRATIONS AS RELATED TO HARVEST REGULATION IN TEXAS*

Jack Ward Thomas, Rodney G. Marburger, and Calvin Van Hoozer

ABSTRACT

Rio Grande turkeys *(Meleagris gallopavo intermedia)* on the Edwards Plateau in Texas made annual migrations averaging 10.9 air-line miles between the farthest known points (53 records of movement indicated that range was 3.5 to 26.0 miles for 310 turkeys marked during 1961-1963). All turkeys returned to the winter areas where they had been marked. All land is privately owned, and hunting rights are rigidly controlled. The present November-December hunting season occurs when turkeys are in winter concentrations, so access to them by hunters is controlled by a few landowners. This leads to underharvest, with only 4 percent of the birds taken annually. One method of increasing the harvest would be to hold a spring gobbler season, which would take place when turkeys are widely dispersed, when access to them is controlled by more landowners, and when they are available to more hunters. Hens should also be legal game in the fall in years of high populations. The socioeconomic factors involved, rather than the biological aspects of winter feeding, complicate the attainment of the proposed change in regulations. The importance of income from leased hunting rights and the use of winter feeding programs make changing difficult.

Biologists and administrators of the Texas Parks and Wildlife Department have long known that hunter harvests of the state's wild turkey population is far below the potential (Table 89). In 1965, Texas had the largest number of turkeys of 14 states that reported populations in excess of 5,000, but the state ranked 13th in the percentage of the population harvested. Six of these states sustain harvests of more than 20 percent of the population per year and are maintaining stable or increasing populations. These harvests are four to eight times the harvest rate for Texas. This study sought to pinpoint one reason for this obvious underutilization of the turkeys so that reasonable alternatives to current regulations could be recommended.

We believed that migration by the Rio Grande turkey was the key to the problem of underutilization. Although eastern *(M. g. silvestris)* and Florida *(M. g. osceola)* races do not demonstrate marked seasonal shifts, the western forms-Merriam's *(M. g. merriami)* and Rio Grande-make seasonal shifts that may be significant to management (Thomas 1969).

METHODS

Three winter concentrations of turkeys in Sutton County were selected for study (Figure 60). The Ross, Wade, and Stewart areas were named for their owners, who donated use of their land for the study.

* A contribution of Texas Federal Aid Project W-62-R.

Table 89. Populations and harvests of turkeys in 1965 in states reporting more than 5,000 birds and holding open seasons.

State	Kill (number)	Population Estimate (number)	Population Harvested (percentage)	Rank (percentage of population harvested)
Georgia	5,000	11,000	45	1
Virginia	3,610	10,000	36	2
Florida	28,600	80,000	36	3
Pennsylvania	15,285	50,000	31	4
West Virginia	1,582	6,000	26	5
Nebraska	1,282	5,500	23	6
North Carolina	1,000	10,000	10	7
South Carolina	2,500	30,000	8	8
Alabama	8,100	100,000	8	9
Arizona	1,971	30,000	7	10
Mississippi	2,950	45,000	7	11
Oklahoma	2,932	50,000	6	12
Texas	12,852	250,000	5	13
Arkansas	1,181	25,000	5	14

Source: U.S. Fish and Wildlife (1966).

The Ross, Wade, and Stewart areas have been described in detail by Thomas et al. (1966). They are 6 to 7 miles apart along an intermittent stream that feeds into the North Llano River. Estimated numbers of turkeys on these areas and the legal kill for each year of the study are shown in Table 90.

Turkeys were trapped in February and March 1961, 1962, and 1963 while they were concentrated in winter areas just before dispersal for nesting. Turkeys were baited into the trap areas with milo maize *(Sorghum vulgare)* and caught with drop nets (Glazener et al. 1964) and cannon nets (Bailey 1959b). They were removed immediately from the nets and put in holding crates, where they remained, relatively calm, until marked and released at the trap sites.

For marking the trapped birds, red, green, or orange Saflag was cut in

Table 90. Turkeys present and legal turkey kill in winter concentrations, 1961-1963, in Sutton County, Texas.

Concentration Area	Year of Estimate	Estimated Population (number)	Males Legally Killed (number)
Ross	1961	500-700	30
	1962	- -	6
	1963	- -	28
Wade	1961	600-800	50
	1962	500-700	50
	1963	300-400	50
Stewart	1961	600-800	5
	1962	500-700	6
	1963	200-300	5

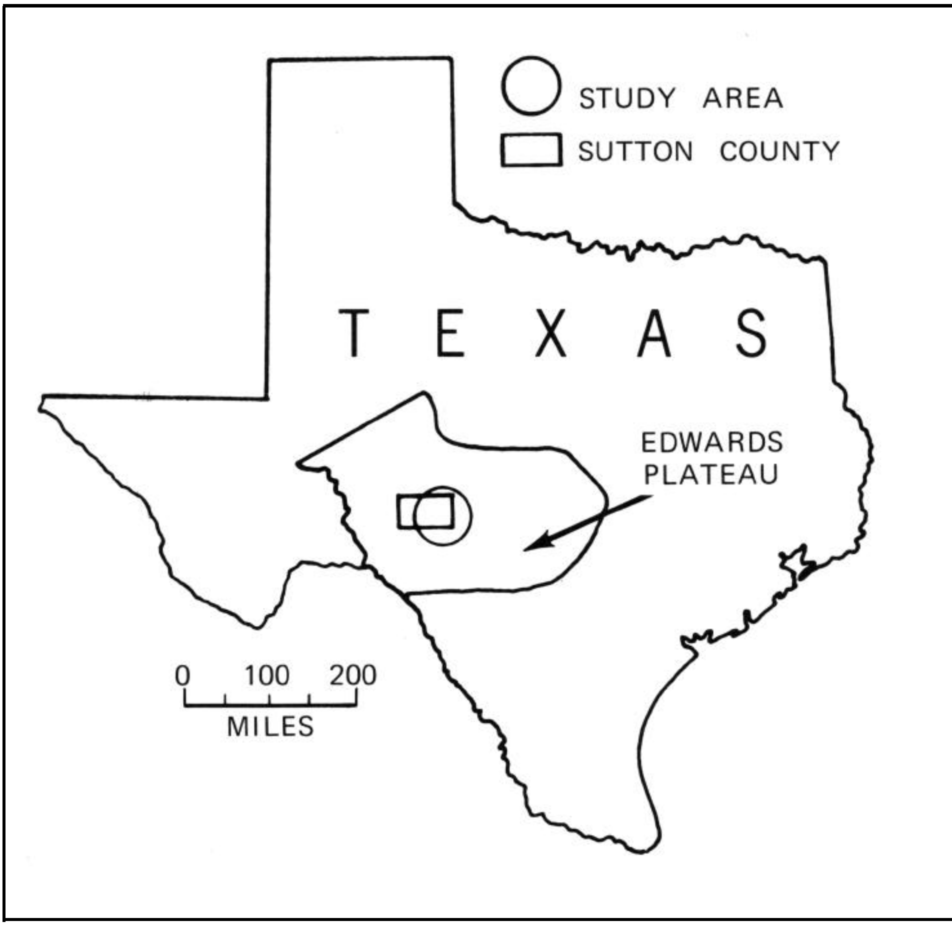


Figure 60. Location of study area on the Edwards Plateau in Texas.

3- x 1.5-inch strips, which were slotted and slipped onto standard aluminum leg bands (Thomas and Marburger 1964). Birds were coded by color to identify the winter concentration area where each was trapped. This technique proved satisfactory, but, in retrospect, we would recommend the use of patagial wing markers (Knowlton et al. 1964).

We anticipated migrations of at least 7 to 18.5 miles (Walker 1951c). Our search area was a circle with a 30-mile radius centered on the winter concentrations (Figure 60). All persons familiar with the lands in this circle were asked to report marked birds, and addressed, franked, postcard forms were provided for reporting.

At least one man, and at times as many as four men, searched daily along all roads in the study area and talked with cooperators from April to October 1961, 1962, and 1963. In addition, five law-enforcement officers who regularly patrolled within the area cooperated in the search and contact work. Equal attention was given to all parts of the study area. When marked birds were reported, the person making the report was visited, and efforts were made to find the bird, the location of the sighting, or both. The movements of turkeys from each concentration area were tabulated and analyzed separately.

Only those records from outside the periphery of areas used during the winter concentration period were considered as dispersals.

During the winter of 1963-64, we interviewed each rancher in Sutton County who had reported turkeys killed on his ranch. Data were obtained concerning: (1) the number of years the ranch was known to have served as a concentration area; (2) the estimated number of birds present that season; (3) the extent and cost of supplemental feeding and the operator's opinion of its value; and (4) the number of turkeys harvested from each ranch.

RESULTS

In the 3 years of trapping, 79 males and 231 females were trapped, marked, and released; 42 birds were retrapped.

MOVEMENTS

In late February of each year, flocks of mature gobblers began to disband and merge with flocks of hens. Dispersal from the winter concentration areas to nest grounds continued until the end of April, when 80 to 90 percent of the winter population had left the concentration areas. The remainder of the turkeys in the concentration areas-both breeders and nonbreeders-stayed throughout the spring and summer.

Turkeys began to concentrate in traditional winter areas in early October, and the movement was completed by mid-November. Trapping was carried on during the concentration periods. Of the 42 birds retrapped, all were recaptured at the same concentration areas where originally marked. Of these, 9 were recaptured after 1 to 60 days, 27 after 11 to 13 months, and 6 after 23 to 25 months.

Turkeys leaving the winter areas, which centered on mature stands of timber along stream courses (Thomas et al. 1966), moved toward the higher and flatter divide areas between watersheds for nest and summer range. There was no movement to lower and more heavily eroded areas. Eight marked turkeys from the Stewart area moved directly through the Wade and Ross areas during the dispersal. The movements were apparently direct, and the birds did not tarry.

Those Rio Grande turkeys that migrated or dispersed on the Edwards Plateau made annual migrations that averaged 10.9 air-line miles between the farthest known points. The range was 3.5 to 26.0 miles, based on movement records of 53 of the 310 turkeys marked during 1961-1963.

We found no differences among birds from the three concentration areas, or among years, either in distances moved or in pattern of dispersal. Therefore, the 53 observations on dispersal movements were pooled for analysis (Tables 91 and 92).

The turkeys from all three trap sites utilized the same general nest and summer areas, and there is little doubt that turkeys from other winter areas utilized them. A boundary connecting their outermost locations enclosed approximately 400,000 acres.

In spite of the routes of dispersal through and around other winter concentrations and the temporary social association with birds from other concentration areas while on summer range, the turkeys returned to the same winter concentration areas from which they had departed 7 to 8 months earlier.

Sutton County comprises 1,493 square miles and, at the time of this study, contained 35 individual winter areas on 29 ranches. Eighty-six percent

Table 91. Summarized data on dispersal from winter areas on the Edwards Plateau, Texas.

Sex	Turkeys (number)	Minimum Movement (miles)	Maximum Movement (miles)	Average Movement (miles)
Male	14	3.5	26.0	10.4
Female	39	4.5	24.0	11.4
Both	53	3.5	26.0	10.9

of the winter concentration areas has been used by turkeys for as long as the persons interviewed could remember. The minimum estimates varied from 16 to 86 years; they averaged 50 years.

Four winter concentration areas were established within memory of the persons interviewed. Two-in existence for 5 and 25 years, respectively-were established by supplementally feeding the turkeys that used the areas during spring and summer. The baited birds stayed through the winter, and they established new winter areas. Another concentration area was established by introducing 150 *wild* game-farm turkeys and feeding them year-round. The fourth area was established, 34 years before the study, by turkeys that voluntarily occupied a previously unused site, which has remained in use.

Artificial feeding, although it is common elsewhere in Texas, has only recently been widely adopted in the study area (Table 93). Turkeys were fed on 29 of the 35 winter areas (83 percent). Of the 29 ranchers who fed turkeys, 48 percent fed them only during the October-March concentration period, 24 percent fed them year-round, and 28 percent fed them only to bait turkeys for hunters.

Ranchers fed turkeys approximately 308,000 pounds of milo maize and 130,000 pounds of shelled yellow corn *(Zea mays)* from June 1, 1963, to May 31, 1964. At the prevailing price of $2.25 per hundredweight for milo and $3.10 per hundredweight for corn, about $11,000 was spent on feeding turkeys during the year. On the 29 areas, 471 gobblers were harvested, representing an expenditure of $23.35 for supplemental feed per bird killed.

Of the 29 ranchers who fed turkeys, 31 percent concluded that the feeding had not increased the population, but they thought that it had helped to hold

Table 92. Distances traveled by turkeys during dispersal from winter areas on the Edwards Plateau, Texas.

Distances Traveled (miles)	Number of Turkeys	
	Gobblers	Hens
2-3.9	1	0
4-5.9	0	2
6-7.9	1	5
8-9.9	8	16
10-11.9	1	4
12-13.9	2	4
14-15.9	0	1
16-17.9	0	1
22-23.9	0	5
24-25.9	0	1
26-27.9	1	0
Total	14	39

Table 93. Number of years that supplemental feeding of turkeys had been practiced as of May 1964 for each winter concentration area in Sutton County, Texas.

Years of Supplemental Feeding	Winter Areas	
	Number	Percentage
0	6	17
1- 5	13	37
6-10	7	20
11-15	4	11
16-20	4	11
21-25	1	3
Total	35	99

the birds. The other 69 percent felt that the feeding program had increased the population on their ranches by 25 to 75 percent.

The amount of food distributed per bird per day varied among concentration areas from 0.033 to 2.00 pounds of grain. This feeding provided various percentages of the required maintenance ration during the winter 'concentration period (Table 94).

In Sutton County, out of an estimated population of 15,745 turkeys, 586 gobblers (four percent of the population) were harvested. Fee-paying hunters took 42 percent of the turkeys killed, nonpaying guests took 58 percent, and landowners took 8 percent.

DISCUSSION

HUNTING SEASON

Movements of turkeys between summer and winter ranges complicate the task of regulating the harvest. Since 1927, the open season on the Edwards

Table 94. Summary of data on supplemental feeding of turkeys, 1963-64, Sutton County, Texas.[a]

Percent of Maintenance Ration Supplied by Supplemental Feed	Areas		Turkeys Affected	
	Number	Percentage	Number	Percentage
0 = no feeding	6	17	2,035	12.9
1-10	0	0	0	0
11-20	5	14	5,700	36.2
21-30	6	17	4,050	25.7
31-40	2	6	700	4.4
41-50	2	6	900	5.7
51-60	2	6	600	3.8
61-70	1	3	200	1.3
71-80	1	3	200	1.3
81-90	3	9	360	2.3
91-100	1	3	50	0.3
100+	6	17	950	6.0
Total	35	101	15,745	99.9

[a]Maintenance ration for a 10-pound turkey was estimated at 0.30 pound of grain per day, according to Brody (1945: 889).

Plateau has occurred during the time when turkeys were concentrated in winter areas. This seasonal restriction in range is important, because all land in the Edwards Plateau is privately owned, and the laws of Texas (Glazener 1963) allow private landowners to lease hunting rights.

As a result of the restricted range of turkeys during the hunting season, a small percentage of landowners (17 percent in Sutton County) control the turkey hunting. This allows them to limit the number of hunters on their

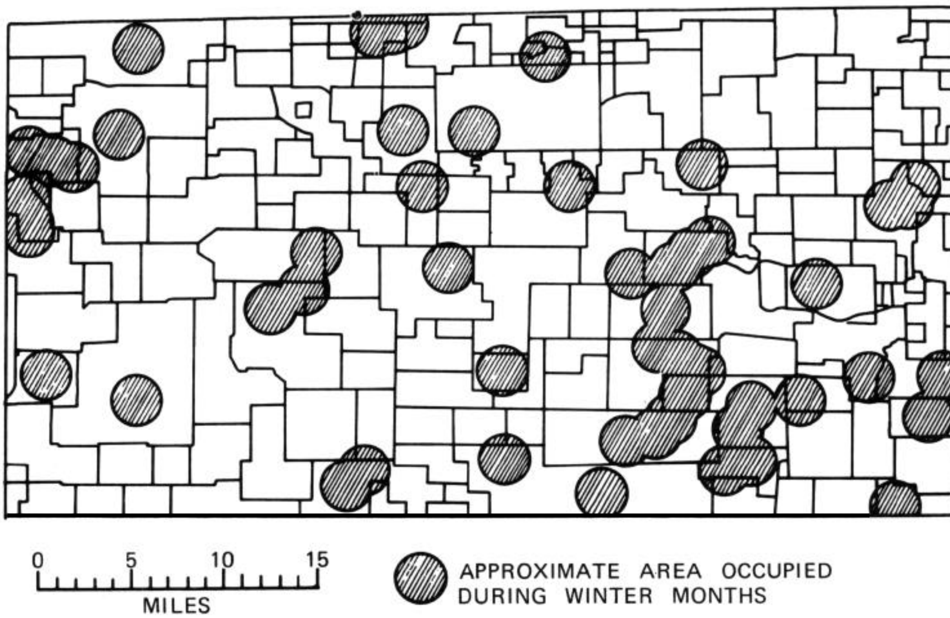


Figure 61. Approximate winter range occupied by turkeys in Sutton County, Texas, 1961-1963, superimposed on a property map.

properties. The area where hunting is practical is also limited, as illustrated by a property map of Sutton County showing the known winter concentrations (Figure 61). Examination of 15 winter concentrations indicated that the average size was about 3,145 acres, equivalent to a circle with a radius of 1.25 miles. Approximately 129,000 (14 percent) of the 955,520 acres in Sutton County were occupied by turkeys during the winter months (Figure 61). Other observations indicate that a larger part of Sutton County is occupied by turkeys in the spring and summer.

Hunters harvest a small percentage of turkey populations in Texas, in general, and on the winter areas studied, in particular (Tables 89 and 90). Of 79 gobblers banded, only 2 were legally harvested in three, 46-day hunting seasons, whereas 2 banded males and 7 banded females were found dead from other causes.

Artificial Feeding

The rationale behind the present fall hunting season, which occurs while the turkeys are on the winter areas, is that landowners spend considerable money to feed turkeys during the winter concentration period, that feeding increases survival rates of turkeys, and that this care entitles the landowners to control the turkey resource during the hunting season.

However, supplemental feeding has only recently been practiced generally (Table 93), although some landowners in the area fed turkeys before 1940 (Ramsey and Taylor 1942). Landowners also reported that the concentration areas had existed for many years before artificial feeding became popular. Except for two cases, these concentration areas did not exist because of the artificial feeding programs; rather, the feeding programs probably existed because of the winter concentrations.

Most turkey concentrations (83 percent) have received supplemental feed for fewer than 15 years (Table 93). Thus, feeding was begun during and after the severe drought of 1950-1957, when turkey populations declined drastically. After this drought, populations increased rapidly and, in 1957, increases of 85 to 378 percent were reported from some counties on the Edwards Plateau (Thomas and Green 1957). The increase in number of turkeys, although attributed by landowners to artificial feeding, was probably the natural response by the turkeys to normal rainfall and improved conditions on the range. Populations increased in areas where no supplemental feeding was done, as well as in areas where turkeys were fed regularly.

Biologists generally agree that the benefits to be derived from artificial feeding are questionable.

Management Recommendations

Regulations for harvesting turkeys are so clouded by sociological considerations that inadequate attention is given to biological considerations. Because almost all of the Rio Grande turkey range in Texas is privately owned and landowners realize an appreciable income from leasing hunting rights, these socioeconomic and biological factors combine to make development of adequate biological programs difficult. It has been estimated that income to landowners from leases for hunting deer and turkeys on the Edwards Plateau compares favorably with the income from livestock (Hahn 1951, Carroll 1960).

The income to landowners, who lease combined hunting rights for deer and turkeys, varies from $0.50 to $2.00 per acre per year. The higher rates are generally associated with the presence of turkeys on the leased area. We believe that gross income to Sutton County landowners from leasing hunting rights for deer and turkeys is at least $300,000 to $500,000 per year.

We believe that the turkey populations on our study area can easily withstand increased exploitation. In addition to a spring season on gobblers, hens could be made legal game during the fall hunting season. Hunting of hens in the fall, in years of high populations, could be supported without damage to the flocks even if the kill were several times the present gobbler kill.

Landowners on whose land the turkeys spend the spring and summer (6 months) control the critical nest habitat but realize no hunting benefits from the turkey population unless their property happens to include a winter area. If nearly all landowners were allowed to participate in the turkey harvest by means of a brief spring hunting season for gobblers only, they might be encouraged to provide suitable nest habitat and watering places. In this way, a neglected aspect of turkey management might receive attention through enlightened self-interest of the landowners.

The biological soundness of hunting gobblers in the spring has been propounded by several authors (Allen 1957, Frye 1957, Colin 1961, Lewis 1961, Gwynn and Shaffer 1962, McInteer 1963a and 1963b, Tully and Hansson 1964, MacDonald 1965, Bailey and Rinell 1968, Wunz 1968, Powell 1967, M. R. C. 1962, Lightsey 1963).

37

PEN-REARED WILD TURKEYS AS SHOOTING-PRESERVE GAME

Vaughn M. Rundquist

ABSTRACT

A stocked population of pen-reared wild turkeys *(Meleagris gallopavo)* was studied on the grounds of the Max McGraw Wildlife Foundation, Dundee, Illinois, part of which is a licensed shooting preserve. The first turkeys released on the study area were wild-trapped birds from Texas, but subsequent releases consisted of game-farm stock from several states. Birds stocked for *immediate-release hunting* were usually harvested less than an hour later; birds harvested by *natural hunting* had spent from less than a day to about a year in the wild. Means of 27 and 49 minutes per man were required to bag one bird by immediate-release hunting and natural hunting, respectively. Stocking and harvest occurred in four upland cover types: mature hardwood forests, brushy edges, weedy meadows, and corn *(Zea mays)* and sorghum *(Sorghum vulgare)* food patches. Hunting expenses, including harvesting fee, processing of the turkey, ammunition, and prorated costs of gun fee, guide tip, meal, and gasoline for travel, totaled $17.27 per bird bagged. The number of males and immatures bagged was proportionally greater than the number released. Diseases, accidents, and predation comprised nonhunting mortality. Total annual mortality averaged 95 percent. Grass (Gramineae) and corn were the most important wild and nonwild foods, respectively. There was virtually no natural recruitment to the preserve turkey population.

This study evaluated the role of pen-reared wild turkeys as game birds on the grounds of the Max McGraw Wildlife Foundation, Dundee, Illinois, part of which is a licensed shooting preserve. The study included the ecology of the turkeys, the harvest, and an economic assessment of this harvest.

I am indebted to R. A. McCabe for organization of this study and for advice in all phases of the investigation; to the College of Agricultural and Life Sciences of the University of Wisconsin and to Max McGraw Wildlife Foundation for financial support; to the entire Foundation personnel, especially G. V. Burger, S. T. Dillon, R. C. Oldenburg, and D. Petersen, for cooperation in supplying records, contributing field observations, and finding carcasses; to colleagues S. L. Beasom and M. P. Locke for help with field observations; to the students and staff of Chicago Junior School for cooperation and great interest in this study; to J. W. Thomson for help in the identification of crop contents; and to C. H. Nellis for helpful suggestions on preparing the manuscript.

MATERIALS AND METHODS

The history of the area and of the wild turkey program was obtained from Foundation records and from interviews with past and present employees and with an associate of the Foundation.

Birds released in 1966 were marked with plain aluminum bands bearing a number and the name and address of the Foundation. Virtually all birds released since 1967 were marked with the plain bands and with numbered, anodized aluminum bands (Hamerstrom and Mattson 1964). Unbanded birds either escaped before banding, lost bands, were released before 1966, or were hatched in the wild. Work in the field was conducted between July 1966 and March 1969.

All turkeys on the area during the present study were artificially hatched, reared, and stocked on the study area, except a few known to be hatched in the wild; only one known wild-hatched bird matured. Turkeys were hunted on the shooting preserve from October 15 to March 15.

The 1,350-acre Foundation is divided into three general habitats: (1) the Agricultural Unit, about 610 acres of fertile, upland farmland; (2) the Central Unit, about 660 acres of forested and reforested upland; and (3) the Fox River Unit, about 80 acres of river bottomland adjacent to the Fox River.

This study concerned mainly the Central Unit. This area is gently rolling farmland planted with native and nonnative hardwoods and conifers. There are also mature oak-sugar maple *(Quercus* spp.- *Acer saccharum)* stands on the Central Unit. The forests are interspersed with food patches of sorghum and corn. In addition to several streams, 25 small lakes and ponds have been constructed on the Central Unit. Other developments include roads and trails throughout the area, buildings, and game-bird rearing and release pens.

Part of this study was conducted on the 60-acre Chicago Junior School campus, Elgin, Illinois, mainly a mature, upland oak forest adjacent to the south end of the Central Unit. This area will hereafter be called the Campus Unit.

RESULTS

STOCKING PROGRAM

Wild-trapped turkeys were first released on the study area about 1940, shortly after the shooting preserve was established (L. LeVeque, personal communication). I was unable to determine whether the area has been stocked each year with wild turkeys since 1940, but turkeys have been stocked annually since 1956. The original stock consisted of wild-trapped birds from the King Ranch, Texas, but since the first release, birds or eggs have been supplied by game farms in Kansas and Pennsylvania and by a local game farm. Thus, the present population cannot be assigned to any one subspecies. These birds have never crossed with domestic turkeys on the study area, but the stock supplied by game farms may have been wild-domestic hybrids.

During this study, birds were stocked to provide two types of hunting: immediate-release hunting and natural hunting. Immediate-release hunting involved the use of immature birds stocked usually less than an hour but sometimes as much as 1 to 2 days before the hunt. Birds harvested by natural hunting included preseason releases of spent breeders, in-season releases of immature birds; and birds released for immediate-release hunts that had not been shot. Turkeys harvested on natural hunts had spent from less than a day to about a year in the wild.

The number of birds stocked for immediate-release hunting depended on the size and the wishes of hunting parties. The numbers of spent breeders released before the season and the numbers of immature birds released during the season varied greatly and depended on the numbers available for stocking and on the number of birds observed in areas open to hunting. The total number of birds released annually increased from 15 in 1961-62 to 497 in 1968-69 and averaged 155.5 for the 8 years. The population in 1967-68 (267 released birds plus 5 remaining from the preceding year) included only one wild-hatched turkey, which is treated as a released bird.

Turkeys were stocked only on the Central Unit. Stocking was done in four cover types: (1) brushy edge-an interspersion of large and small woody growth, ponds, and roads; (2) corn or sorghum food patches; (3) weedy meadows; and (4) hardwood forests. Stocking for immediate-release hunting was done in all four cover types; stocking for natural hunting was done only in brushy edges and hardwood forests.

Turkeys were removed from the pen, placed in crates, and hauled to the release site. Most birds stocked for immediate-release hunting were placed in an area from which egress was difficult. Two such areas used with considerable success were a wooded ravine and a small, sparsely wooded peninsula extending into a lake. This method of release kept turkeys from avoiding the hunters. The major benefit from such artificial releasing was a near-complete harvest with minimum crippling.

MOVEMENTS

Daily movements of turkeys on the south end of the study area usually occurred between any two of three units (Central, Agricultural, and Campus units). The Campus Unit served as a sanctuary during hunting season. Turkeys were often observed in a wooded residential area in northern Elgin, Illinois, about 0.5 mile from the southern edge of the Central Unit. The greatest distance that a turkey was known to have moved from the Central Unit was 1.6 air-line miles. In nearly all movements from the Central Unit, turkeys traveled to artificial food sources, either spilled feed or feed provided by landowners.

The north end of the Central Unit contained three turkey pens, at least one of which was usually occupied. These were important in holding stocked birds in that area since the pens served as a focus for the birds' daily activities.

The extent of movements depended largely on the presence of readily available artificial food sources and on the occupied turkey pens rather than on the quality of natural habitats.

FLOCKS

A flock was a group of two or more turkeys. Flocks were usually formed by birds released at the same time, and the sizes of the flocks were relatively stable within a week after release. Among four flocks studied in 1967 and 1968, the sizes of the flocks varied directly with numbers of birds released in any one area, Stability of flocks varied inversely with size, as Bailey and Rinell (1967a:87) observed among wild turkeys. The ratios of sex and age varied and depended on those of releases and of the harvest.

FOOD HABITS

The turkeys on the McGraw Wildlife Foundation area fed on 7 cultivated plants, about 125 wild plants, 25 animal species, and 8 other materials. These foods were determined by field observation and by analysis of 123 crops from dead birds. Each crop contained from 1 to 25 identifiable foods. Two nonwild foods and eight wild foods occurred in 10 or more crops (Table 95). Corn and grasses were the most important nonwild and wild foods, respectively.

Table 95. The occurrence and amounts of foods found in 10 or more of 123 wild turkey crops collected at McGraw Wildlife Foundation, Dundee, Illinois.

Food Item	Occurrence: Number of Crops	Occurrence: Percentage	Mean Weight (grams)	Mean Volume (ml)
Corn *(Zea mays)* - fruits	87	71	31.9 (Tr[a]-188.5)[b]	37.1 (Tr-222)[b]
Oats *(Avena sativa)* - spikelets	14	11	0.4 (Tr-2.1)	0.6 (Tr-3.5)
Grasses (Gramineae)-leaves and stems	87	71	0.5 (Tr-9.0)	1.6 (Tr-36.0)
Avens *(Geum canadense)-fruits*	20	16	0.3 (Tr-1.9)	0.5 (Tr-2.9)
White clover *(Trifolium repens)* - leaves	15	12	0.1 (Tr-1.0)	0.2 (Tr-1.7)
Douglas fir *(Pseudotsugu taxifolia)* - leaves and stems	13	11	Tr (Tr-0.2)	0.1 (Tr-0.5)
Lamb's-quarters *(Chenopodium album)* - fruits	12	10	0.1 (Tr-0.9)	0.2 (Tr-1.5)
Common motherwort *(Leonurus cardiaca)* - fruits	12	10	0.1 (Tr-0.4)	0.3 (Tr-0.7)
Muhly *(Muhlenbergia sobolifera)-spikelets*	10	8	0.1 (Tr-0.8)	0.2 (Tr.-1.5)
White heath aster *(Aster pilosus)-leaves*	10	8	0.1 (Tr-0.3)	0.3 (Tr-0.9)

[a]Tr-less than 0.1 gram or milliliter.
[b]Range.

NATURAL RECRUITMENT

Natural recruitment was limited and unimportant to the shooting-preserve operation. The 10 nests I discovered were located in relatively exposed situations, such as in light fencerow cover or beside buildings. All of them were destroyed accidentally or by predators or were deserted. Only three broods were observed, and only one wild-hatched poult was known to mature.

NONHUNTING MORTALITY

The causes of most nonhunting mortality were unknown. Known causes included diseases (enterohepatitis and ornithosis-7 deaths), accidents (automobiles and one haymower- deaths), and predation (11 deaths). Main predators were great horned owls *(Bubo virginianus),* which killed six turkeys, and stray dogs *(Cunis familiaris),* which killed five turkeys. Other potential predators on the study area were red foxes *(Vulpes fulva),* gray foxes *(Urocyon cinereoargenteus),* raccoons *(Procyon lotor),* and opossums *(Didelphis marsupialis) .*

HARVEST

Wild turkey hunts occurred only on the Central Unit and were generally conducted between 9:00 AM and 4:00 PM in all kinds of weather. Usually there was only one hunt per day, but the area could satisfactorily accommodate two hunting parties at one time. All hunting parties were accompanied by at least one guide.

Each party had its choice of two methods of hunting. Hunters using the immediate-release method desired relatively large numbers of birds that were easily located. Occasionally the bag included birds from earlier releases. Since the turkeys had little time to become conditioned to the wild, they were often extremely tame.

Fifty-five percent were shot on the ground, 41 percent were bagged in flight, and 4 percent were shot as they perched in trees.

Another type of immediate-release hunting used occasionally consisted of releasing turkeys in the air from behind sufficient vegetation to screen the releasing crew. These releases were made in such a way that the turkeys flew toward a firing line. Usually these *hunts* also included pheasants *(Phasianus colchicus)* and chukar partridges *(Alectoris graeca).*

Natural hunting, including walk-up and drive hunting, appealed to those who enjoyed shooting in the field. Birds taken this way were stocked between hunts during the season, released before the season, or remained unharvested from previous immediate-release hunting. Since these birds had been subjected to repeated gunning, they were considerably more wary than turkeys used for immediate-release hunts, and they flushed readily. Of the turkeys bagged on natural hunts, 44 percent were shot while flying, and 26 percent of them were shot from trees.

Fifty-six percent of the birds taken by all hunting methods were harvested within 1 day of release and 73 percent within 4 days.

Wild turkeys were harvested in all four cover types in which they were stocked. Most birds were bagged in mature hardwood forests. Upland brushy edges were the second most important cover type with respect to the number of turkeys bagged.

Hunting parties and number of turkeys killed were smaller for natural hunts than for immediate-release hunts (Table 96). Only half as many birds were harvested by natural hunting as by immediate-release hunting. Hunters were not guaranteed a wild turkey but only the opportunity to shoot one for a gun fee of $10 per day. There was no bag limit for either hunting method, but hunters paid a harvest fee of $15 for each turkey bagged. Hunters spent nearly twice as much time afield in bagging a turkey by the natural method as by the immediate-release method (Table 96).

During the hunting season in 1968-69, the cost to bag a turkey averaged $17.27 (Table 97). Most of this amount included the harvesting fee, processing of the bagged turkey, and ammunition. The harvesting fee and cost of process-

Table 96. A comparison of two methods of hunting wild turkeys, 1967-1969, on the McGraw Wildlife Foundation, Dundee, Illinois.

	Immediate-Release Hunting			Natural Hunting			
	1967-68	1968-69	Average for 26 Hunts	1967-68	1968-69	Average for 16 Hunts	Average for 42 Hunts
Number of hunts	13	13	26	7	9	16	42
Hunters per hunt	4.3(2-7)[a]	6.9(3-11)	5.6(2-11)	4.3(2-8)	2.9(2-4)	3.5(2-8)	4.8(2-11)
Length of time per hunt	34(5-165)	27(17-47)	30(5-165)	41(14-82)	49(3-123)	46(3-123)	36(3-165)
Birds bagged per hunt	5.7(0-11)	7.0(1-19)	6.4(0-19)	2.7(0-5)	3.7(1-8)	3.3(0-8)	5.2(0-19)
Man-minutes per bird bagged	26	27	27	66	39	49	34

[a]Range.

Table 97. Costs of bagging a wild turkey during the hunting season of 1968-69, on the McGraw Wildlife Foundation, Dundee, Illinois.

Item	Cost/Bird Bagged
Harvest fee	$15.00
Processing of turkey	1.50
Ammunition	0.33[a]
Prorated costs (x 3 percent, ÷ 5.6 turkeys/hunt)[b]	
Gun fee	0.28[c]
Guide tip	0.07[d]
Meal	0.06[e]
Gasoline for travel	0.03[f]
Total	$17.27

[a]Based on $3.90 per box of 25 shells (12-gauge, shot sizes 2 and 6) and 2.1 shells per bird bagged.
[b]Three percent of all game birds killed were turkeys, and 5.6 turkeys were killed per hunt.
[c]Based on $10.00 per hunter per day and 5.3 hunters per hunting party.
[d]Based on a mean of $12.50 per hunting party per day.
[e]Based on $2.25 per meal and 5.3 hunters per hunting party.
[f]Based on use of two automobiles per hunting party, a 90-mile round trip, 40.9 cents per gal. and 15 miles per gal.

ing ($1.50) were constant, regardless of size or sex of bird. Only 3 percent of the game birds harvested on the shooting preserve during that hunting season were wild turkeys. Based on 3 percent of the total harvest of all game birds, the prorated costs of gun fee, guide tip, meal, and gasoline for travel totaled $0.44, and are included in the total of $17.27 per turkey.

GUNS, AMMUNITION, AND DOGS

Weapons used in both methods of hunting were shotguns ranging in size from 10 gauge to .410 gauge; 12 gauge and 16 gauge were most popular. Shot sizes ranged from 2 to 7½; sizes 2 and 6 were used most often. Hunters could rent guns and buy ammunition on arrival at the shooting preserve if they did not bring them.

Labrador retrievers furnished by the preserve were often used for flushing, or retrieving, or for both. Hunters who wanted to use their own dogs were allowed to do so. Generally, only one dog per hunt was used, although two were sometimes used if there were at least two guides. Dogs were used on 70 percent of immediate-release hunts and 50 percent of natural hunts.

POPULATION DYNAMICS

I computed population statistics for April 1967 through March 1968 (Tables 98 and 99). The turkey population includes all releases plus survivors

Table 98. Mortality and survival, by sex, of the game-farm turkey population, 1967-68, on the McGraw Wildlife Foundation, Dundee, Illinois.

	Population		Harvest		Nonhunting Mortality		Total Mortality		Survival	
Sex	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Male	147	54	109	65	29	36	138	55	9	43
Female	123	46	59	35	52	64	111	45	12	57
Total	270[a]		168		81		249		21	

[a]Two unsexed birds excluded.

Table 99. Mortality and survival, by cohort, of the game-farm turkey population, 1967-68, on the McGraw Wildlife Foundation, Dundee, Illinois.

	Population		Harvest		Nonhunting Mortality		Total Mortality		Survival	
Cohort	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Immature	231	85	164	96	48	59	212	84	19	91
Adult	41	15	6	4	33	41	39	16	2	10
Total	272		170		81		251		21	

from the previous year. Nonhunting mortality includes that observed plus that computed when the survival was determined by observation on July 1 of the following year. In 1966-67, mortality data in each sex and age group were incomplete, but the total mortality rate was 97 percent; the total mortality rate for 1967-68 was 92 percent. The mean of these two rates (95 percent) was used to compute the nonhunting mortality for 1968-69. Each sex and age was harvested at a rate disproportionate to the ratios of sex and age of the available population (Tables 98 and 99). A greater proportion of males than females, and of immatures than adults, was harvested.

DISCUSSION

The qualities of the wild turkeys on the grounds of the McGraw Wildlife Foundation probably represented the best compromise for normally secretive, wide-ranging game birds used on an area of under 1,000 acres in an urban setting. Reproductive success, resistance to nonhunting mortality, and extreme wariness of truly wild turkeys had been replaced by tameness, which facilitated both pen rearing and local releasing.

Occasionally the Foundation birds showed several of the qualities of native wild turkeys, such as ability to escape predators, including man; to use natural foods exclusively; and to move relatively long distances. The almost total lack of reproduction in the wild and a high rate of nonhunting mortality did not leave even a token breeding population on the study area. On the other hand, some turkeys were able to avoid predators for relatively long periods; these birds provided sport for the more aggressive hunters. Pheasants, chukar partridges, bobwhites *(Colinus virginianus),* and mallards *(Anus platyrhynchos)* on the shooting preserve provided more sport than turkeys and comprised 97 percent of the total game-bird harvest. However, a few hunters preferred turkeys to other game birds, because they are less costly per unit of weight.

Problems of loss through egress and highway mortality probably cannot be decreased or eliminated, and they will surely enlarge with an increase in number of turkeys stocked and urbanization of the surrounding area.

Carefully bred game-farm turkeys were used to extend the turkey range in Pennsylvania. Wildlife managers usually discourage such a practice in order to avoid transmitting diseases to the turkey range and to prevent genetic contamination of the native wild birds (Latham 1956:124, 127-128). Neither transmission of disease nor genetic contamination was involved in using game-farm turkeys at McGraw Wildlife Foundation, for no native wild turkeys existed nearby. The objective at this shooting preserve was to supply game birds for recreational use for those willing to pay for production of the birds. This objective was successfully met.

Most hunting parties wanted to bag at least one turkey per hunter with minimum effort. Some hunting parties were more aggressive: they enjoyed spending several hours in the field and were satisfied with less than one bird per man. Regardless of hunters' attitudes, I believe it is the duty of the shooting-preserve manager to keep the aesthetic values of hunting at the highest possible level and to provide a successful and economically sound harvest.

The adaptable nature of the wild turkey permits its use as a game bird in a variety of situations. I recommend that only healthy, vigorous, and wary pen-reared birds be released. They not only will provide more sport for the hunter, both for immediate-release and natural harvests, but will also survive nonhunting mortality factors better than birds of poor-quality.

The release of spent breeders in summer is inadvisable because of the high rate of nonhunting mortality. Holding the breeders for in-season release is costly. Latham (1956:127) came to similar conclusions concerning immature pen-reared males. Instead of releasing spent breeders, I recommend that they be processed for eating.

The study suggested that egress can be decreased by providing ample supplies of artificial feed on the preserve and by fencing the preserve.

These recommendations should keep the aesthetic values of hunting at a high level, provide successful hunts, and keep harvest costs low.

The McGraw wild turkey is a valuable game bird, with respect both to rearing and releasing and to hunting by a limited number of hunters desiring a game bird larger than more popular species hunted on the preserve. Pen-reared wild turkeys can no doubt be similarly used on other shooting preserves with the results obtained at McGraw Wildlife Foundation.

SUMMARY
NEEDS AND OPPORTUNITIES FOR MANAGING TURKEY POPULATIONS

Laurence R. Jahn

This national meeting has served as an important vehicle for exchanging information on problems, advances, and opportunities in turkey research and management. All 41 speakers and participants in the discussions contributed important information. My purpose is to identify (1) outstanding progress in research and management, and (2) future needs to maintain and restore turkey populations in an environment dominated by man.

For convenience, my remarks will focus on four topics: (1) the status of turkeys, (2) census and other techniques, (3) harvest management, and (4) habitat management.

STATUS OF WILD TURKEYS

Mosby (1973) reported that the status of the population of each of the four subspecies of turkeys (eastern, Florida, Merriam's, and Rio Grande) in the United States is excellent. Suitable conditions of habitat, favorable attitudes of landowners, and transplants of widely adaptable wild stock have resulted in a larger population of turkeys in more places today than 30 years ago. Turkeys in the United States are now plentiful in areas outside as well as within their historical distributional boundaries, but the status of the two subspecies in Mexico contrasts sharply. Gould's turkey *(Meleagris gallopavo mexicana)* may be declining in parts of its range and the Mexican turkey *(M. g. gallopavo)* may now be endangered (Aldrich 1967:44). Investigations are needed to establish the current status of these subspecies.

Almost all successful efforts to restore populations have involved wild-trapped turkeys. Wisconsin (Dreis et al. 1973) and Michigan (Ignatoski 1973) are two exceptions to this generalization, but I sense that those populations are not displaying the characteristics of dramatic growth shown by thriving wild populations.

McCaslan*, Prestwood et al. (1973), Dreis et al. (1973), Wunz (1973), and others presented outstanding reasons for using wild rather than game-farm stock in efforts of restoration. Hand-reared turkeys display behavioral characteristics that contribute to their own high mortality, and they are carriers of diseases, such as blackhead, which are lethal in the wild turkeys with which this stock would be in contact.

Dickneite (1973) emphasized the long-term economic soundness of using wild turkeys for transplants. He also properly stressed the need for ecological surveys of prospective areas to be used for releasing the birds and the importance of using petitions and informational meetings to involve local people in restocking projects. Capel (1973) and Wigal (1973) stressed the necessity of selecting the subspecies of turkey for transplanting that is adapted to the climatic conditions at the proposed site chosen for release.

Foote's (1959:193-194) summary statement in 1959 on hand-reared turkeys, presented at the First National Wild Turkey Symposium, applies equally well today. It is futile to use game-farm stock in attempting to establish wild populations. Wunz (1973) further stressed that stocking hand-reared turkeys detracts from sound efforts of management.

Game-farm turkeys should now be recognized as having only limited uses. Rundquist (1973) suggested that hand-reared turkeys of good quality are valuable as game birds at shooting preserves for people willing to pay to hunt them. No problems of disease or genetic contamination are involved at preserves where wild turkey populations do not exist and where practically all released turkeys soon die through shooting or natural mortality.

Trapping and transplanting within states, using wild stock adapted to local environments, now seems to be the major remaining effort required to place turkeys in almost all suitable units of habitat. If achieved through cooperative efforts within and among states, Mosby's (1973) long-term challenge of having a huntable turkey population in every state, except Alaska, may be satisfied in the next few decades. This goal can only be achieved if a suitable habitat base with minimal human disturbance will continue to exist.

CENSUS AND OTHER TECHNIQUES

Although the current status of turkeys in the United States is good, many speakers testified to difficulties in determining the numbers of turkeys in a state, region, or locality. Techniques used to census are, in many cases, less precise than desired. This weakness has prevailed for many years and was identified specifically at the First National Wild Turkey Symposium. In the subsequent decade, some progress has been made in capitalizing on the behavioral characteristics of turkeys to appraise the status of state, regional, and local populations.

Statewide and regional estimates are usually calculated on the basis of the known total square miles of range occupied by turkeys and extrapolating an average turkey density to the entire area. A further refinement is to use this procedure for different strata and to determine the sum of all estimates of strata to get the grand total. These procedures are used to provide the estimated statewide fall figures for turkey populations reported annually since 1951 by the U.S. Fish and Wildlife Service. Though considered crude, these estimates are the best available on a statewide basis. They could be improved by refining stratification according to ecological types of turkey habitat and sharpening estimates of density for each stratum.

Bailey (1973) identified the need for a similar classification of primary and marginal turkey range for applying different types of hunting regulations. Clark* described application of this approach for establishing turkey-hunting seasons in Mississippi. However, I was a bit surprised to see so little direct attention devoted to methods used to census turkey populations and to the accuracy of population and harvest figures now being used.

Counts of winter flocks are made in several states by conservation workers, land operators, and others. Cook (1973) found the testimony of land operators in Texas reasonably reliable where winter roosts are stable and not disturbed by people. Obviously, to use this technique with confidence requires careful selection of roosts-a difficult task.

Winter counts are most reliable when deep snow concentrates turkeys. Dreis et al. (1973) reported that the snowmobile is useful in getting to turkey concentrations when conditions permit travel. However, deep, soft, fluffy snow immobilizes both turkeys and snowmobiles.

Lewis and Kelly's (1973) penetrating analyses of winter census data and band recoveries advanced understanding of the characteristics of survival of a local Missouri turkey population. More such pioneering in-depth studies would be helpful.

Summer roadside surveys were reported by Shaw (1973) to be of considerable value in establishing trends of populations at state and regional levels in sparsely settled rural areas of Arizona. Additional testing is recommended before this technique can be accepted for general application.

Hen:poult counts collected objectively, but incidentally, by conservation workers on extensive travel during routine activities in the field yield important indices to reproductive success. Shaw inferred that formal sampling methods are not necessary for obtaining hen:poult data. But the difficult job is identifying the percentage of hens of breeding age that produce broods. This is a critical variable influenced primarily by (1) excessive rainfall lowering reproductive success and (2) breeding age of the flock, particularly hens. Hillestad (1973) showed through intensive studies on the eastern turkey in Alabama that up to 40 percent of the subadult females nest.

Kiel** outlined advantages of using the helicopter for censusing hens and poults on the King Ranch in Texas. Although this technique requires more trials than other methods in different types of vegetation, he considers it the best approach for open types of habitat.

Advantages of having a turkey-hunting permit and a mandatory hunter-checking system to obtain information on turkeys seen, heard, and bagged were emphasized by Donohoe and McKibben (1973) for Ohio. Experiences in Wisconsin substantiated that view. Turkeys encountered per unit of effort can frequently serve as valuable population indices.

Improved techniques of trapping and marking, including use of radiotelemetry, wing markers, and colored leg bands, have been instrumental in providing more refined information on life-history and population of local turkey flocks. Findings presented in the well-attended session concerning techniques and in 15 reports illustrate the values of using precise techniques to remove speculation, answer particular problems, and place turkey management on a sounder factual foundation. Information given in those reports on the behavior of flocks of turkeys, individual birds within flocks, techniques to determine age, breeding age of subadults, renesting, predation, movements, and survival is clear evidence of outstanding progress made in accumulating knowledge on each subspecies of wild turkey. But in many instances, as illustrated by data on movement, more extensive analyses are needed to define specific implications for management. In the future, a great deal of research must be oriented to solving specific problems or filling remaining gaps in knowledge.

Accumulated information and views offered by Prestwood et al. (1973), Wunz (1973), Trainer (1973), McCaslan*, and others permit drafting a four-phase professional concensus on approaches to help prevent outbreaks of disease among turkeys.

1. Refrain from introducing game-farm turkeys into existing wild turkey populations.
2. Avoid intensive control of natural predators. Recognize predation as a natural mechanism for culling sick or weak turkeys from flocks. Removal of contaminated individuals helps prevent spread of disease among surviving members of a flock.
3. Rotate locations of trap sites, emergency feeding locations, and food plantings to prevent excessive contamination of the soil with disease organisms.
4. Encourage hunting of turkeys, particularly when high levels of population are approached. Substitute hunting for nonhunting mortality, as is possible, without lowering a turkey population.

HARVEST MANAGEMENT

Harvest of all four subspecies of turkeys in the United States is increasing. A 172 percent increase in the harvest occurred in 16 years, involving 47,000 turkeys in 1952 and 128,000 in 1968. This substantial increase reflects the spectacular successes with releases of wild-trapped turkeys. Many huntable populations have been established within 3 to 5 years after initial transplants.

Much speculation remains over the magnitude of hunting mortality that different turkey populations can withstand without declining. With total annual mortality reported ranging from 40 to 75 percent, hunting has accounted for an average of 20 percent in fall any-sex seasons and 8 percent in spring gobbler seasons. These estimated removals are below undefined maximum allowable limits for stable turkey populations.

Two speakers provided new insight on permissible levels of turkey harvest. Lewis and Kelly (1973) reported no adverse effects excluding crippling loss, on a Missouri population when 43 percent of the gobblers were harvested in spring hunting seasons. This finding clearly shows that more intensive hunting of toms in spring is permissible.

Rush (1973) inferred that removing 37 to 43 percent of both sexes, through annual trapping over a decade, stabilized a turkey population in Arkansas. This hypothesis needs additional testing on an adequate-sized area, using objective measurements of the population. More studies are needed in different ecological areas to define the degree to which mortality due to hunting in fall and spring can replace natural mortality without lowering a turkey population.

To avoid waste, any-sex seasons are preferred over gobbler-only seasons in fall. Logan* described how hunters, particularly the inexperienced, fail to differentiate hens from young toms in fall gobbler seasons. Hens are shot, presumably identified in hand, and left in the field. Permitting fall hunting of both sexes avoids this waste.

Currently, turkey populations are generally underharvested. Mosby (1973) estimates that the fall population of turkeys in the United States in 1970 should number about 1,250,000. If true, harvesting a third would involve a little over 400,000 turkeys. This means that slightly more than a quarter of a million turkeys could have been safely added to the harvest in 1968. The challenge is to find the mix of spring gobbler and fall any-sex hunting seasons acceptable to the public, particularly landowners, to achieve this larger harvest. Designing and tailoring the hunting regulations, administrative procedures, and efforts to enforce them for individual states and localities to enable the harvesting of available turkeys, while maintaining adequate breeding stock, will require increased attention in future years.

Managed hunting, in which the number of hunters that participate is limited, will be required in some states and areas. This need for managing hunters with the aid of electronic equipment when necessary, is greatest where turkey populations fluctuate widely between years and where demands of hunters exceed space for hunting or supplies of turkeys. In Wisconsin (Dreis et al. 1973), Michigan (Ignatoski 1973), and Ohio (Donohoe and McKibben 1973), numbers of hunters are limited to maintain reasonable densities of hunters and quality of hunting on restricted turkey ranges. Nebraska (Suetsugu and Menzel 1963:303) uses permits and limits the number of hunters to help maintain high hunter success. Segmented seasons with different groups of hunters for each period have been used in Wisconsin (Dreis et al. 1973) and Michigan (Ignatoski 1973), and were suggested for Ohio (Donohoe and McKibben 1973), to distribute opportunities to hunt the turkey. The need for these types of intensive hunter management is greatest on public lands that are the most accessible. Under these conditions in Wisconsin (Dreis et al. 1973), four hunters applied for every available turkey permit. Charging a fee reduced the proportion of permits not used from 33 percent to less than 5 percent.

Where access of hunters to turkeys is restricted and landowners have overly protective attitudes, as in Texas (Thomas et al. 1973a), the problem is to find approaches acceptable to land operators that will permit the attainment of an adequate harvest of turkeys. Gore (1973) believes that more liberal and diversified hunting regulations would enable landowners to make better use of Rio Grande turkeys. He anticipates that the use of flexible hunting seasons would encourage landowners interested in maintaining and providing adequate habitat for turkeys. These are fundamental views that need to be explored in depth. The goal should be to modify and use regulations, whenever possible, to create incentives for landowners that encourage proper management of turkeys.

Trophy value of the turkey is reflected by actions of land operators as well as hunters. Some landowners enjoy having the birds on their properties and protect them. In fact, excessive protection was identified as a problem in several states and may reflect the growing *protectionist* philosophy discussed by Lindzey and Wanless (1973).

Satisfaction with turkey hunting has been high in spite of generally low hunter success, particularly in spring gobbler seasons. The inference is clear. The kill is less important to most hunters than the opportunity to hunt these trophy game birds. They enjoy the outing, hearing and seeing turkeys, and occasionally shooting or bagging a bird. As one turkey hunter remarked to me, “It is a real status symbol to display a wild turkey beard, but not necessary for a satisfying hunt.”

HABITAT MANAGEMENT

Findings from studies on food habits demonstrate the necessity of having a variety of plant communities within the annual, seasonal, and daily cruising radii of turkeys to satisfy their nutritional needs. Yearly movements of flocks define the total area to be considered in management. But defining the ecological patterns of different habitats required to yield the right types of foods and to insure their presence on public and private lands requires much additional effort.

PUBLIC LANDS

A number of speakers stressed the need and potential for managing turkeys on public lands. They made it crystal clear that good wildlife habitat rarely results from routine application of timber-management procedures by state and federal agencies. Desirable habitat is the product of careful, concerted planning by foresters and wildlife managers, and of intensive management designed for specific plant communities (for example, oak-hickory, oak-pine, and others).

The new U.S. Forest Service handbook described by Holbrook (1973) will summarize concepts and guidelines required to work wildlife-benefiting features into plans for managing different types of forests. Need for this document and its application on the ground has been felt for a long time. We anxiously await its completion. It should provide a sound base of information for planning and improving coordination of forest and wildlife management on a watershed and compartment basis.

Dellinger (1973), in his highly respected comprehensive report, underscored the necessity of establishing specific *acceptable* population levels for turkeys and other major wildlife species per thousand acres of public forest lands in Missouri. Habitat-management prescriptions developed for Missouri forests to permit attainment of those goals should be defined, with proper modifications, for other types of forests in other states. Generalities must be replaced with precise management prescriptions for different plant communities.

Shortcomings of standard forest-compartment inventories, now used for evaluating wildlife populations before and after silvicultural treatments, were identified. Improved inventories of compartments and better financing of the inventories are required to permit effective coordination of forest and wildlife management. But lack of additional funds must not become an excuse for delaying installation of improvements in existing programs of forest management.

We must unite forces to obtain the added 10 to 20 cents per acre needed to upgrade existing inadequate inventories of compartments. To continue conducting inventories of limited value is poor economics and definitely not in the best public interest.

Initial plans for each timber-cutting compartment must include considerations for turkeys and other wildlife. If appropriate considerations for wildlife are not established initially, commitments for 80 to 100 years will be programmed with few, if any, opportunities for correcting deficiencies by adding features that are beneficial to wildlife later. The immediate needs are (1) to convince forest supervisors to give greater consideration to wildlife-habitat needs, (2) to design timber-management plans that satisfy habitat requirements of wildlife, and (3) to assist in obtaining funds required to implement those sound plans. Only through objective cooperative planning and action can these goals be achieved. The challenge to both foresters and wildlife managers is tremendous.

Wildlife biologists and managers should visit more public forests and become acquainted with current forest-management programs and forest supervisors. Improved understanding by all personnel definitely seems required to advance proposed new programs on a management-unit basis.

Donohoe and McKibben (1973) expressed the need to delineate turkey management units in Ohio's forests. Holbrook (1973) suggested that about 5,000 acres constitutes a management unit for the eastern turkey in southeastern forests.

It was gratifying to learn of the recently established in-depth study in West Virginia (Thomas et al. 1973b) to define precisely how even-aged hardwood management affects wildlife populations on the Monongahela National Forest. This study is an excellent example of the type of planning and targeting required to design investigations to yield information important to the agencies of management. Findings should help resolve current differences of opinion on handling even-aged hardwoods. A better balance in forest and wildlife management should eventually be achieved on the millions of acres of forested lands. This balance would be in the best public interest.

PRIVATE LANDS

On private lands, overriding natural and human forces are influencing turkey habitat beneficially and adversely. The natural succession of plants on abandoned farms has produced attractive habitat for turkeys, particularly in the eastern and southern United States. Several speakers expressed concern for adverse effects of land-use activities on turkey habitat in the West and Southwest. There, excessive disturbances caused by increasing human activities are restricting the distribution and numbers of turkeys. Gore (1973) presented an excellent overall analysis of land uses influencing turkey habitat in Texas.

Increasing human populations have generated greater demands for livestock, thereby stimulating overgrazing and conversion of woody habitat to cropland, open pastures, and reservoirs. Uniform, wide expanses of intensively used agricultural lands do not accommodate turkeys. Important turkey roosts, mast-producing trees, and cover for breeding and nesting are destroyed in these areas.

Capel (1973) described how taxpayers' funds are being distributed through the Agricultural Conservation Program in Kansas to accelerate the clearing of woody vegetation to improve and create pastures. Public monies are paid in all states to destroy natural habitat essential for maintaining public resources, such as turkeys and other wildlife. If taxpayers knew, I suspect they would object to these land-conversion payments, especially if the new grasslands are badly overgrazed and contribute to watershed and flooding problems.

My impression is that many state wildlife agencies need better periodic measurements of their turkey habitat. Routine forest inventories may yield part of the desired information. But more appropriate figures seem needed to appraise the adverse and beneficial influences of extensive land-use activities on the turkey's habitat base.

Even in the absence of government subsidies, maintenance of turkey habitat frequently is given little or no consideration by most landowners under modern systems of intensive land use. Continuation of these attitudes and expanding demands for intensive land use will eventually shrink turkey habitat unless intensive land management succeeds in changing predicted trends. Gore (1973) and others emphasized that the long-term future of midcontinent turkeys seems to hinge on whether limited critical habitat can be maintained under the present system of agricultural economics and increasing demands of society.

Land-use practices to benefit turkeys were identified. But wide differences of opinions on the need for using some techniques in local areas prohibit forming generalizations on their values. For example, supplemental feeding is considered important when mast crops fail or during droughts, particularly in the south-central states. Emotion favors this position, but no one has stated how much supplemental feeding improves turkey survival during these critical times. More exact information is needed by wildlife managers to aid them in developing recommendations for intensive management in local situations.

The primary need of biologists, wildlife managers, and interested landowners to manage wild turkeys on a basis of sustained yield is an overall management plan for the entire area covered by the birds in a year. This area constitutes a management unit, Its dimensions are defined by movements of nearly separate flocks of turkeys. Within the unit, properties and actions of different landowners must satisfy the seasonal habitat requirements of turkeys. Independent actions of individual landowners should contribute to common management goals.

Behavioral characteristics of the Merriam's and Rio Grande turkeys and their existence on predominantly private lands favor the management-unit approach. These birds annually return to the same winter ranges, and frequently the identical roost sites, as long as the habitat is suitable and human disturbance is not excessive (Crockett 1973, Thomas et al. 1973a). Thomas et al. also found that dispersal patterns of Rio Grande turkeys and distances from roosts to breeding grounds were similar among years. Areas encompassed by annual movements of winter turkey flocks to winter roosts, nest grounds, and summer areas were identified by three speakers as involving 20,000, 60,000, and 400,000 acres.

Turkey management units should be delineated by wildlife biologists and managers, be advanced as potential vehicles for interesting landowners in managing turkeys on a basis of sustained yield, and be established as landowner cooperatives. They definitely are needed to insure continued presence of roost trees, minimum human disturbance, adequate cover for nesting and brooding, and the variety of foods required to insure survival of adult and young turkeys. Cooperative management units could help prevent adverse actions of one landowner from defeating the well-intentioned efforts of others who are maintaining habitat for turkeys.

The cooperative management-unit plan, if used objectively, can stimulate identification of (1) key units of habitat to be maintained, (2) limiting factors requiring correction to permit the increase of local turkey flocks, (3) numbers of turkeys that can be harvested, and (4) the potential economic returns to land operators for managing turkeys intensively. Gore (1973) believes that unless wild turkeys in Texas gain adequate economic importance, they will disappear from many private lands. The management-unit concept is proposed to help prevent that belief from becoming a reality. The preventive approach is clearly defined, but the extent of the landowners' interest in it, and his acceptance of it, remain to be determined in localities where intensive management is needed.

Intensive habitat management on the basis of delineated management units definitely seems needed on some private and most public lands. Developing and implementing overall plans and precise prescriptions should and will, in my judgment, receive much more attention in the environmental decade of the 1970's.

* Editor's note.-This report was presented at the Second National Wild Turkey Symposium, but it does not appear in this book.

** Comments made as Session Chairman at the Second National Wild Turkey Symposium. These comments are not included in this book.

LITERATURE CITED

ALDRICH, JOHN W. 1967. Taxonomy, distribution and present status. Pages 17-44. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

ALLEN, RALPH H., JR. 1957 (1956). Is a spring gobbling season biologically sound? Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 10:124-126.

ANDERSON,ROY C., AND ANNIE K. PRESTWOOD. 1969. *Singhfilaria hayesi* n. sp. from *Meleagris gallopavo* and a revision of Lemdaniinae (= Eufilariinae). Canadian Journal of Zoology 47(5):1015-1019.

ANNEREAUX, RALPH F. 1940. A note on *Echinoparyphium recurvatum* (von Linstow) parasitic in California turkeys. Journal of the American Veterinary Medical Association 96(1):62-64.

AUDUBON, JOHN JAMES. 1840-1844. The birds of America. Vol. 5:42-57, Dover reprint, 1967. Dover Publications, Inc., New York. 7 volumes.

AUSTIN, DAVID H. 1966 (1965). Trapping turkeys in Florida with the cannon net. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 19:16-22.

_____, AND JERRY H. PEOPLES. 1968 (1967). Capturing hogs with alpha-chloralose. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 21:201-205.

BAILEY, R. WAYNE. 1957. Population characteristics of the wild turkey in West Virginia. Proceedings of the Northeastern Fish and Wildlife Conference, New Haven, Connecticut. Pages 1-12. Multilith.

_____ . 1959a. The 1958 wild turkey kill. West Virginia Department of Natural Resources, Job Completion Report, Pittman-Robertson Project W-33-R-6. Charleston. 25 pp. Mimeo.

_____ . 1959b. Preliminary report on wild turkey banding studies as applicable to management in West Virginia. Proceedings of the National Wild Turkey Symposium 1:146-158.

_____ . 1963. Progress with wild turkeys. West Virginia Conservation 27(7):12-16.

_____ . 1967. Behavior. Pages 93-111. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

_____ . 1973 (1970). Restoring wild-trapped turkeys to nonprimary range in West Virginia. Pages 181-185. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, AND KERMIT T. RINELL. 1965. Wild turkey population trends, productivity and harvest. Federal Aid to Wildlife Restoration Project W-39-R-7. Charleston, West Virginia. 15 pp. Mimeo.

_____, AND _____. 1966. Wild turkey population trends, productivity and harvest, Annual Report, West Virginia Department of Natural Resources. 14 pp.

_____, AND _____. 1967a. Events in the turkey year. Pages 73-91. *In* Oliver

H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, DC. 589 pp.

_____, AND _____. 1967b. Management of the eastern turkey in the northern hardwoods. Pages 261-302. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

_____, AND _____. 1968. History and management of the wild turkey in West Virginia. West Virginia Department of Natural Resources, Division of Game and Fish Bulletin 6. Charleston. 59 pp.

_____, HANS G. UHLIG, AND GEORGE BREIDING. 1951. Wild turkey management in West Virginia. West Virginia Conservation Commission, Division of Game Management Bulletin 2. Charleston. 49 pp.

BAILEY, VERNON. 1905. Biological survey of Texas. U.S. Biological Survey, North American Fauna 25.222 pp.

BALDWIN, WILLIAM P. 1947. Trapping wild turkeys in South Carolina. Journal of Wildlife Management 11(1):24-36.

BARKALOW, FREDERICK S., JR. 1949. A game inventory of Alabama. Alabama Department of Conservation, Montgomery. 140 pp.

BARROWS, WALTER BRADFORD. 1912. Michigan bird life. The Michigan Agricultural College; Wynkoop Hallenbeck Crawford Company, Lansing. 822 pp.

BECKMAN, HARRY. 1961. Pharmacology: the nature, action and use of drugs. 2nd ed. W. B. Saunders Company, Philadelphia and London. 805 pp. (Reprinted in 1963.)

BENNITT, RUDOLF, AND WERNER O. NAGEL. 1937. A survey of the resident game and furbearers of Missouri. University of Missouri Studies 12(2):3-215.

BENT, ARTHUR CLEVELAND. 1932. Life histories of North American gallinaceous birds. Smithsonian Institution, U.S. National Museum Bulletin 162. U.S. Government Printing Office, Washington, D.C. 490 pp.

BEQUAERT, J. 1933. Notes on Hippoboscidae. 4. On the larger species of Lynchia Weyenbergh *(Olfersia* of authors; *Icosta* Speiser; *Ornithoponus* Aldrich). Psyche 40(2):68-82.

_____. 1945. Notes on Hippoboscidae. 19. Additions to the larger species of *Lynchia,* with descriptions of two new species. Psyche 52(1-2):88-104.

BISHOPP, F. C., AND HELEN LOUISE TREMBLEY. 1945. Distribution and hosts of certain North American ticks. Journal of Parasitology 31(1):1-54.

BLAKEY, HAROLD L. 1937. The wild turkey on the Missouri Ozark range (preliminary report). U.S. Bureau of Biological Survey, Wildlife Research and Management Leaflet BS-77. 32 pp. Mimeo.

_____. 1941. Status and management of the eastern wild turkey. American Wildlife 30(3):139-143.

_____. 1944. Wild turkey vs. range management. Texas Game and Fish 2(10):6-7,14-15.

BOEKER, ERWIN L., AND VIRGIL E. SCOTT. 1969. Roost tree characteristics for Merriam's turkey. Journal of Wildlife Management 33(1):121-124.

BORG, KARL. 1955. Om *chloralosen* och dess användning vid fångst av kråk- och måsfåglar, duvor etc. Viltrevy 1(1):88-121. (In Swedish; English summary.)

BOTERO, H., AND W. M. REID. 1969. The effects of the tapeworm *Raillietina cesticillus* upon body weight gains of broilers, poults and on egg production. Poultry Science 48(2):536-542.

BRINKMAN, KENNETH A., AND RICHARD C. SMITH. 1968. Managing shortleaf pine in Missouri. University of Missouri, Agricultural Experiment Station Bulletin 875. Columbia. 35 pp.

BRODY, SAMUEL. 1945. Bioenergetics and growth. Reinhold Publishing Corporation, New York. 1023 pp.

BRUMFIELD, HELEN P., HAROLD BENSON, AND BENJAMIN S. POMEROY. 1961. Procedure for modified complement-fixation test with turkey, duck, and chick serum antibody. Avian Diseases 5(3):270-282.

BRUNER, W. E. 1931. The vegetation of Oklahoma. Ecological Monographs 1(2):99-188.

BUIKSTRA, CYRUS ALBERT. 1968. The re-establishment of the wild turkey in Payne County, Oklahoma. M.S. Thesis. Oklahoma State University, Stillwater. 48 pp.

BURGER, GEORGE V. 1954. The status of introduced wild turkeys in California. California Fish and Game 40(2):123-145.

BURGET, MARTIN L. [Compiler]. 1957a. The wild turkey in Colorado. Federal Aid Progress Report, Colorado W-39-R. Colorado Game, Fish, and Parks Department, Denver. 68 pp. Processed.

_____. 1957b. Pages 55-56. *In* Martin L. Burget [Compiler], The wild turkey in Colorado. Federal Aid Progress Report, Colorado W-39-R. Colorado Game, Fish, and Parks Department, Denver. 68 pp. Processed.

BYRD, ELON E., AND ANNIE K. PRESTWOOD. 1969. A new genus and species, *Psilotornus audacirrus* (Trematoda : Digenea : Psilostomatidae), from the wild turkey in Alabama. Transactions of the American Microscopical Society 88(3):366-369.

_____, _____, FOREST E. KELLOGG, AND RICHARD W. HEARD. 1967. Newhosts and locality records for the large liver fluke, *Athesmia heterolecithodes* (Braun, 1899) Looss, 1899 (Dicrocoeliidae) of birds and mammals. Journal of Parasitology 53(5):1116-1117.

_____, RICHARD W. HEARD, AND FOREST E. KELLOGG. 1969. Trematodes of the genus *Renicola* Cohn, 1904 (Trematoda: Digenea: Renicolidae). Page 75. *In* Program and Abstracts, 44th Annual Meeting of the American Society of Parasitology, Washington, D.C., November 3-7.

CAMPBELL, LOUIS W. 1940. Birds of Lucas County. Toledo Museum of Science Bulletin 1(1):1-225.

CANTNER, DANFORD E. 1955. An evaluation of the techniques used to restock unoccupied wild turkey habitat in Virginia. M.S. Thesis. Virginia Polytechnic Institute, Blacksburg. 61 pp.

CAPEL, STEPHEN W. 1970. A nationwide survey of turkey management with special emphasis on hunting seasons and regulations. Kansas Forestry, Fish and Game Commission, Wildlife Bulletin 2. 26 pp.

_____. 1973 (1970). Introduction of Rio Grande turkeys into Kansas. Pages 11-17. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

CARRIKER, M. A., JR. 1954. Report on a collection of Mallophaga, largely Mexican (Part 1). Florida Entomologist 37(4):191-207.

_____. 1956. Report on a collection of Mallophaga, largely Mexican (Part 2). Florida Entomologist 39(3):119-132.

CARROLL, T. D. 1960. Assay of Texas game . . . and the dollar worth of deer. Texas Game and Fish 18 (3):10-11.

CHAPMAN, FLOYD B. 1938. The development and utilization of the wildlife resources of unglaciated Ohio. Ph.D. Thesis. The Ohio State University, Columbus. 791 pp.

_____. 1953. Ohio tackles turkey restoration. Ohio Conservation Bulletin 17(1):20-21.

CHRISTISEN, DONALD M. 1968. Missouri mast studies. Federal Aid in Wildlife Restoration Project Report, Missouri 13-R-23:8.

_____, AND LEROY J. KORSCHGEN. 1955. Acorn yields and wildlife usage in Missouri. Transactions of the North American Wildlife Conference 20:337-356.

CLARK, W. K. 1947. The status of hybrid wild turkeys in Missouri. M.A. Thesis, University of Missouri, Columbia. 135 pp.

CLAY, THERESA. 1938. A revision of the genera and species of Mallophaga occurring on gallinaceous hosts. Part *1. Lipeurus* and related genera. Proceedings of the Zoological Society of London, Series B 108(2):109-204 + 14 plates.

COCHRAN, WILLIAM W., AND REXFORD D. LORD, JR. 1963. A radio-tracking system for wild animals. Journal of Wildlife Management 27(1):9-24.

COLIN, WAYNE F. 1961. A biologist's view of a spring hunting season on turkey gobblers. Virginia Wildlife 22(3):4-5.

COLLINS, H. R., AND D. K. WEBB, JR. 1966. The Hanging Rock iron region of Ohio. Ohio Historical Society Brochure, Columbus.

COOK, R. L. 1968. Status and present-day management of Rio Grande turkey. Texas Parks and Wildlife Department Staff Report. 8 pp. Mimeo.

_____. 1973 (1970). A census technique for the Rio Grande turkey. Pages 279-283. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

COOK, R. S., D. O. TRAINER, AND W. C. GLAZENER. 1966. *Haemoproteus* in wild turkeys from the coastal bend of south Texas. Journal of Protozoology 13(4):588-590.

COOLEY, R. A., AND GLEN M. KOHLS. 1944. The genus *Amblyomma* (Ixodidae) in the United States. Journal of Parasitology 30(2):77-111.

CRAIG, FRANK R., AND FREDERICK S. BARKALOW, JR. 1950. Blackhead in wild turkeys on free range in North Carolina. Wildlife in North Carolina 14(2):18-19.

CRAWFORD, H. S., AND R. G. LEONARD. 1965 (1963). The Sylamore deer study. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 17:9-13.

CRIDER, E. DALE, AND JIMMIE C. MCDANIEL. 1967. Alpha-chloralose used to capture Canada geese. Journal of Wildlife Management 31(2):258-264.

_____, AND ___. 1969 (1968). Oral drugs used to capture waterfowl. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 22:156-161.

_____, VERN D. STOTTS, AND JIMMIE C. MCDANIEL. 1969 (1968). Diazepam and alpha-chloralose mixtures to capture waterfowl. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 22:133-141.

CROCKETT, BEN C. 1973 (1970). Quantitative evaluation of winter roost sites of the Rio Grande turkey in north-central Oklahoma. Pages 211-218. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

CURTIS, J. T., AND R. P. MCINTOSH. 1951. An upland forest continuum in the prairie-forest border region of Wisconsin. Ecology 32(3):476-496.

DALKE, PAUL D., W. K. CLARK, JR., AND L. J. KORSCHGEN. 1942. Food habit trends of the wild turkey in Missouri as determined by dropping analysis. Journal of Wildlife Management 6(3):237-243.

_____, A. STARKER LEOPOLD, AND DAVID L. SPENCER. 1946. The ecology and management of the wild turkey in Missouri. Missouri Conservation Commission Technical Bulletin 1. Jefferson City. 86 pp.

DALLAS MORNING NEWS, THE. 1966. Texas almanac and state industrial guide. Dallas, Texas. 704 pp.

_____. 1970. Texas almanac and state industrial guide. Dallas, Texas. 704 pp.

DAMBACH, CHARLES A. 1948. The relative importance of hunting restrictions and land use in maintaining wildlife populations in Ohio. Ohio Journal of Science 48(6):209-229.

DAVIS, HENRY E. 1949. The American wild turkey. Small-Arms Technical Publishing Co., Georgetown, South Carolina. 328 pp.

DAVIS, JAMES R. 1962. Wild turkey investigations. Population trends and distribution 1953-1960. Job Completion Report, Project W-35-R, Work Plan 2, Job 2-B. Pittman-Robertson Projects, Alabama Department of Conservation, Montgomery. 66 pp.

_____. 1964. Internal and external parasites and diseases of wild turkeys. Pages 21B-24B. *In* Annual Progress Report, Alabama Department of Conservation, Montgomery.

_____. 1966. Internal and external parasites and diseases of wild turkeys. Page 28B. In Annual Progress Report, Alabama Department of Conservation, Montgomery.

_____. 1969. Wild turkey investigations. Kill studies. Job Completion Report, Project W-35-R-15, Work Plan 2, Job 2-A. Pittman-Robertson Activities, Game and Fish Division, Alabama Department of Conservation, Montgomery. 24 pp.

_____, AND W. J. HAMRICK. 1969. Wild turkey investigations. Flocking, flock movement and shuffling. Job Completion Report, Project W-35-R-15, Work Plan 2, Job 2-F. Pittman-Robertson Activities, Game and Fish Division, Alabama Department of Conservation, Montgomery. 41 pp.

DEBALD, PAUL S., AND ROGER E. MCCAY. 1969. The timber resources of the Ohio Hill Country. U.S. Department of Agriculture Forest Service Resource Bulletin NE-14. Upper Darby, Pennsylvania. 75 pp.

DELLINGER, GEORGE P. 1973 (1970). Habitat management for turkeys in the oak-hickory forests of Missouri. Pages 235-244. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs, University of Missouri Press, Columbia. 368 pp.

DICKNEITE, DAN F. 1973 (1970). Restoration of the eastern wild turkey in Missouri, Pages 19-24. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

DILL, HERBERT H., AND W. H. THORNSBERRY. 1950. A cannon-projected net trap for capturing waterfowl. Journal of Wildlife Management 14(2):132-137.

DONOHOE, ROBERT W., AND CHARLEY MCKIBBEN. 1970. The wild turkey in Ohio. Ohio Game Monographs 3. Ohio Department of Natural Resources, Columbus. 32 pp.

_____, AND _____. 1973 (1970). Status of the wild turkey in Ohio. Pages 25-33. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, ALAN TALBOTT, AND KEN LANDES. 1967. Management plan for Phillips

Knob wild turkey management area, Wayne National Forest-Ohio. Ohio Department of Natural Resources, Division of Wildlife, New Marshfield. 13 PP.

_____, CHARLEY E. MCKIBBEN, AND CHARLES B. LOWRY. 1968. Turkey nesting behavior. Wilson Bulletin 80(1):103-104.

DOOLITTLE, W. T. 1966. Some implications of even-aged timber management in the production of Appalachian hardwoods. Forest Products Journal 16(7):25-28.

DREIS, ROBERT E., CLARENCE F. SMITH, AND LEWIS E. MYERS. 1973 (1970). Wisconsin's wild turkey restoration experiment. Pages 45-48. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

DUVENDECK, JERRY PAUL. 1964. The value and prediction of acorn crops for deer. Ph.D. Thesis. Michigan State University, East Lansing. 92 pp.

EDMINSTER, FRANK C. 1954. American game birds of field and forest: their habits, ecology, and management. Charles Scribner's Sons, New York. 490 pp.

EIS, ARLENE J. 1969. Population estimates for Ohio. Economic Research Division, Development Department, Columbus. 9 pp.

ELLIS, JAMES E., AND JOHN B. LEWIS. 1967. Mobility and annual range of wild turkeys in Missouri. Journal of Wildlife Management 31(3):568-581.

EMERSON, K. C. 1951. A list of Mallophaga from gallinaceous birds of North America. Journal of Wildlife Management 15(2):193-195.

ENG, ROBERT L. 1959. Status of turkey in Montana. Proceedings of the National Wild Turkey Symposium 1:19-20.

ESSEX, B. L. [Resource analyst]. 1968. Forest land in Indiana counties, 1967. U.S. Department of Agriculture, North Central Forest Experiment Station Research Note NC-57. St. Paul. 4 pp.

ETKIN, WILLIAM [Editor]. 1964. Social behavior and organization among vertebrates. The University of Chicago Press, Chicago. 307 pp.

EVANS, RAYMOND D. 1968. Recommended guides for coordinating timber management with wildlife habitat management in the Missouri Ozarks. Missouri Department of Conservation, Jefferson City. 20 pp. Mimeo.

FERGUSON, R. H. 1964. The timber resources of West Virginia. U.S. Forest Service Resource Bulletin NE-2. 123 pp.

FOOTE, LEONARD E. 1959. Summarization of the first national wild turkey symposium. Proceedings of the National Wild Turkey Symposium 1:192-197.

FOWELLS, H. H. 1965. Silvics of forest trees of the United States. U.S. Department of Agriculture, Washington, D.C. 762 pp.

FOX, H. 1923. Disease in captive wild mammals and birds. Incidence, description, comparison. J. B. Lippincott Company, Philadelphia. 665 pp.

FREY, M. L., R. P. HANSON, AND D. P. ANDERSON. 1968. A medium for the isolation of avian mycoplasmas. American Journal of Veterinary Research 29(11):2163-2171.

FROILAND, SVEN G. 1962. The genus *Salix* (willows) in the Black Hills of South Dakota. U.S. Department of Agriculture Technical Bulletin 1269. 75 pp.

FRYE, O. E. 1957. Why a spring gobbler season? Florida Wildlife 10(10) : 5, 32.

FULLER, H. E. 1927. The ways of the wild turkey. Outdoor Life and Recreation 60(6):28-30,76.

GANSNER, DAVID A. 1965. Missouri's forest. U.S. Forest Service Resource Bulletin CS-2. Central States Forest Experiment Station, Columbia, Missouri. 53 PP.

GARDINER, JOHN L., AND EVERETT E. WEHR. 1949. Some parasites of the wild turkey *(Meleagridis* [sic] *gallopavo silvestris)* in Maryland. Proceedings of the Helminthological Society of Washington 16(1):16-19.

GILPIN, DAVID D. 1959. Recent results of wild turkey restocking efforts in West Virginia. Proceedings of the National Wild Turkey Symposium 1:87-91.

GIST, NOEL P., THOMAS C. MORELOCK, CLARENCE M. TUCKER, AND W. FRANCIS ENGLISH. 1950. Missouri: its resources, people, and institutions. University of Missouri, Columbia. 605 pp.

GLAZENER, W. C. 1963. An example of wild turkey restoration. Texas Game and Fish 21(2):22-24,27.

_____. 1967. Management of the Rio Grande turkey. Pages 453-492. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

_____, A. S. JACKSON, AND M. L. Cox. 1964. The Texas drop-net turkey trap. Journal of Wildlife Management 28(2):280-287.

_____, R. S. COOK, AND D. 0. TRAINER. 1967. A serologic study of diseases in the Rio Grande turkey. Journal of Wildlife Management 31(1):34-39.

GLOVER, FRED A. 1948. Winter activities of wild turkey in West Virginia. Journal of Wildlife Management 12(4):416-427.

_____, AND R. WAYNE BAILEY. 1949. Wild turkey foods in West Virginia. Journal of Wildlife Management 13(3):255-265.

GOGGANS, JAMES G. 1966. A survey of blood parasites in the wild turkey of Alabama. M.S. Thesis. Auburn University, Auburn, Alabama. 35 pp.

GOOD, HENRY G., AND LLOYD C. WEBB. 1940. Spring foods of the wild turkey in Alabama, Alabama Game and Fish News 12(3):3-4, 13.

GORDON, ROBERT B. 1969. The natural vegetation of Ohio in pioneer days. Ohio Biological Survey Bulletin n. s. 3(2):1-113. The Ohio State University, Columbus.

GORE, HORACE G. 1970 (1969). Exploitation and restoration of turkey in Texas. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 23 : 37-45.

_____. 1973 (1970). Land-use practices and Rio Grande turkeys in Texas. Pages 253-262. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

Goss, N. S. 1891. History of the birds of Kansas. Geo. W. Crane & Co., Topeka, Kansas. 693 pp.

GRAMOWSKI, T. W. 1969. The characterization of mycoplasmas isolated from wild turkeys. M.S. Thesis. University of Wisconsin, Madison. 60 pp.

GWYNN, JACK V., AND C. H. "KIT" SHAFFER. 1962. Tom turkey test number two. Virginia Wildlife 23(9):8-9, 20.

HAHN, HENRY C., JR. 1951. Economic value of wild game in the Edwards Plateau region of Texas. Texas Game, Fish and Oyster Commission, Federal Aid Report Series 8. 50 pp.

HALE, E. B., AND M. W. SCHEIN. 1962. The behaviour of turkeys. Pages 531-564. In E. S. E. Hafez [Editor], The behaviour of domestic animals. The Williams and Wilkins Company, Baltimore. 619 pp.

HALL, JOHN M. 1950. Turkey sex, age ratio, and population trend survey. Job Completion Report, Federal Aid Project 25-R-3, Job 1. Arizona Game and Fish Department, Phoenix.

HALLORAN, PATRICIA O'CONNOR. 1955. A bibliography of references to diseases in wild animals and birds. Galliformes. American Journal of Veterinary Research 16(61, part 2):359-381. 465 pp.

HAMERSTROM, F. N., JR., AND O. E. MATTSON. 1964. A numbered, metal color-band for game birds. Journal of Wildlife Management 28(4):850-852.

HAMILTON, M. 1962. Grouse-turkey investigations. Indiana Quarterly Progress Report, Pittman-Robertson W-2-R-22. Indianapolis. 141 pp. Mimeo.

HARDY, FREDERICK C. 1959. Results of stocking wild-trapped and game farm turkeys in Kentucky. Proceedings of the National Wild Turkey Symposium 1:61-65.

HARLOW, R. F., AND R. L. DOWNING. 1969. The effects of size and intensity of cut on production and utilization of some deer foods in the southern Appalachians. Proceedings of the Northeastern Fish and Wildlife Conference 26:45-50.

_____, D. F. STRODE, AND L. M. OLIPHANT. 1966. Timber and deer thrive under even-aged hardwood management. Southern Lumberman 213(2656):118-120.

HARPER, H. T. 1970. Operational management plan for wild turkeys. California Department of Fish and Game. Loose-leaf.

HARTLEY, H. O., P. G. HOMEYER, AND E. L. KOZICKY. 1955. The use of log transformations in analyzing fall roadside pheasant counts. Journal of Wildlife Management 19(4):495-496.

HARTMAN, GEORGE F. 1959. Wisconsin's wild turkey project. Proceedings of the National Wild Turkey Symposium 1:22-24.

HAUGEN, ARNOLD O. 1961. Turkey talk for Paint Creek. Iowa Conservationist 20(1):100-101.

HERRICK, OWEN W., AND J. EDWIN MORSE. 1968. Investment analyses of stand improvement and reforestation opportunities in Appalachian forests. U.S. Forest Service Research Paper NE-l 11. Northeastern Forest Experiment Station, Upper Darby, Pennsylvania. 43 pp.

HEWITT, OLIVER H. [Editor]. 1967. The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

HICKEY, JOSEPH J. 1952. Survival studies of banded birds. U.S. Fish and Wildlife Service Special Science Report, Wildlife 15. 177 pp.

HIGHTOWER, B. G., V. W. LEHMAN, AND R. B. EADS. 1953. Ectoparasites from mammals and birds on a quail preserve. Journal of Mammalogy 34(2): 268-271.

HILLESTAD, HILBURN O. 1973 (1970). Movements, behavior, and nesting ecology of the wild turkey in eastern Alabama. Pages 109-123. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, AND DANIEL W. SPEAKE. 1971 (1970). Activities of wild turkey hens and poults as influenced by habitat. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 24:244-251.

HOFFMAN, DONALD M. 1962. The wild turkey in eastern Colorado. A research and management study of Merriam's wild turkey in eastern Colorado. Colorado Game and Fish Department Technical Publication 12. Denver. 47 + [2] pp.

_____. 1968. Roosting sites and habits of Merriam's turkeys in Colorado. Journal of Wildlife Management 32(4):859-866.

HOLBROOK, HERMAN L. 1958 (1957). The Francis Marion turkey project. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 11:355-363.

_____. 1973 (1970). Management of wild turkey habitat in southern forest types. Pages 245-252. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, AND JAMES C. LEWIS. 1967. Management of the eastern turkey in the southern Appalachian and Cumberland Plateau region. Pages 343-370. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

HOSLETT, SHERMAN A. 1965. The mammals of Winneshiek and Allamakee counties, Iowa. Iowa State Journal of Science 39(4):359-386.

HUGGINS, ERNEST J., AND CARL F. DAUMAN. 1961. *Mediorhynchus grandis* (Acanthocephala: Gigantorhynchidae) in a wild turkey of South Dakota. Journal of Parasitology 47(4, Section 2):30-31.

HURT, J. J. 1968. Surveys and management of wild turkeys. Pittman-Robertson Project W-15-R-24, Work Plan M-67. Nebraska Game and Parks Commission, Lincoln. 39 pp. Mimeo.

IGNATOSKI, F. J. 1973 (1970). Status of wild turkeys in Michigan. Pages 49-53. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

JACOBS, KARL F. 1964. Upland game census. Oklahoma Pittman-Robertson Project W-82-R-2. 3 pp. Mimeo.

_____. 1967 (1964). An electrically actuated release mechanism for drop-nets. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 18:30-34.

JANSON, VICTOR S., AND GORDON L. ZORB. 1966. Michigan's 1965 wild turkey season. Michigan Department of Conservation, Game Division Report 2489. 10 pp. Mimeo.

JENSEN, HERBERT A. 1947. A system for classifying vegetation in California. California Fish and Game 33(4):199-266.

JOHNSON, A. SYDNEY. 1970. Biology of the raccoon *(Procyon lotor varius* Nelson and Goldman) in Alabama. Auburn University, Agricultural Experiment Station Bulletin 402. 148 pp.

JONAS, ROBERT. 1966. Merriam's turkeys in southeastern Montana. Montana Fish and Game Department Technical Bulletin 3. 36 pp.

JONES, LYNDS. 1903. The birds of Ohio: a revised catalogue. Ohio State Academy of Science, Special Papers 6. 241 pp.

JUDD, SYLVESTER D. 1905. The grouse and wild turkeys of the United States, and their economic value. U.S. Department of Agriculture, Biological Survey Bulletin 24. 55 pp.

KALMBACH, E. R. 1944. The armadillo: its relation to agriculture and game. Texas Game, Fish and Oyster Commission, Austin. 60 pp.

KÉLER, ST. VON. 1958. The genera *Oxylipeurus* Mjöberg and *Splendoroffula* Clay and Meinertzhagen (Mallophaga). Deutsche Entomologische Zeitschrift n. s. 5(3-4):299-362.

KELLOGG, FOREST E. 1969. Parasite and disease studies on southeastern game birds, Ph.D. Thesis. University of Georgia, Athens. 88 pp.

_____, ANNIE K. PRESTWOOD, ROBERT R. GERRISH, AND GARY L. DOSTER. 1969. Wild turkey ectoparasites collected in the southeastern United States. Journal of Medical Entomology 6(3):329-330.

KELLY, P. E. 1969. Mobility of the eastern wild turkey. M.A. Thesis. University of Missouri, Columbia. 142 pp.

KING, D. B., E. V. ROBERTS, AND R. K. WINTERS. 1949. Forest resources and industries of Missouri. University of Missouri, Agricultural Experiment Station Research Bulletin 452. Columbia. 89 pp.

KLONGLAN, EUGENE D. 1962. Wintering of wild turkeys in Yellow River Forest area. Iowa State Conservation Commission Quarterly Biology Reports 14(1):13-15.

KNODER, C. EUGENE. 1955. Progress in wild turkey restoration. Ohio Department of Natural Resources, Division of Wildlife Leaflet 34. Columbus. 7pp.

_____. 1957. Last of the farm turkeys. Ohio Conservation Bulletin 21(3):12-13.

_____. 1959. Morphological indicators of heritable wildness in turkeys *(Meleagris gallopavo)* and their relation to survival. Proceedings of the National Wild Turkey Symposium 1:116-135.

KNOWLTON, FREDERICK F., EDWIN D. MICHAEL, AND W. C. GLAZENER. 1964. A marking technique for field recognition of individual turkeys and deer. Journal of Wildlife Management 28(1):167-170.

KORSCHGEN, LEROY J. 1962. Foods of Missouri deer, with some management implications. Journal of Wildlife Management 26(2):164-172.

_____. 1967. Feeding habits and foods. Pages 137-198. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

KOZICKY, EDWARD L. 1942. Pennsylvania wild turkey food habits based on dropping analysis. Pennsylvania Game News 13(8):10-11, 28-29, 31.

_____. 1948a. Some protozoan parasites of the eastern wild turkey in Pennsylvania. Journal of Wildlife Management 12(3):263-266.

_____. 1948b. Life history and management of the wild turkey *(Meleagris gallopavo silvestris)* in Pennsylvania. Ph.D. Thesis. Pennsylvania State College, University Park. 258 pp.

_____, AND ROSS METZ. 1948. The management of the wild turkey in Pennsylvania. Pennsylvania Game News 19(4):3, 20-21, 26-27, 30-31.

LANDES, KENNETH, PAUL BROHN, ROBERT DONOHOE, AND ALAN TALBOTT. 1966. Wildlife management plan for Irish and Jackson Run wild turkey management area, Wayne National Forest-Ohio. Ohio Department of Natural Resources, Division of Wildlife, New Marshfield. 15 pp.

LATHAM, ROGER M. 1956. Complete book of the wild turkey. The Stackpole Company, Harrisburg, Pennsylvania. 265 pp.

LEOPOLD, ALDO. 1929. Report on a game survey of Indiana. Indianapolis. 106 pp. Mimeo.

_____. 1933. Game management. Charles Scribner's Sons, New York and London. 481 pp.

LEOPOLD, A. STARKER. 1943. Wild turkey management in Missouri. Missouri Federal Aid to Wildlife Research Project (MO 1-5-R) 9:55. Missouri Conservation Commission, Jefferson City.

_____. 1944. The nature of heritable wildness in turkeys. Condor 46(4):133-197.

_____, AND PAUL D. DALKE. 1943. The 1942 status of wild turkeys in Missouri. Journal of Forestry 41(6):428-435.

LEWIS, JAMES C. 1962. Wild turkeys in Allegan County, Michigan. M.S. Thesis. Michigan State University, East Lansing. 35 pp.

_____. 1963. Observations on the winter range of wild turkeys in Michigan. Journal of Wildlife Management 27(1):98-102.

LEWIS, JOHN B. 1958 (1957). Trends in wild turkey population in the Missouri Ozarks. Proceedings of the Annual Meeting of the Society of American Foresters 57:92-94.

_____. 1961. Wild turkeys in Missouri, 1940-1960. Transactions of the North American Wildlife and Natural Resources Conference 26:505-512.

_____. 1967. Management of the eastern turkey in the Ozarks and bottomland hardwoods. Pages 371-407. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

_____. 1969a. Wild turkey investigations. Pages 33-51. *In* 1968-1969 Missouri Department of Conservation Annual Report, Jefferson City. 236 pp.

_____. 1969b. Statewide wild turkey population studies. Federal Aid to Wildlife Project 13-R-23. Missouri Department of Conservation, Jefferson City. 20 pp. Mimeo.

_____, AND ROBERT P. BREITENBACH. 1966. Breeding potential of subadult wild turkey gobblers. Journal of Wildlife Management 30(3):618-622.

_____, AND GENE KELLY. 1973 (1970). Mortality associated with the spring hunting of gobblers. Pages 295-299. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

LIGHTSEY, G. K. 1963. Spring gobbler hunt: here's how! Virginia Wildlife 24(4):7.

LIGON, J. STOKLEY. 1946. History and management of Merriam's wild turkey. New Mexico Game and Fish Commission; University of New Mexico Publications in Biology 1. 84 pp.

LINDZEY, JAMES S. 1967a. Highlights of management. Pages 245-259. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

_____. 1967b. A look to the future. Pages 549-551. In Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

_____, AND DAVID D. WANLESS. 1973 (1970). Problems in wild turkey management and research. Pages 229-232. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

LOVE, GARY J., SARA ANN WILKIN, AND MELVIN H. GOODWIN, JR. 1953. Incidence of blood parasites in birds collected in southwestern Georgia. Journal of Parasitology 39(1):52-57.

LOVELESS, C. M. 1951. The wild turkey in Mississippi. Mississippi Game and Fish 14(11):10-11,14.

MACDONALD, DUNCAN. 1964. Turkey hen:poult ratios-are they an accurate index of production? Proceedings of the Annual Conference of the Western Association of Game and Fish Commissioners 44:206-210.

_____. 1965. Gobbler hunt for New Mexico. New Mexico Wildlife 10(3):5.

_____, AND ROBERT A. JANTZEN. 1967. Management of the Merriam's turkey. Pages 493-534. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

MARKLEY, MERLE H. 1967. Limiting factors. Pages 199-243. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

MARTIN, A. C., H. S. ZIM, AND A. L. NELSON. 1951. American wildlife & plants:

a guide to wildlife food habits. McGraw-Hill Book Co., Inc., New York. 500 pp.

MARTIN, LARRY L. 1968 (1967). Comparison of methoxymol, alpha-chloralose, and two barbiturates for capturing doves. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 21:193-200.

MARTIN, LEO M., AND THOMAS Z. ATKESON. 1954. Swimming by wild turkey poults. Wilson Bulletin 66(4):271.

MASON, CHARLES. 1964. Turkey restoration in New York. Proceedings of the Northeastern Fish and Wildlife Conference, Hartford, Connecticut. 6 pp. Mimeo.

MAXFIELD, BURTON G., W. MALCOLM REID, AND FRANK A. HAYES. 1963. Gastrointestinal helminths from turkeys in southeastern United States. Journal of Wildlife Management 27(2):261-271.

MCDOWELL, ROBERT D. 1956. Productivity of the wild turkey in Virginia. Virginia Commission of Game and Inland Fisheries Technical Bulletin 1. 44 pp.

MCILHENNY, EDWARD AVERY. 1914. The wild turkey and its hunting. Doubleday, Page and Company, Garden City, New York. 245 pp.

MCINTEER, JIM. 1963a. Why shoot gobblers in spring? Virginia Wildlife 24(5):8-9.

_____. 1963b. Can we continue to hunt our turkeys and have them too? Virginia Wildlife 24(12):4-6.

MCKEEVER, STURGIS. 1961. The occurrence of *Rhopalias macracanthus* (Trematoda: Rhopaliasidae) in the wild turkey *(Meleagris gallopavo).* Journal of Parasitology 47(1):60.

MENZEL, KARL, AND JAMES J. HURT. 1973 (1970). Releases of Merriam's turkeys in nontypical habitat. Pages 187-192. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

MISSOURI GAME AND FISH DEPARTMENT. 1928. Pages 40-46. In Annual Report, Jefferson City.

MOHR, CARL O. 1947. Table of equivalent populations of North American small mammals. American Midland Naturalist 37(1):223-249.

MOSBY, HENRY S. 1949. The present status and the future outlook of the eastern and Florida wild turkeys. Transactions of the North American Wildlife Conference 14:346-353.

_____. 1959. General status of the wild turkey and its management in the United States, 1958. Proceedings of the National Wild Turkey Symposium 1:1-11.

_____. 1967. Population dynamics. Pages 113-136. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

_____. 1973 (1970). The changed status of the wild turkey over the past three decades. Pages 71-76. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, AND CHARLES O. HANDLEY. 1943. The wild turkey in Virginia: its status, life history, and management. Virginia Commission of Game and Inland Fisheries, Richmond. 281 pp.

_____, AND DANNY E. CANTNER. 1956. The use of avertin in capturing wild turkeys and as an oral-basal anaesthetic for other wild animals. Southwestern Veterinarian 9(2):132-136.

M. R. C. 1962. Our spring gobbler season rationale. Virginia Wildlife 23(4):1.

MURPHY, DEAN A., AND HEWLETTE S. CRAWFORD. 1970. Wildlife foods and understory vegetation in Missouri's national forests. Missouri Department of Conservation Technical Bulletin 4. 47 pp.

MURRY, ROBERT E. 1966 (1965). Tranquilizing techniques for capturing deer. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 19:4-15.

_____, AND DAN DENNETT. 1965 (1963). A preliminary report on the use of tranquilizing compounds in handling wildlife. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 17:134-139.

MURTON, R. K. 1962. Narcotics *v.* wood-pigeons. Agriculture 69(7):336-339.

_____, A. J. ISAACSON, AND N. J. WESTWOOD. 1963. The use of baits treated with $_{a}$-chloralose to catch wood-pigeons. Annals of Applied Biology 52(2):271-293.

____,____, and _____. 1965. Capturing columbids at the nest with stupefying baits. Journal of Wildlife Management 29(3):647-649.

MUSGROVE, JACK W., MARY R. MUSGROVE, AND KENNETH E. COLTON. 1941. Birds of Iowa pioneer days. Annals of Iowa Series 3, 22:543-555.

MYERS, J. HOWARD. 1968. West Virginia Blue Book. Jarrett Printing Company, Charleston. 1063 pp.

NIXON, CHARLES M. 1962. Wild turkey aging. Game Research in Ohio 1:107-117. Ohio Department of Natural Resources, Columbus.

ODUM, EUGENE P. [in collaboration with Howard T. Odum]. 1959. Fundamentals of ecology. 2nd ed. W. B. Saunders Company, Philadelphia and London. 546 pp.

OSCHWALD, W. R., F. F. RIECKEN, R. I. DIDERICKSEN, W. H. SHOLTES, AND R. W. SCHALLER. 1965. Principal soils of Iowa. Iowa State University of Science and Technology, Cooperative Extension Service in Agronomy, Special Report 42.

PHILLIPS, JOHN C. 1928. Wild birds introduced or transplanted in North America. U.S. Department of Agriculture Technical Bulletin 61. 64 pp.

PLIS, STANLEY, AND GEORGE HARTMAN. 1958. Are the turkeys talking? Wisconsin Conservation Bulletin 23(2):11-14.

POWELL, JAMES A. 1965. The Florida wild turkey. Florida Game and Fresh Water Fish Commission Technical Bulletin 8. Tallahassee. 28 pp.

_____. 1967. Management of the Florida turkey and the eastern turkey in Georgia and Alabama. Pages 409-451. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society, Washington, D.C. 589 pp.

PRESTWOOD, ANNIE KATHERINE. 1968. Parasitism among wild turkeys *(Meleagris gallopavo silvestris)* of the Mississippi Delta. Ph.D. Thesis. University of Georgia, Athens. 67 pp. + appendix (unpaged).

_____, AND W. M. REID. 1966. *Drepanidotaenia watsoni* sp. n. (Cestoda, Hymenolepididae) from the wild turkey of Arkansas. Journal of Parasitology 52(3):432-436.

_____, FOREST E. KELLOGG, AND GARY L. DOSTER. 1973 (1970). Parasitism and disease among southeastern wild turkeys. Pages 159-167. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

PRICE, EMMETT W. 1965. Trematodes of poultry. Pages 1035-1055. *In* H. E.

Biester and L. H. Schwarte [Editors], Diseases of poultry. 5th ed. Iowa State University Press, Ames. 1382 pp.

PRICE, PAUL H., RIETZ C. TUCKER, AND O. L. HAUGHT. 1938. Geology and natural resources of West Virginia. Vol. 10. West Virginia Geological Survey. 462 pp.

PROUD, JOHN C. 1969. Wild turkey studies in New York by radio-telemetry. New York Fish and Game Journal 16(1):46-83.

RAMSEY, ROBERT R., AND WALTER P. TAYLOR. 1942. A winter feeding program for the wild turkey in Texas. Texas Agricultural Experiment Station Progress Report 808. 3 pp.

RAYBOURNE, JACK W. 1969 (1968). Telemetry of turkey movements. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 22:47-54.

RECHENTHIN, C. A., H. M. BELL, R. J. PEDERSON, AND D. B. POLK. 1964. Grassland restoration. Part 2 . . . Brush control. U.S. Department of Agriculture, Soil Conservation Service, Temple, Texas. 39 pp.

REED, CHARLES D. 1941. Climate of Iowa. Pages 862-872. *In* Climate and man. Yearbook of Agriculture, U.S. Government Printing Office, Washington, D.C. 1248 pp.

REEVES, R. H., AND W. G. SWANK. 1955. Food habits of Merriam's turkey. Federal Aid Project No. W-49-R-3. Arizona Game and Fish Department, 15 pp. Litho.

REID, W. MALCOLM. 1967. Etiology and dissemination of the blackhead disease syndrome in turkeys and chickens. Experimental Parasitology 21(2):249-275.

RICE, ELROY L. 1965. Bottomland forests of north-central Oklahoma. Ecology 46(5):708-714.

_____, AND WM. T. PENFOUND. 1959. The upland forests of Oklahoma. Ecology 40(4):593-608.

RIPLEY, T. H., AND J. P. MCCLURE. 1963. Deer browse resources of north Georgia. U.S. Forest Service Research Bulletin SE-2. Southeastern Forest Experiment Station, Asheville, North Carolina. 20 pp.

ROACH, B. A., AND S. F. GINGRICH. 1968. Even-aged silviculture for upland central hardwoods. U.S. Forest Service Agriculture Handbook 355. Northeastern Forest Experiment Station, Upper Darby, Pennsylvania. 39 pp.

ROBERTS, HARVEY A. 1956. Investigations of the frequency and kinds of disease and parasites found among wild turkeys in Pennsylvania. Page 7. *In* Semiannual Progress Report, Pennsylvania Game Commission, Harrisburg.

_____. 1957. Factors affecting the wild turkey population in Pennsylvania. Proceedings of the Northeastern Fish and Wildlife Conference, New Haven, Connecticut. 9 pp. Mimeo.

_____. 1959. Aspects of harvest and hunting pressure in Pennsylvania's wild turkey range. Proceedings of the National Wild Turkey Symposium 1:31-35.

ROBINETT, H. L., AND R. L. COOK. 1970. Edwards Plateau game management survey. Progress Report, Federal Aid Project W-62-R-17. 7 pp.

ROSLIEN, O. J. 1963. Blood parasite occurrence in Iowa quail. M.S. Thesis. Iowa State University, Ames. 96 pp.

RUHL, HARRY D. 1954. Report on the wild turkey. Michigan Department of Conservation, Game Division Report 2084. 8 pp. Mimeo.

RUNDQUIST, VAUGHN M. 1973 (1970). Pen-reared wild turkeys as shooting-preserve game. Pages 309-316. *In* Glen C. Sanderson and Helen C. Schultz

[Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

RUSH, GENE. 1973 (1970). The hen-brood release as a restoration technique. Pages 193-197. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

SCHORGER, A. W. 1966. The wild turkey: its history and domestication. University of Oklahoma Press, Norman. 625 pp.

SCHULTZ, VINCENT, AND ROBERT D. MCDOWELL. 1957. Some comments on a wild turkey brood study. Journal of Wildlife Management 21(1):85-89.

SCHULZ, A. F. 1964. Regeneration cuts and wildlife. Region 7 Wildlife Workshop, Newcomb, New York. 9 pp.

SEGELQUIST, CHARLES A., FRED D. WARD, AND ROBERT G. LEONARD. 1969. Habitat-deer relations in two Ozark enclosures. Journal of Wildlife Management 33(3):511-520.

SELF, J. TEAGUE, AND J. LOUIS BOUCHARD. 1950. Parasites of the wild turkey, *Meleagris gallopavo intermedia* Sinnet, from the Wichita Mountains Wildlife Refuge. Journal of Parasitology 36(5):502-503.

SEVER, JOHN LEWIS. 1962. Application of a microtechnique to viral serological investigations. Journal of Immunology 88(3):320-329.

SHAFFER, C. H., AND JACK V. GWYNN. 1967. Management of the eastern turkey in oak-pine forests of Virginia and the Southeast. Pages 303-342. *In* Oliver H. Hewitt [Editor], The wild turkey and its management. The Wildlife Society. 589 pp.

SHAW, HARLEY G. 1973 (1970). The roadside survey for Merriam's turkeys in Arizona. Pages 285-293. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

SICKELS, ARTHUR C. 1959. Comparative results of stocking game farm and wild trapped turkeys in Ohio. Proceedings of the National Wild Turkey Symposium 1:75-83.

SMITH, AUSTIN PAUL. 1916. Additions to the avifauna of Kerr Co., Texas. Auk 33(2):187-193.

SMITH, C. F. 1965. Turkey tracks. Wisconsin Conservation Bulletin 30(2):3-6.

SMITH, H. N., AND C. A. RECHENTHIN. 1964. Grassland restoration. The Texas brush problem. U.S. Department of Agriculture, Soil Conservation Service, Temple, Texas. 25 pp.

SMITH, RONALD H. 1960. Turkey population trend techniques. Job Completion Report, Federal Aid Project W-78-R-7, Work Plan 1, Job 5. Arizona Game and Fish Department, Phoenix.

_____. 1962. Turkey population trend techniques. Job Completion Report, Federal Aid Project W-78-R-7, Work Plan 1, Job 5. Arizona Game and Fish Department, Phoenix.

SMITH, W. A., AND B. BROWNING. 1967. Wild turkey food habits in San Luis Obispo County, California. California Fish and Game 53(4):246-253.

SNYDER, R. L. 1953. Ability of spring released wild turkeys to survive and adapt to a natural environment. Pages 23-24. *In* Quarterly Progress Report, Pennsylvania Game Commission, Harrisburg.

SPEAKE, DAN W., LARRY H. BARWICK, HILBURN O. HILLESTAD, AND WALKER STICKNEY. 1970 (1969). Some characteristics of an expanding turkey population. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 23:46-58.

STEEL, ROBERT GEORGE DOUGLAS, AND JAMES H. TORRIE. 1960. Principles and procedures of statistics. McGraw-Hill Book Company, Inc., New York. 481 pp.

STEYERMARK, JULIAN ALFRED. 1963. Flora of Missouri. The Iowa State University Press, Ames. 1725 pp.

STODDARD, H. L. 1931. The bobwhite quail: its habits, preservation and increase. Charles Scribners Sons, New York. 559 pp.

_____. 1935. Wild turkey management. Transactions of the American Game Conference 21:326-333.

_____, Sr. 1963. Maintenance and increase of the eastern wild turkey on private lands of the coastal plain of the deep Southeast. Tall Timbers Research Station Bulletin 3. 49 pp.

STOUT, BRIAN, GEORGE DELLINGER, AND JOHN LEWIS. 1964. A practical examination method for forest land managers. Presented at the 26th Annual Midwest Wildlife Conference, Bloomington, Indiana. 12 pp. Multilith.

SUETSUGU, HARVEY Y., AND KARL E. MENZEL. 1963. Wild turkey introductions in Nebraska. Transactions of the North American Wildlife and Natural Resources Conference 28:297-307.

TABER, F. WALLACE. 1945. Contribution on the life history and ecology of the nine-banded armadillo. Journal of Mammalogy 26(3):211-226.

TABER, RICHARD D., AND I. McT. COWAN. 1969. Capturing and marking wild animals. Pages 277-317. *In* R. H. Giles, Jr. [Editor], Wildlife management techniques. The Wildlife Society, Washington, D.C. 623 pp.

TABER, WENDELL. 1955. Notes on behavior of the wild turkey. Wilson Bulletin 67(3):213.

TAFT, ROBERT. 1952. [A hunter's paradise.] Reprinted, with additions, from *The Editor's Page*, Transactions of the Kansas Academy of Science 55(1):38-41.

TEXAS AGRICULTURAL STABILIZATION AND CONSERVATION COMMITTEE. 1968. Annual statistical report. College Station, Texas. 101 pp.

TEXAS DEPARTMENT OF AGRICULTURE. 1969. Texas livestock statistics. Bulletin 55. Austin. 32 pp.

TEXAS GAME, FISH AND OYSTER COMMISSION. 1945. Annual report. Austin. 33 PP.

THOMAS, JACK WARD. 1964. Diagnosed diseases and parasitism in Rio Grande wild turkeys. Wilson Bulletin 76(3):292.

_____. 1969. Seasonal shifts in range by the Rio Grande turkey. M.S. Thesis. West Virginia University, Morgantown. 86 pp. Processed.

_____, AND HOUSTON GREEN. 1957. Something to gobble about. Texas Game and Fish 15(11):9-11, 24.

_____, AND RODNEY G. MARBURGER. 1964. Colored leg markers for wild turkeys. Journal of Wildlife Management 28(3):552-555.

_____, AND J. C. PACK. 1969. Joe Typical-profile of a hunter. Outdoor West Virginia 32(11):19-20.

_____, CALVIN VAN HOOZER, AND RODNEY G. MARBURGER. 1966. Wintering concentrations and seasonal shifts in range in the Rio Grande turkey. Journal of Wildlife Management 30(1):34-49.

_____, RODNEY G. MARBURGER, AND CALVIN VAN HOOZER. 1973a. (1970). Rio Grande turkey migrations as related to harvest regulations in Texas. Pages 301-308. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, JAMES C. PACK, JOHN D. GILL, AND R. WAYNE BAILEY. 1973b. (1970). Even-age management, turkeys, and turkey hunters-a new study. Pages

273-276. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

THOMPSON, WAYNE H., AND ALFRED S. EVANS. 1965. California encephalitis studies in Wisconsin, American Journal of Epidemiology 81(2):230-244.

THORNTON, PHILIP L., AND JAMES T. MORGAN. 1959. The forest resources of Iowa. U.S. Department of Agriculture Forest Survey Release 22.

TRAINER, DANIEL O. 1973 (1970). Some diseases of wild turkeys from Texas and Wisconsin. Pages 169-173. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, W. C. GLAZENER, R. P. HANSON, AND B. D. NASSIF. 1968. Infectious disease exposure in a wild turkey population. Avian Diseases 12(1):208-214.

TRAUTMAN, MILTON B. 1940. The birds of Buckeye Lake, Ohio. University of Michigan, Museum of Zoology Miscellaneous Publications 44. University of Michigan Press, Ann Arbor. 466 pp.

TULLY, BOB, AND PETE HANSSON. 1964. Springtime turkey hunting. Colorado Outdoors 13(2):8-11.

TURPIN, TOM. 1966. Hunting wild turkeys. Penn's Woods Call Company, Delmont, Pennsylvania. 54 pp.

U.S. DEPARTMENT OF AGRICULTURE. 1964. Land and Water Conservation Fund Act of September 3, 1964. Forest Service Manual. Page 228.

U.S. FISH AND WILDLIFE SERVICE. 1953. Inventory of big-game animals of the United States. Wildlife Leaflet 348. Washington, D.C.

_____. 1966. Big game inventory for 1965. Wildlife Leaflet 473. Washington, D.C. 4 pp.

_____. 1969. Big game inventory for 1968. Wildlife Leaflet 487. Washington, D.C. 4 pp.

U.S. FOREST SERVICE. 1969. Forests . , . for the future. 8 pp.

U.S. STUDY COMMISSION. 1962. Report: Texas summary and recommendations. 18 pp.

U.S. WEATHER BUREAU. 1959. Climatography of the United States. No. 60-13.

_____. 1960. Climatography of the United States. No. 60-41.

VAN ROEKEL, HENRY. 1965. Pullorum disease. The standard tube agglutination test. Pages 243-247. *In* H. E. Biester and L. H. Schwarte [Editors], Diseases of poultry. 5th ed. The Iowa State University Press, Ames. 1382 pp.

WALKER, EUGENE A. 1949. A study of factors influencing wild turkey populations in the central mineral region of Texas. Final Report, Texas Federal Aid Project 33-R. Texas Game, Fish and Oyster Commission, FA Report Series 4. Austin. 28 pp. Mimeo.

_____. 1951a. Land use and wild turkeys. Texas Game and Fish 9(11):12-16.

_____. 1951b. A study of factors influencing wild turkey populations in the live oak-shin oak divide area of the Edwards Plateau of Texas. Texas Game, Fish and Oyster Commission, Federal Aid Report Series 6. Austin. 45 pp. Mimeo.

_____. 1951c. Wild turkey studies in the divide area of the Edwards Plateau. Texas Game, Fish and Oyster Commission, Federal Aid Report Series 6. Austin. 45 pp.

_____, AND A. J. SPRINGS. 1952. Factors concerned with the success and failure of turkey transplants in Texas. Job Completion Report, Texas Pittman-Robinson Project W-44-R-2. 20 pp. Multilith.

WAPANOCCA NATIONAL WILDLIFE REFUGE. 1969. Annual turkey population. Pages 32-34. *In* Annual Wildlife Inventory Report, Turrell, Arkansas.

WATTS, C. ROBERT. 1968. Rio Grande turkeys in the mating season. North American Wildlife and Natural Resources Conference 33:205-210.

WEHR, EVERETT E. 1962. Studies on leucocytozoonosis of turkeys, with notes on schizogony, transmission, and control of *Leucocytozoon smithi*. Avian Diseases 6(2):195-210.

_____. 1965. Nematodes and acanthocephalids of poultry. Pages 965-1005. *In* H. E. Biester and L. H. Schwarte [Editors], Diseases of poultry. 5th ed. The Iowa State University Press, Ames. 1382 pp.

_____, AND DON R. COBURN. 1943. Some economically important parasites of the wild turkey and Hungarian partridge of Pennsylvania. Pennsylvania Game News 13(11):14-15, 31.

WHEELER, ROBERT J., JR. 1948. The wild turkey in Alabama. Alabama Department of Conservation, Walker Printing Co., Montgomery. 92 pp.

WIGAL, DENNIS DEAN. 1968. Status of the wild turkey in northeast Iowa. M.S. Thesis. Iowa State University, Ames. 150 pp.

_____. 1973 (1970). Status of the introduced Rio Grande turkey in northeastern Iowa. Pages 35-43. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

_____, AND ARNOLD O. HAUGEN. 1968. Survival, reproductive success, and spread of introduced Rio Grande turkeys in northeast Iowa. Proceedings of the Iowa Academy of Science 75:130-141.

WILLIAMS, ARTHUR B. [Editor]. 1950. Birds of the Cleveland region. Cleveland Museum of Natural History Scientific Publications, Volume 10. Cleveland, Ohio. 215 pp.

WILLIAMS, LOVETT E., JR. 1961. Notes on wing molt in the yearling wild turkey. Journal of Wildlife Management 25(4):439-440.

_____. 1966. Capturing wild turkeys with alpha-chloralose. Journal of Wildlife Management 30(1):50-56.

_____. 1968 (1967). Preliminary report on methoxymol to capture turkeys. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 21:189-193.

_____, DAVID H. AUSTIN, AND JERRY PEOPLES. 1967 (1966). Progress in capturing turkeys with drugs applied to baits. Proceedings of the Annual Conference of the Southeastern Association of State Game and Fish Commissioners 20:219-226.

_____, _____, NEAL F. EICHHOLZ, TOMMIE E. PEOPLES, AND ROBERT W. PHILLIPS. ‘1969 (1968). A study of nesting turkeys in southern Florida. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 22:16-30.

_____, _____, TOMMIE E. PEOPLES, AND ROBERT W. PHILLIPS. 1973 (1970). Capturing turkeys with oral drugs. Pages 219-227. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

WILLIAMS, OWEN L. 1931. Cestodes from the eastern wild turkey. Journal of Parasitology 18(1):14-20.

WILSON, H. LEE, AND JAMES LEWIS. 1959. Establishment and spread of the wild turkey in southwestern Michigan. Journal of Wildlife Management 23(2):210-215.

WRIGHT, ALBERT HAZEN. 1915. Early records of the wild turkey. IV. Auk 32(2):207-224.

WUNZ, GERALD A. 1962. Pennsylvania's new look in turkey management. Pennsylvania Game News 33(2):15-17.

_____. 1968. Why a spring gobbler season? Pennsylvania Game News 39(2):17-22.

_____. 1973 (1970). Evaluation of game-farm and wild-trapped turkeys in Pennsylvania. Pages 199-209. *In* Glen C. Sanderson and Helen C. Schultz [Editors], Wild turkey management: current problems and programs. University of Missouri Press, Columbia. 368 pp.

AND ARNOLD H. HAYDEN. 1967. The wild turkey in Pennsylvania. Pennsylvania Game News 38(11):7-13.

WYOMING GAME AND FISH COMMISSION. 1947. How have the turkeys fared? Wyoming Wild Life 11(10):4-12, 39.

ZEEDYK, W. D. 1968. Wildlife under even-aged management. Presented at the 25th Annual Meeting of the Kentucky-Tennessee Section of the Society of American Foresters. 16 pp. Multilith.

1969. Wildlife habitat under even-aged forest management. U.S. Forest Service, Southern Region, Atlanta. 9 pp. Mimeo.

This page has been intentionally left blank to preserve the continuity of the original document.

APPENDIX : LIST OF CONTRIBUTORS
SECOND NATIONAL WILD TURKEY SYMPOSIUM
FEBRUARY 1970

DAVID H. AUSTIN Biologist, Florida Game and Fresh Water Fish Commission, Sebring

R. WAYNE BAILEY Forest Game Research Leader, West Virginia Division of Wildlife Resources, Elkins

LARRY H. BARWICK Graduate Research Assistant, Alabama Cooperative Wildlife Research Unit, Auburn University, Auburn (Present Address: Florida Game and Fresh Water Fish Commission, Wildlife Research Projects, Gainesville)

ERWIN L. BOEKER Biologist, Bureau of Sport Fisheries and Wildlife, Tempe, Arizona

HUGH BROWN Darlington Game Bird Farm, El Reno, Oklahoma

STEPHEN W. CAPEL Biologist, Kansas Forestry, Fish and Game Commission, McPherson

CHAMP CLARK Biologist, Mississippi Game and Fish Commission, Liberty

ROBERT L. COOK Biologist, Texas Parks and Wildlife Department, Junction

BEN C. CROCKETT Oklahoma Cooperative Wildlife Research Unit, Oklahoma State University, Stillwater

JAMES R. DAVIS Biologist, Alabama Department of Conservation, Jackson

GEORGE P. DELLINGER Supervisor, Land Management Branch, Missouri Department of Conservation, Jefferson City

DAN F. DICKNEITE Biologist, Missouri Department of Conservation, Jefferson City

ROBERT W. DONOHOE Biologist, Ohio Division of Wildlife, New Marshfield

GARY L. DOSTER Research Assistant, Southeastern Cooperative Wildlife Disease Study, Department of Pathology and Parasitology, College of Veterinary Medicine, University of Georgia, Athens

ROBERT E. DREIS District Director, Division of Fish, Game and Enforcement, Wisconsin Department of Natural Resources, Spooner

JOHN D. GILL Northeastern Forest Experiment Station, U.S. Forest Service, Morgantown, West Virginia

HORACE G. GORE Biologist, Texas Parks and Wildlife Department, Waco

WILLIAM J. HAMRICK Biologist, Alabama Department of Conservation, Montgomery

HAROLD T. HARPER Upland Game Coordinator, California Department of Fish and Game, Sacramento

HILBURN O. HILLESTAD Graduate Research Assistant, Alabama Cooperative Wildlife Research Unit, Auburn University, Auburn (Present Address: Institute of Natural Resources, University of Georgia, Athens)

DONALD M. HOFFMAN Wildlife Researcher, Colorado Division of Game, Fish and Parks, Fort Collins

H. L. HOLBROOK Chief, Wildlife Management Branch, US. Forest Service, Atlanta, Georgia

JAMES J. HURT Biologist, Nebraska Game and Parks Commission, Alliance

F. J. IGNATOSKI Biologist, Game Division, Michigan Department of Natural Resources, Baldwin

LAURENCE R. JAHN Field Representative, Wildlife Management Institute, Horicon, Wisconsin (Present Address : Conservation Director, Wildlife Management Institute, Washington, D.C.)

FOREST E. KELLOGG Research Associate, Southeastern Cooperative Wildlife Disease Study, Department of Pathology and Parasitology, College of Veterinary Medicine, University of Georgia, Athens

GENE KELLY Biologist, Missouri Department of Conservation, Jefferson City

JAMES EARL KENNAMER Instructor, Department of Wildlife and Fisheries, Mississippi State University, State College (Present Address : Department of Zoology-Entomology, Auburn University, Auburn, Alabama)

LEROY J. KORSCHGEN Biologist, Missouri Department of Conservation, Columbia

JAMES C. LEWIS Assistant Unit Leader, Oklahoma Cooperative Wildlife Research Unit, Oklahoma State University, Stillwater

JOHN B. LEWIS Biologist, Missouri Department of Conservation, Columbia

JAMES S. LINDZEY Leader, Pennsylvania Cooperative Wildlife Research Unit, Pennsylvania State University, University Park

ROSS A. LOCK Land Management Supervisor, Nebraska Game and Parks Commission, Alliance

TOM H. LOGAN Biologist, Oklahoma Department of Wildlife Conservation, Elk City

WILLIAM H. LUNCEFORD, JR. Graduate Research Assistant, Department of Wildlife and Fisheries, Mississippi State University, State College

RODNEY G. MARBURGER Biologist, Texas Parks and Wildlife Department, Kerrville

WILLIAM L. MCCASLAN Biologist, Oklahoma Department of Wildlife Conservation, Shattuck

ROBERT D. MCGUIRE McLean High School, McLean, Virginia

CHARLEY E. MCKIBBEN Biologist, Ohio Division of Wildlife, New Marshfield

KARL MENZEL Biologist, Nebraska Game and Parks Commission, Bassett

HENRY S. MOSBY Professor, Division of Forestry and Wildlife Sciences, Virginia Polytechnic Institute, Blacksburg

LEWIS E. MYERS Area Game Manager, Division of Fish, Game and Enforcement, Wisconsin Department of Natural Resources, Dodgeville

JOSEPH J. NEMICK Upland Game Biologist, Wyoming Game and Fish Commission, Newcastle

JAMES C. PACK Biologist, West Virginia Department of Natural Resources, Elkins

TOMMIE E. PEOPLES Game Manager, Florida Game and Fresh Water Fish Commission, Palmdale

LYLE E. PETERSEN Biologist, South Dakota Department of Game, Fish and Parks, Rapid City

ROBERT W. PHILLIPS Game Manager, Florida Game and Fresh Water Fish Commission, Wildlife Research Projects, Gainesville

ANNIE K. PRESTWOOD Research Associate, Southeastern Cooperative Wildlife Disease Study, Department of Pathology and Parasitology, College of Veterinary Medicine, University of Georgia, Athens

ARTHUR H. RICHARDSON Biologist, South Dakota Department of Game, Fish and Parks, Rapid City

VAUGHN M. RUNDQUIST Department of Wildlife Ecology, University of Wisconsin, Madison (Present Address: Department of Zoology and Entomology, Montana State University, Bozeman)

GENE RUSH Administrative Assistant, Arkansas Game and Fish Commission, Little Rock

VIRGIL E. SCOTT Research Biologist, Bureau of Sport Fisheries and Wildlife, Tempe, Arizona

HARLEY G. SHAW Research Biologist, Arizona Game and Fish Department, Flagstaff

CLARENCE F. SMITH Game Manager, Division of Fish, Game and Enforcement, Wisconsin Department of Natural Resources, Meadow Valley Station, Babcock

WALTON A. SMITH California Department of Fish and Game, Sacramento

DAN W. SPEAKE Leader, Alabama Cooperative Wildlife Research Unit, Auburn University, Auburn

JACK WARD THOMAS Research Wildlife Biologist, Northeastern Forest Experiment Station, U.S. Forest Service, Morgantown, West Virginia

DANIEL O. TRAINER Professor, Department of Veterinary Science, University of Wisconsin, Madison

CALVIN VAN HOOZER Biologist, Texas Parks and Wildlife Department, Sonora

DAVID D. WANLESS Graduate Assistant, Department of Forestry and Wildlife Management, Pennsylvania State University, University Park

C. R. WATTS Biologist, Montana Fish and Game Department, Helena

DENNIS D. WIGAL Iowa Cooperative Wildlife Research Unit, Iowa State University, Ames (Present Address : Arizona Game and Fish Department, Phoenix)

LOVETT E. WILLIAMS, JR. Biologist, Florida Game and Fresh Water Fish Commission, Wildlife Research Projects, Gainesville

GERALD D. WISE Biologist, Indiana Department of Natural Resources, Orleans

GERALD A. WUNZ Biologist, Pennsylvania Game Commission, Milroy

SESSION CHAIRMEN AND DISCUSSION LEADERS

Dale H. Arner, Head
Department of Wildlife and Fisheries
Mississippi State University, State College

Thomas S. Baskett, Chief
Division of Wildlife Research
Bureau of Sport Fisheries and Wildlife
Washington, D.C.

Frederick C. Hardy, Pittman-Robertson Coordinator
Kentucky Department of Fish and Wildlife Resources
Frankfort

Robert A. Jantzen, Director
Arizona Game and Fish Department
Phoenix

Earl F. Kennamer, Biologist
Bureau of Sport Fisheries and Wildlife
Extension Service
Auburn University
Auburn, Alabama

William H. Kiel, Jr., Biologist
King Ranch, Inc.
Kingsville, Texas

Roger L. Kirkman, Wildlife Biologist
Mark Twain National Forest
Springfield, Missouri

C. Eugene Knoder, Associate Director
Research Department
National Audubon Society
Tavernier, Florida

James C. Lewis, Assistant Unit Leader
Oklahoma Cooperative Wildlife Research Unit
Oklahoma State University, Stillwater

Allen W. Stokes, Professor
Department of Wildlife Resources
Utah State University, Logan

Donald D. Strode, Assistant Director
Wildlife Management, U.S. Forest Service
Washington, D.C.

Daniel Q. Thompson, Leader
New York Cooperative Wildlife Research Unit
Cornell University, Ithaca

Program Committee

John B. Lewis, Chairman
Missouri Department of Conservation
Columbia

R. Wayne Bailey
West Virginia Division of Wildlife Resources
Elkins

C. Phillip Agee
Nebraska Game and Parks Commission
Lincoln

Robert E. Dreis
Wisconsin Department of Natural Resources
Spooner

W. C. Glazener
Welder Wildlife Foundation
Simon, Texas

Victor S. Janson
Michigan Department of Natural Resources
Lansing

James A. Powell
Florida Game and Fresh Water Fish Commission
Tallahassee

Clarence F. Smith
Wisconsin Department of Natural Resources
Spooner

Arrangements Committee Missouri Chapter, The Wildlife Society

REGISTRATION
Leroy J. Korschgen
Missouri Department of Conservation

TRANSPORTATION
Jack A. Stanford
Missouri Department of Conservation

BANQUET
Bill T. Crawford
Missouri Department of Conservation

TREASURER
W. Reid Goforth
Missouri Cooperative Wildlife Research Unit

PRINTING AND PUBLICITY
Mac Johnson
Missouri Department of Conservation

COORDINATOR
Glenn D. Chambers
Missouri Department of Conservation

EDITORIAL COMMITTEE

The following individuals each reviewed one or more manuscripts for this book: C. Phillip Agee, Dale H. Arner, David H. Austin, R. Wayne Bailey, Thomas S. Baskett, Erwin L. Boeker, Glenn D. Chambers, Bill T. Crawford, George P. Dellinger, Dan F. Dickneite, Robert E. Dreis, William R. Edwards, Wm. H. Elder, Steve Gallizioli, W. C. Glazener, James B. Hale, William R. Hanson, Federick C. Hardy, Donald M. Hoffman, Laurence R. Jahn, William H. Kiel, Jr., Roger L. Kirkman, C. Eugene Knoder, Leroy J. Korschgen, Edward L. Kozicky, Ronald F. Labisky, Daniel W. Lay, John B. Lewis, James S. Lindzey, Duncan MacDonald, Karl Menzel, Carl O. Mohr, Henry S. Mosby, Horace W. Norton, James A. Powell, Annie K. Prestwood, R. J. Robel, Virgil E. Scott, Harley G. Shaw, Robert I. Smith, Allen W. Stokes, Donald D. Strode, James G. Teer, Jack Ward Thomas, Daniel Q. Thompson, Daniel O. Trainer, Frederic H. Wagner, Lovett E. Williams, Jr., and William D. Zeedyk.

INDEX

Acanthocephala: among southeastern wild turkeys, 165
Age classification: of Merriam's turkeys in Arizona, 291
Alabama: movements, behavior, and nesting ecology of the eastern wild turkey in, 109; movements of wild turkeys in, 135; seasonal movements and activities of wild turkey gobblers in, 125
All-age forest management: value of, for the eastern wild turkey in Missouri, 239-242
Alpha-chloralose: for capture of wild turkeys, 219
Arizona: roadside survey for Merriam's turkey in, 285; seasonal food habits of Merriam's turkey in, 151
Arkansas : hen-brood release technique in, 193
Armadillo: tested as potential egg predator of the wild turkey, 175
Arthropoda: among southeastern wild turkeys, 165
Austin, David H. *See* Williams, Lovett E., Jr.

B

Bacterial disease: among southeastern wild turkeys, 165-166; from wild turkeys in Texas and Wisconsin, 171-172
Bailey, R. Wayne: Restoring wild-trapped turkeys to nonprimary range in West Virginia, 181; Techniques of turkey management, 179. *See also* Thomas, Jack Ward
Banding: of Merriam's turkey in the Pine Ridge of Nebraska, 103-104; of the eastern wild turkey in South Dakota, 4-5; of the eastern wild turkey in spring in Missouri, 296-297
Band recoveries: of game-farm turkeys in Pennsylvania, 200; of Merriam's turkeys in the Pine Ridge of Nebraska, 104-105
Band returns: factors influencing, from game-farm turkeys in Pennsylvania, 201; of the eastern wild turkey in Alabama, 137; of the eastern wild turkey in South Dakota, 5
Barwick, Larry H., and Dan W. Speake: Seasonal movements and activities of wild turkey gobblers in Alabama, 125
Behavior: effects of man on, in wild turkeys, 232; of eastern wild turkey gobblers in Alabama, 131-133; of game-farm turkeys in Pennsylvania, 202, 205; of the eastern wild turkey in Alabama. 109. 121-123; of the Florida wild turkey in Florida, 79
Black Hills: Merriam's wild turkey in the, 3
Blackhead: among hybrid turkeys in Michigan, 50; among southeastern wild turkeys, 160
Boeker, Erwin L. *See* Scott, Virgil E.
Bonasa umbellus: effects of even-age management on, 273
Brood hens: deceptive behavior of, in the Florida wild turkey in Florida, 97; response to disturbance of, in the Florida wild turkey in Florida, 97
Brood range: early, of the Florida wild turkey in Florida, 90-91
Brood studies, 76
Broods: behavior of, in the Florida wild turkey in Florida, 98-99; of the Florida wild turkey in Florida, 79
Burning, prescribed: in southern forest types, 248, 251-252

C

California: turkey stocking program in, 55
Cannon-netting: of wild turkeys, 1
Capel, Stephen W.: Introduction of Rio Grande turkeys into Kansas, 11
Capture: of wild turkeys treated with oral drugs, 219, 226
Capture methods: for the Florida wild turkey in Florida, 87-88
Census -technique, 277, 318-319; for the eastern wild turkey in Indiana, 68-69; for the Rio Grande turkey in Texas, 279
Cestoda: among southeastern wild turkeys, 164
Colorado : some effects of weather and timber management on the Merriam's turkey in, 263
Color-marking: of the Merriam's turkey in the Pine Ridge of Nebraska, 103-104
Competition: of wild turkeys with other species, 231
Cook, Robert L. A census technique for the Rio Grande turkey, 279
Cost: of game-farm and wild-trapped turkeys in Pennsylvania, 204; of trapping and releasing the eastern wild turkey in Missouri, 23
Crockett, Ben C.: Quantitative evaluation of winter roost sites of the Rio Grande turkey in north-central Oklahoma, 211

D

Dasypus novemcinctus: tested as a potential egg predator of the wild turkey, 175
Davis, James R.: Movements of wild turkeys in southwestern Alabama, 135
Deer, white-tailed : effects of even-age management on, 273
Dellineer. George P. : Habitat management for Turkeys in the oak-hickory forests of Missouri, 235
Dickneite, Dan F.: Restoration of the eastern wild turkey in Missouri, 19
Disease: among southeastern wild turkeys, 159, 160-164, 165-166; of the wild turkey, 141; of wild turkeys from Texas and Wisconsin, 169-172
Dispersal: of the Rio Grande turkey in Iowa, 39-40
Donohoe, Robert W., and Charley E. McKibben: Status of the wild turkey in Ohio, 25
Doster, Gary L. See Prestwood, Annie K.

Dreis, Robert E., Clarence F. Smith, and Lewis E. Myers: Wisconsin's wild turkey restoration experiment, 45
Drugs, oral: for capture of wild turkeys, 219

E

EAM. *See* Even-age management
Eastern wild turkey: April foods of, in Missouri, 143; crossed with domestic turkeys in Wisconsin, 45; effects of even-age management on, 273; habitat management for, in the oak-hickory forests of Missouri, 235; hen-brood release as a restoration technique in Arkansas, 193; in Michigan, 49; mortality associated with spring hunting of gobblers, 295; movements, behavior, and nesting ecology in Alabama, 109; movements of, in Alabama, 135; parasitism and disease among southeastern, 159; restoration of, in Indiana, 65; restoration of, in Missouri, 19; restoring to nonprimary range in West Virginia, 181; seasonal movements and activities of gobblers in Alabama, 125
Even-age management: and turkey habitat in West Virginia, 273; in southern forest types, 245; value of, for the eastern wild turkey in Missouri, 239-242

F

Feeding, artificial: of Rio Grande turkeys in Texas, 307-308
Florida wild turkey: observations on movement, behavior, and development of broods, 79
Food habits: in April of the eastern wild turkey in Missouri, 143, 145-150; of pen-reared wild turkeys on a shooting preserve, 311; of the eastern wild turkey in South Dakota, 5; of the wild turkey, 141; of turkeys in California, 59-61; seasonal, of the Merriam's wild turkey in Arizona, 151, 153-157

G

Game-farm turkeys: as shooting preserve game, 309; evaluation of, in Pennsylvania, 199
Gill, John D. *See* Thomas, Jack Ward
Gore, Horace G.: Land-use practices and Rio Grande turkeys in Texas, 253
Grouse, ruffed: effects of even-age management on, 273

H

Habitat: for turkeys in California, 59
Habitat improvement: objectives of, in the oak-hickory forests of Missouri, 237
Habitat management: for the eastern wild turkey in the oak-hickory forests of Missouri, 235; for the wild turkey, 233, 321; for the wild turkey in southern forest types, 245; recommendations for, in the oak-hickory forests of Missouri, 236-237
Haemoproteus meleagridis: in wild turkeys from Texas and Wisconsin, 172
Harper, Harold T., and Walton A. Smith: California's turkey stocking program, 55
Harvest: of hybrid turkeys in Michigan, 51-53; of pen-reared wild turkeys on a shooting preserve, 312-313; of the wild turkey in Ohio, 29-31
Harvest management, 277, 320-321
Harvest mortality: of the eastern wild turkey in Missouri, 297
Harvest regulation: of the Rio Grande turkey in Texas, 301
Hatching: hazards of rain and water to, 89; hour of leaving nests and roosts, 89-90; of the Florida wild turkey in Florida, 88
Hen-brood release: as restoration technique in Arkansas, 193
Heterakis gallinarum: among southeastern wild turkeys, 160
Hillestad, Hilburn O.: Movements, behavior, and nesting ecology of the wild turkey in eastern Alabama, 109
Histomonas meleagridis: among hybrid turkeys in Michigan, 50; among southeastern wild turkeys, 160
Historical review : of the wild turkey in Ohio, 25
History : of the eastern wild turkey in South Dakota, 4
Hoffman, Donald M.: Some effects of weather and timber management on Merriam's turkeys in Colorado, 263
Holbrook, H. L.: Management of wild turkey habitat in southern forest types, 245
Hunting: of gobblers in spring, 295; of hybrid turkeys in Wisconsin, 48
Hunting season : effects of movements on the, in the Rio Grande turkey in Texas, 306-307; of the eastern wild turkey in Missouri, 23-24; of the eastern wild turkey in South Dakota, 9; of turkeys in California, 63; on hybrid turkeys in Michigan, 50-53
Hurt, James J., Ross A. Lock, and Karl Menzel: Movement of Merriam's turkey in the Pine Ridge of Nebraska, 101. *See also* Menzel, Karl

I

Ignatoski, F. J.: Status of wild turkeys in Michigan, 49
Incubating hens: response to disturbance of the Florida wild turkey in Florida, 96
Indiana: restoration of the wild turkey in, 65
Introductions: of the eastern wild turkey in Indiana, 65-67; of the Merriam's turkey in nontypical habitat in Nebraska, 187; of the Rio Grande turkey into Kansas, 11; of the wild turkey in California, 55-59
Iowa: status of the introduced Rio Grande turkey in, 35

J

Jahn, Laurence R. : Summary: needs and opportunities for managing turkey populations, 317

K

Kansas : introduction of the Rio Grande turkey in, 11
Kellogg, Forest E. *See* Prestwood, Annie K.
Kelly, Gene. *See* Lewis, John B.
Kennamer, James Earl, and William H. Lunceford, Jr.: Armadillos tested as

potential egg predators of wild turkeys in the Mississippi Delta, 175
Korschgen, Leroy J.: April foods of wild turkeys in Missouri, 143; Food habits, disease and predation, 141

L

Land use: and the Rio Grande turkey in Texas, 253; and wild turkeys, 230-231
Lewis, John B.: Census techniques and harvest management, 277; Habitat management, 233
Lewis, John B., and Gene Kelly: Mortality associated with the spring hunting of gobblers, 295
Lindzey, James S., and David D. Wanless: Problems in wild turkey management and research, 229
Lock, Ross A. *See* Hurt, James J.
Lunceford, William H., Jr. *See* Kennamer, James Earl

M

Management: of hybrid turkeys in Wisconsin, 48; of the eastern wild turkey in Indiana, 67-68; of turkeys in California, 61-62; problems of, in wild turkeys, 229; techniques of, for wild turkeys, 179
Management recommendations: for Rio Grande turkeys in Texas, 308
Marburger, Rodney G. *See* Thomas, Jack Ward
Marking: of eastern wild turkey gobblers in Alabama, 126
Max McGraw Wildlife Foundation: use of pen-reared wild turkeys for shooting preserve game, 309
McKibben. Charley E. *See* Donohoe, Robert W. ,
Meleagris gallopavo intermedia. See Rio Grande turkey
Meleagris gallopavo merriami. See Merriam's turkey
Meleagris gallopavo osceola. See Florida wild turkey
Meleagris gallopavo silvestris. See Eastern wild turkey
Menzel, Karl, and James J. Hurt: Releases of Merriam's turkeys in nontypical habitat, 187. *See also* Hurt, James J.
Merriam's turkey : in the Black Hills of South Dakota, 3; movement of, in the Pine Ridge of Nebraska, 101; recent history of, in the Pine Ridge of Nebraska, 102; releases of, in nontypical habitat in Nebraska, 187; roadside survey for, in Arizona, 285; seasonal food habits of, on the Fort Apache Indian reservation, 151; some effects of weather and timber management on, in Colorado, 263
Methoxymol: for capture of wild turkeys, 219
Michigan: status of wild turkeys in, 49
Migration : of the Rio Grande turkey in Texas as related to harvest regulation, 301
Missouri: April foods of the eastern wild turkey in, 143; habitat management for the eastern wild turkey in the oak-hickory forests of, 235; mortality associated with the spring hunting of gobblers in, 295; restoration of the eastern wild turkey in, 19
Mortality : associated with spring hunting of gobblers, 295; of game-farm turkeys in Pennsylvania, 203; of poults of the eastern wild turkey in Alabama, 121; of the eastern wild turkey in Missouri due to harvest, 297
Mortality, nonhunting: of pen-reared wild turkeys on a shooting preserve, 312
Mosby, Henry S.: Restoration and introductions of the wild turkey, 1; The changed status of the wild turkey over the past three decades, 71
Movement, 76; of banded eastern wild turkeys in South Dakota, 5; of the eastern wild turkey in Alabama, 109, 113-116, 137-139; of the Florida turkey in Florida, 79; of the Merriam's turkey in the Pine Ridge of Nebraska, 101, 105-107; seasonal, of eastern wild turkey gobblers in Alabama, 125, 128-131; of pen-reared wild turkeys on a shooting preserve, 311; of the Rio Grande turkey in Texas, 304-305
Myers, Lewis E. See Dreis, Robert E.

N

Narcosis : of wild turkeys as a result of oral drugs, 223-225
Nebraska : movement of the Merriam's turkey in the Pine Ridge of, 101; releases of the Merriam's turkey in nontypical habitat in, 187
Nebraska National Forest: releases of the Merriam's turkey in, 191
Nematoda: among southeastern wild turkeys, 165
Nesting: of the Florida turkey in Florida, 88-90
Nesting ecology, 76; of the eastern wild turkey in Alabama, 109, 116-119

0

Odocoileus virginianus: effects of even-age management on, 273
Ohio: status of the wild turkey in, 25
Oklahoma : quantitative evaluation of winter roost sites of the Rio Grande turkey in, 211
Oral drugs : effect on reproduction in the wild turkey, 226; response to, by wild turkeys in relation to age and sex, 226-227
Overgrazing : effects on the Rio Grande turkey in Texas, 254-255

P

Pack, James C. *See* Thomas, Jack Ward
Parasites : of the eastern wild turkey in South Dakota, 7
Parasitism: among southeastern wild turkeys, 159, 161, 164-165
Pennsylvania : evaluation of game-farm and wild-trapped turkeys in, 199
Peoples, Tommie E. *See* Williams, Lovett E., Jr.
Petersen, Lyle E., and Arthur H. Richardson: Merriam's wild turkey in the Black Hills of South Dakota, 3

Phillips, Robert W. *See* Williams, Lovett E., Jr.
Population: decline of the eastern wild turkey in Missouri, 19-20; implications of parasitism and disease on the wild turkey in the southeast, 166; of hybrid turkeys in Michigan, 49; status of the wild turkey over the past three decades, 71
Population, historic: of the eastern wild turkey in Missouri, 19
Population, winter: of the Merriam's turkey in Colorado, 266
Population changes: of hybrid turkeys in Wisconsin, 46
Population dynamics : of pen-reared wild turkeys on a shooting preserve, 314-315
Population estimates: of the eastern wild turkey in Missouri, 297
Population increase: in the continental United States, 2
Potential: of the Rio Grande turkey in Kansas, 17
Poults: age at first flight in the Florida turkey in Florida, 98; response to disturbance in the Florida turkey in Florida, 97
Poult survival: of game-farm turkeys in Pennsylvania, 202-203
Predation: on hybrid turkeys in Wisconsin, 48; on nests of the eastern wild turkey in Alabama, 119-120; on the wild turkey, 141, 231
Prestwood, Annie K., Forest E. Kellogg, and Gary L. Doster: Parasitism and disease among southeastern wild turkeys, 159
Private lands: potential for managing the wild turkey on, 322-323
Public lands: potential for managing the wild turkey on, 321-322

R

Radiotelemetry: of the eastern wild turkey in Alabama, 109
Radio-tracking technique: on the Florida turkey in Florida, 85-87
Range : of the eastern wild turkey in Alabama, 113-116
Range, annual: of eastern wild turkey gobblers in Alabama, 127-131
Releasing: of eastern wild turkey gobblers in Alabama, 126
Reproduction: of game-farm turkeys in Pennsylvania, 202; of subadult Rio Grande turkeys in Kansas, 15-16; of the eastern wild turkey in South Dakota, 7-8; of the Rio Grande turkey in Iowa, 38
Research: problems of, in the wild turkey, 229
Restoration: evaluation of game-farm and wild-trapped turkeys for, in Pennsylvania, 199; hen-brood release technique in Arkansas, 193; of the eastern wild turkey in Indiana, 65; of the eastern wild turkey in Missouri, 19, 20-22; of the wild turkey, 1-2; of the wild turkey in Ohio, 26-29; of wild-trapped eastern wild turkeys to nonprimary range in West Virginia, 181; using hybrid turkeys in Wisconsin, 45
Richardson, Arthur H. *See* Petersen, Lyle E.
Rio Grande turkey: a census technique for, in Texas, 279; effects of land-use practices on, in Texas, 253; introduction into Kansas, 11; migrations as related to harvest regulation in Texas, 301; quantitative evaluation of winter roost sites in north-central Oklahoma, 211; status of, in Iowa, 35
Roadside survey: for the Merriam's turkey in Arizona, 285
Roost counts: of the Rio Grande turkey in Texas, 281
Roost sites: evaluation of, for the Rio Grande turkey in Oklahoma, 211; of the Merriam's turkey in Colorado, 271
Roost trees: measurements of, used by the Rio Grande turkey in Oklahoma, 215
Roosting: of broods of the Florida turkey in Florida, 95
Rundquist, Vaughn M.: Pen-reared wild turkeys as shooting-preserve game, 309
Rush, Gene: The hen-brood release as a restoration technique, 193

S

Salmonella pullorum: not found in wild turkeys from Texas, 171
Salmonella typhimurium: not found in wild turkeys from Texas, 171
Sciurus spp. : effects of even-age management on, 273
Scott, Virgil E., and Erwin L. Boeker: Seasonal food habits of Merriam's turkeys on the Fort Apache Indian reservation, 151
Sex classification: of Merriam's turkeys in Arizona, 291
Shaw, Harley G.: The roadside survey for Merriam's turkeys in Arizona, 285
Shooting-preserve game: use of pen-reared wild turkeys as, 309
Smith, Clarence F. *See* Dreis, Robert E.
Smith, Walton A. *See* Harper, Harold T.
South Dakota: the Merriam's wild turkey in the Black Hills of, 3
Speake, Dan W. *See* Barwick, Larry H.
Squirrel: effects of even-age management on, 273
Status: of the wild turkey, 317
Stocking: of hybrid turkeys in Michigan, 49; of pen-reared wild turkeys as shooting preserve game, 310
Stocking program: of hybrid wild turkeys in Wisconsin, 45-46
Subadult breeding: of the Rio Grande turkey in Kansas, 15-16
Survival : of game-f arm and wild-trapped turkeys in Pennsylvania, 204-205; of the Rio Grande turkey in Iowa, 38

T

Texas : census technique for the Rio Grande turkey, 279; land-use practices and Rio Grande turkeys in, 253; Rio Grande turkey migrations as related to harvest regulation, 301; some diseases of wild turkeys from, 169
Thomas, Jack Ward, James C. Pack, John D. Gill, and R. Wayne Bailey: Even-age management, turkeys and turkey hunters: a new study, 273

Thomas, Jack Ward, Rodney G. Marburger, and Calvin Van Hoozer: Rio Grande turkey migrations as related to harvest regulation in Texas, 301
Timber management: effects of, on the Merriam's turkey in Colorado, 263, 271
Timber stand improvement: in southern forest types, 249, 251
Trainer, Daniel O.: Some diseases of wild turkeys from Texas and Wisconsin, 169
Transplanting: of hybrid turkeys in Wisconsin, 47; of the Rio Grande turkey in Kansas, 13-14; success of the Rio Grande turkey in Kansas, 14
Trapping: of eastern wild turkey gobblers in Alabama, 126; of game-farm turkeys in Pennsylvania, 203; of the eastern wild turkey in Missouri, 22-23; of the eastern wild turkey in South Dakota, 4; of the eastern wild turkey in spring in Missouri, 296-297; of the Merriam's turkey in the Pine Ridge of Nebraska, 102-103, 104; of the Rio Grande turkey in Kansas, 13-14
Trematoda: among southeastern wild turkeys, 164
Tribromoethanol: for capture of the wild turkey, 219
TSI: *See* Timber stand improvement

V

Van Hoozer, Calvin. *See* Thomas, Jack Ward
Viral disease : among southeastern wild turkeys, 165-166

W

Wanless, David D. *See* Lindzey, James S.
Wapanocca National Wildlife Refuge: hen-brood release as a restoration technique on, 196-197
Weather: effects on roadside surveys of Merriam's turkey in Arizona, 293; effects on the Merriam's turkey in Colorado, 263, 269-271; effects on the Rio Grande turkey in Iowa, 41; effects on the use of oral drugs to capture turkeys, 227; effects on turkey populations, 231
West Virginia: even-age management, turkeys and turkey hunters, 273; restoring wild-trapped turkeys to nonprimary range in, 181
Wigal, Dennis D.: Status of the introduced Rio Grande turkey in northeastern Iowa, 35
Williams, Lovett E., Jr.: Movements, nesting ecology and brood studies, 76
Williams, Lovett E., Jr., David H. Austin, Tommie E. Peoples, and Robert W. Phillips: Capturing turkeys with oral drugs, 219; Observations on movement, behavior, and development of turkey broods, 79
Wisconsin: some diseases of wild turkeys from, 169; wild turkey restoration experiment in, 45
Wise, Gerald D.: Restoration of the wild turkey in Indiana, 65
Wunz, Gerald A.: Evaluation of game-farm and wild-trapped turkeys in Pennsylvania, 199