FOOD HABITS OF THE MOURNING DOVE

IN NORTHWEST OKLAHOMA

By

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Bachelor of Science

Cornell University

Ithaca, New York

1967

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1970

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ACKNOWLEDGEMENTS

I would like to express my appreciation to my major adviser, Dr. John A. Morrison, leader of the Oklahoma Cooperative Wildlife Research Unit, for his guidance throughout all phases of this project. I am also grateful to Dr. Wilfred E. McMurphy for his assistance in plant identification and for his suggestions for improving the manuscript. Dr. Arthur E. Harriman reviewed the manuscript and offered valuable suggestions. Thanks are also due to Dr. Robert I. Smith and Mr. James C. Lewis for their help and encouragement during the field work. Project support was provided by the Oklahoma Cooperative Wildlife Research Unit.*

Special thanks are due to: Dr. Robert D. Morrison and Mr. Byron Brandt, Oklahoma State University, for their help with the data analysis; to Mr. Richard Martin for his assistance and cooperation during the field work; to Messrs. Kenneth Cook, Michael Gabbard, Larry Hart, and Ronald Little for their field assistance; to the Rangers of the Oklahoma Department of Wildlife Conservation and the numerous landowners who cooperated in this study; to Miss Cecilia Gomez who assisted in the laboratory work; to Mr. David Watts for his capable assistance with the illustrative material; and to Messrs. Peter Kehde and David Chesemore and the other Unit Fellows for their assistance and encouragement throughout this study.

*Oklahoma Department of Wildlife Conservation, Oklahoma State University, U.S. Fish and Wildlife Service, and the Wildlife Management Institute cooperating.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The increasing economic and recreational value of the mourning dove (Zenaidura macroura) necessitates an intensive research program into its biology, habits, and ecology. More doves have been harvested annually than any other game bird, and their importance is increasing as hunting pressures increase and as opportunities for hunting other species diminish.

Eastern, central, and western management units have been established in the United States on the premise that the majority of the doves harvested in a management unit are also produced in that unit (Kiel, 1959). Units also differ in environmental characteristics. Although biologists in the eastern unit have studied this bird intensively, little is known about the ecological status of doves in the western unit or in the central unit, which includes Oklahoma.

Dove management is particularly important in Oklahoma because large numbers migrate through the state each fall between nesting areas in the north and wintering areas in the south. The state is also a major producer of doves. Dove hunting is increasing in Oklahoma, and in 1967 approximately 50,000 hunters took 1.25 million birds (Williamson, 1968). It is, therefore, essential to understand dove ecology, including food habits, for making sound decisions for regulating hunting and management.

This investigation constitutes one phase of an intensive study on dove ecology conducted by the Oklahoma Cooperative Wildlife Research Unit. Other investigations include population characteristics of the mourning dove and the distribution and habitat preference of the breeding population in northcentral Oklahoma.

Food type, abundance, and distribution are basic factors determining animal numbers and success. Lack (1954) suggested that food may be the limiting factor for many species of animals. Consequently, a knowledge of feeding habits is essential for proper management of doves. This research was conducted to determine quantitatively and qualitatively foods consumed by doves, seasonal trends in their diet, extent of dove usage of agricultural crops, and effect of local ecological conditions and land-use on dove food habits.

CHAPTER II

METHODS

Differentiation of Study Area Components and Plant Identification

Food-habit studies are particularly important when they are correlated with the geography, plant communities, and land-use types within the sampling units (Hartley, 1948). One purpose of this study was to compare food habits of doves along three study transects which differed in vegetational and land-use patterns.

Aerial photographs and a modified reconnaissance-primary survey method were employed to determine the major plant communities and patterns of vegetation, dominant and common species, and land-use patterns. The aim of reconnaissance was to get a general idea of the landscape and its mantle of vegetation (Cain and Castro, 1959). The primary survey consisted of recognizing and describing the major plant associations, listing the species composing them, studying their relationships, and recording their distribution on maps (Tansley, 1958).

Aerial photographs of the study area were obtained from the Agriculture Stabilization and Conservation Service of the U.S. Department of Agriculture. Base maps, drafted from these photographs, were used to differentiate major ecological types, and to determine the distribution of vegetation, water, and land-use types. The acreage of each type was determined with a compensating polar planimeter.

The base maps were used in the field for identifying and recording characteristics of an area. The general cover-types of individual areas were examined. Rectangular quadrats, 1 x 1 m and $\frac{1}{4}$ x 1 m, were placed both randomly and systematically in each herbaceous vegetative type, and the enclosed plant species were recorded. In timbered and shrubby areas, belt transects, approximately 1 m x 25 to 75 m, were walked and a species list of vascular vegetation was compiled. General observations and frequent visits to each cover-type throughout the period of investigation provided additional information on the general floristic composition of each area.

Specimens were collected, numbered, placed in a vasculum, and later transferred to a plant press for future identification. Nomenclature of the vascular plants follows that of Waterfall (1966), nomenclature of the cultivated crops is after Bailey and Bailey (1941), and common names are cited according to Darrow, et al. (1966).

Collection, Preparation, and Analysis of Crop Contents

Study transects were visited four or five times a week, and dove feeding areas along these transects were recorded. Areas were both observed and walked to determine local concentrations of doves and to obtain specimens. Approximately ten doves were collected randomly by gun from each of the three transects each week. The sex, age, location, date, and weight were recorded for each dove collected. The crop contents were removed, dried in petri dishes under a heat lamp, and then stored in vials for subsequent analysis. The bird's internal organs were removed, washed, and stored in 10 per cent formalin for parasite examination at a later time.

Analysis of crop contents was a modification of a method proposed by Davison (1940). Contents were separated by size by the use of .5-, 1-, 1.5-, 2-, and 3-mm mesh screens. Seeds of different species having the same size were then separated by hand, and each type was placed in a plastic container.

Graduated cylinders have been used almost without exception for determining volumes in food habits studies. Although a graduated cylinder may give satisfactory readings, it is not precise in determining the volume of small quantities of seeds. Inglis and Barstow (1960) suggest a volumetric measuring technique involving the use of a syringe and sand. However, this technique appears neither convenient nor rapid enough for a large number of measurements. During this study, an accurate, rapid, and inexpensive technique for making volumetric measurements was developed.

The apparatus was constructed by removing the ends of a 10-cc pipette, creating a narrow cylinder calibrated in tenths of a cc. A stopper was fitted to the zero mark in the cylinder. The instrument was held vertically by a clamp to a ring stand. A clamp, supporting a 50-cc burette, was attached to a metal sleeve which fitted over the ring stand and rested on the clamp which supported the cylinder. This arrangement permitted an easy swinging motion so that the burette could be conveniently positioned above the cylinder or moved away permitting the addition of seeds to the cylinder. The burette was positioned 1-2 mm above the instrument. A glass plunger, the top of which was flattened vertically to function as a handle, was used to force seeds out of the instrument upon completion of the measuring. Figure 1 illustrates the operation of this device.

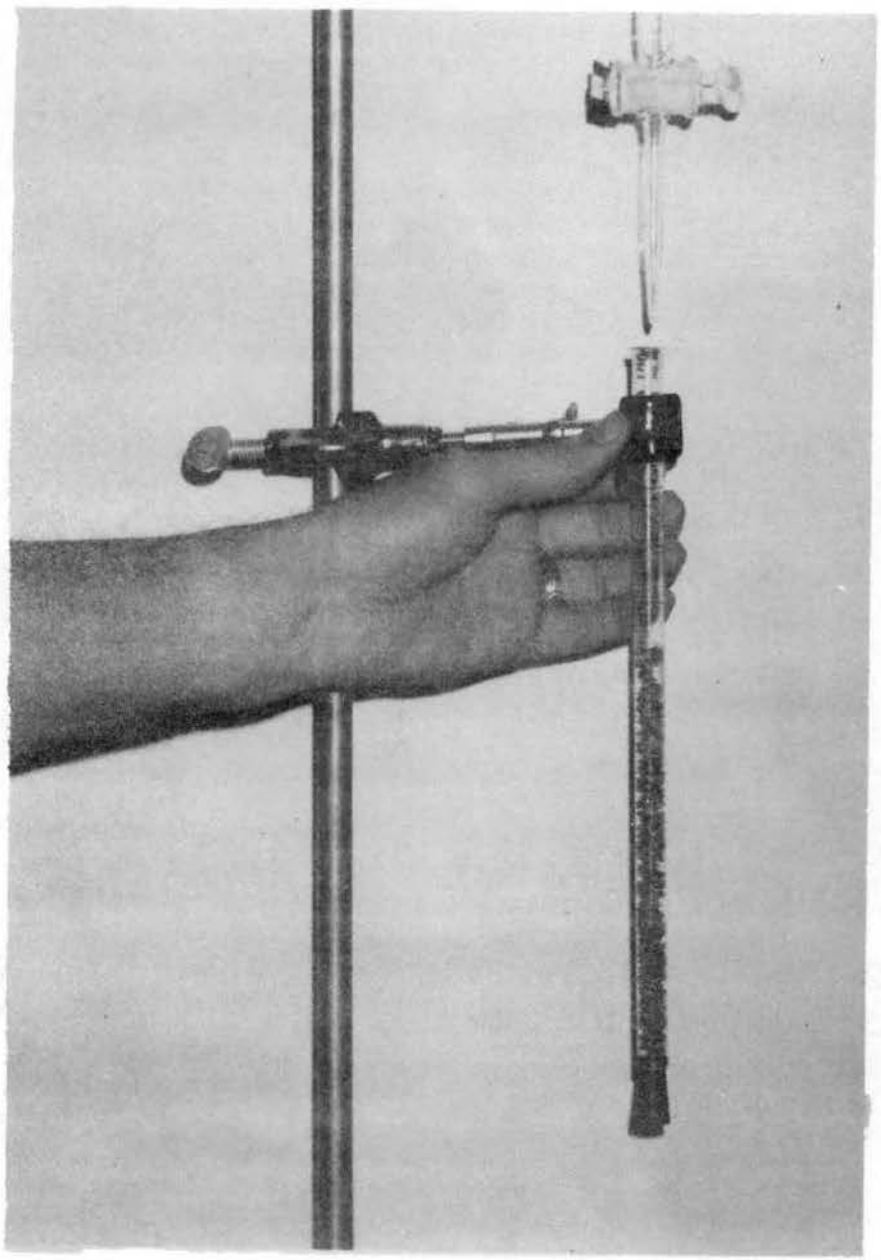

Figure 1. Volumetric Measuring Instrument and Technique: (A) Seeds and a Known Quantity of Water are Placed in the Cylinder.

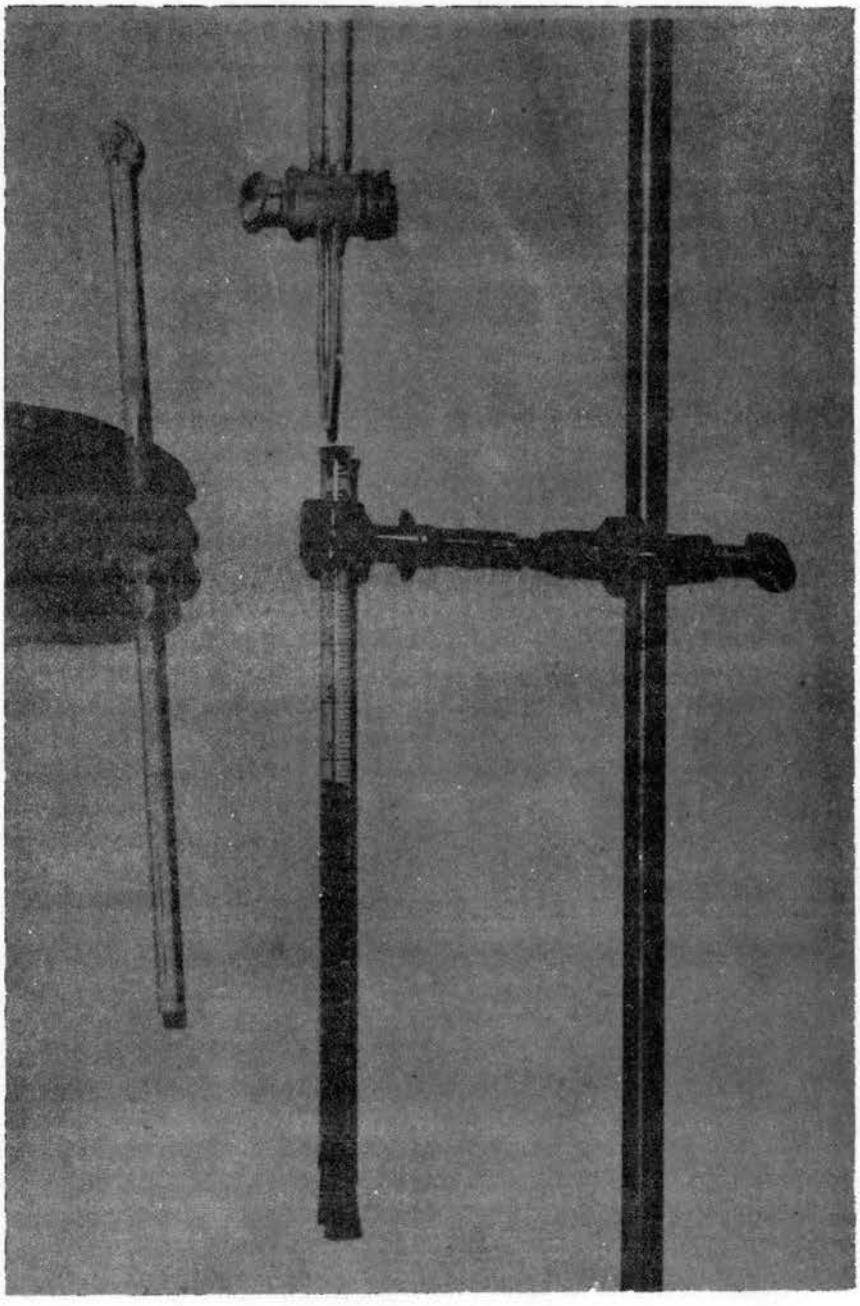

Figure 1 con't. (B) Difference between Known Quantity of Water added and Final Volumetric Reading Gives Volume of Food Item. Plunger is Shown along Side of the Instrument.

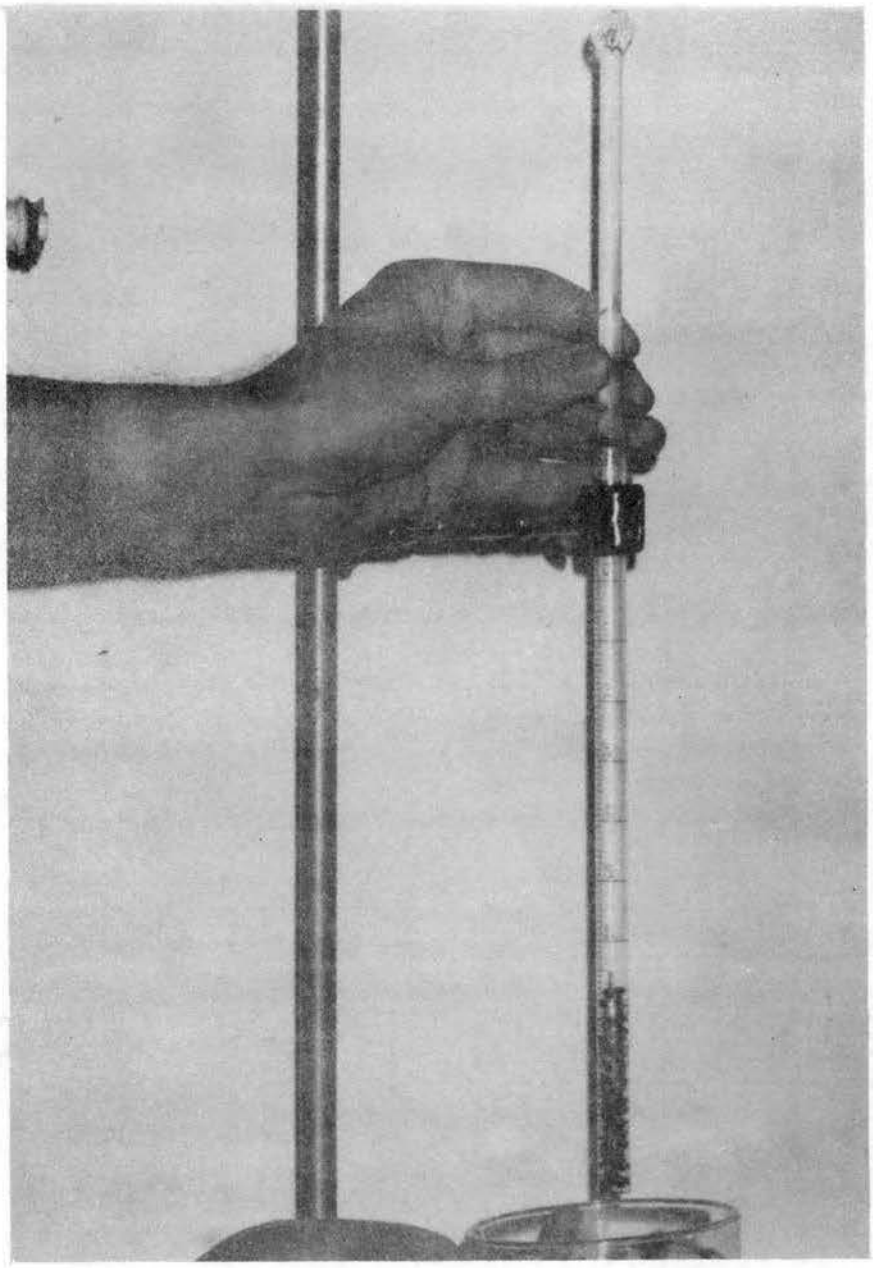

Figure 1 con't. (C) Burette is moved Aside, Stopper is Removed, and the Plunger is pushed through the Cylinder to Force out Contents.

The component seed species in a dove crop were measured individually. The per cent of the total volume of a crop which a seed species comprised was computed by the aggregate-volume method of Martin, Gensch, and Brown (1946). Food items measuring less than .05 cc were recorded as "trace." The frequency of occurrence, calculated as the per cent of total crops containing a particular food item, was also determined.

A representative of each seed type was given a number and placed in a container for reference. Seeds were later identified to species, when possible, through reference to the collection of seeds of the Oklahoma Cooperative Wildlife Research Unit, to Martin and Barkley (1961), and to Musil (1963).

CHAPTER III

DESCRIPTION OF THE STUDY AREA

Location and Characteristics

Field studies were conducted on three east-west transects in a 27-square-mile area in northeastern Dewey County, Blaine County, and southcentral Major County in northwest Oklahoma (Figure 2). Transect I is an 11-mile route located 3 miles north of the Canton Public Hunting Area. Transect II is an 8-mile route on the Canton Public Hunting Area, north of the Canton Reservoir. Four miles of this route are on the east and 4 miles are on the west part of the Canton Public Hunting Area. Transect III, 3 miles south of the management area, is 8 miles long. Each transect is 1 mile wide and is interrupted at 1-mile intervals by north-south section roads.

Physiography, Vegetation, and Edaphic Factors

The study area includes five game habitat types (Figure 2): tallgrass prairie, post oak-blackjack forest, bottomland, sand-sage grassland, and stabilized dune (Duck and Fletcher, 1944). The following description of physiographic and soil characteristics is based on Duck and Fletcher (1944) and implies the pristine conditions undisturbed by agriculture or cultural changes.

The tallgrass type consists of a mixture of big bluestem (Andropogon Gerardi), little bluestem (A. scoparius), silver bluestem

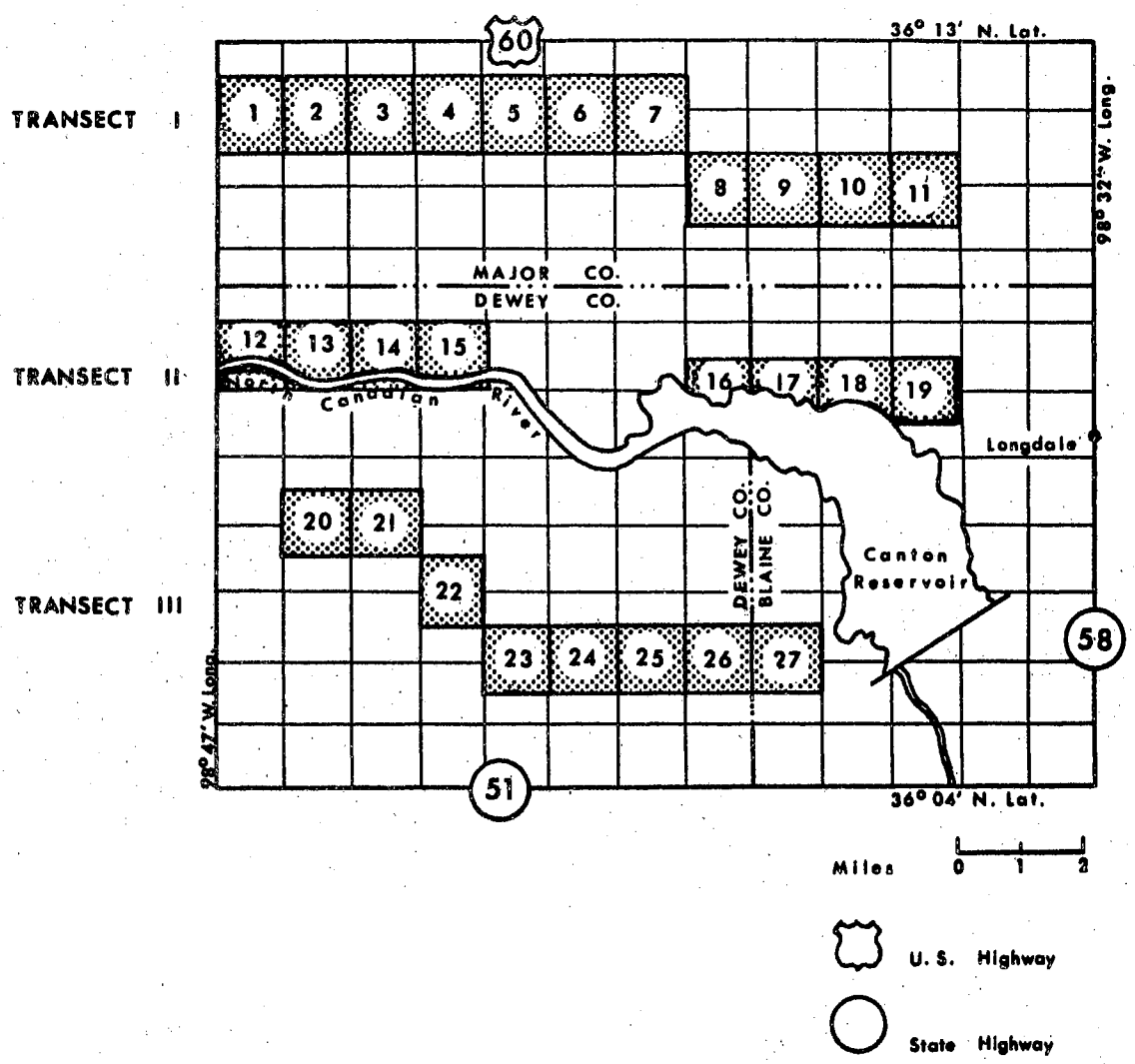

Figure 2. Location of the Three Study Transects in Northwest Oklahoma, Including Distribution of Game Habitat Types (Overlay).

(A. saccharoides), Indian grass (Sorghastrum nutans), and switchgrass (Panicum virgatum). The topography varies from flat to gently rolling. The soils are generally derived from shales and clays of the Permian Red Beds and range from light sandy loams to heavier silt loams and clays. This type, the vegetation of which is included in Table I under "Native Pasture," is presently devoted largely to agriculture and grazing.

The post oak-blackjack type ("Upland Forest") is considered a forest-grassland ecotone with representatives of both the forest and grassland vegetational types present. Blackjack oak (Quercus marilandica) is the dominant species. Plants in this type, identified on the study area, are included in Table I. The topography is generally rolling to rough. The soils are coarse-textured, relatively poor, and are developed from residual sandstones and weathered shales.

Bottomlands include the stream course and first terrace of all the regular drainages of the state. Cottonwood (Populus deltoides) is the dominant vegetation type (Table I). The topography of this type varies from flat bottomlands to steep valleys. Bottomlands differ from other timbered areas in that most of the bottom soils are extremely fertile and deep, being alluvial in origin (Duck and Fletcher, 1944). Bottomland vegetation and flooded areas are included under "Riparian" in Table I.

The sand-sage grassland type includes the areas on which sand-sage (Artemisia filifolia) forms an important part of the ground cover. Other species associated with this type are presented in Table I.

TABLE I

VEGETATIVE TYPES (EXCLUDING CROP LANDS) AND PLANT SPECIES IN THE STUDY AREA IN NORTHWEST OKLAHOMA

Plants		Vegetative Type							
Scientific Name	Common Name	Native Pasture	Sand-sage Grassland	Upland Forest	Riparian	Cottonwoods	Weed Fields	Windbreak	Roadside
Amaranthus sp.	pigweed					X	X		X
Ambrosia psilostachya	western ragweed	X	X	X		X	X	X	X
A. trifida	giant ragweed								X
Andropogon Gerardi	big bluestem	X							X
A. Hallii	sand bluestem		X						
A. saccharoides	silver beardgrass	X							X
A. scoparius	little bluestem	X	X	X			X		X
A. ternarius	splitbeard bluestem	X							
Aristida oligantha	prairie threeawn	X		X			X		X
Artemisia filifolia	sand sagebrush		X						X
A. ludoviciana	Louisiana wormwood	X		X			X		X
Asclepias sp.	milkweed	X							
Aster ericoides	heath aster								X
Bouteloua curtipendula	side-oats grama	X		X					
B. gracilis	blue grama	X	X	X			X		
B. hirsuta	hairy grama	X		X					
Bromus cartharticus	rescue grass	X					X		
B. japonicus	Japanese brome	X					X	X	X
B. tectorum	downy brome	X							X
Buchloe dactyloides	buffalograss	X							
Bumelia lanuginosa	gum bumelia					X			
Carex sp.	sedge	X			X				
Cassia fasciculata	partridgepea	X							
Celtis reticulata	netleaf hackberry				X	X			

TABLE I (continued)

Plants		Vegetative Type							
Scientific Name	Common Name	Native Pasture	Sand-sage Grassland	Upland Forest	Riparian	Cottonwoods	Weed Fields	Windbreak	Roadside
Cenchrus pauciflorus	field sandbur	X	X	X			X		X
Chenopodium album	common lambsquarters						X		
Chloris verticillata	tumble windmillgrass	X					X		
Chrysopsis pilosa	soft goldaster	X							
Cirsium undulatum	wavyleaf thistle	X							
Cornus sp.	dogwood				X				
Croton sp.	croton	X	X				X		
Cyperus sp.	flatsedge				X				
Desmanthus illinoensis	bundleflower					X			
Desmodium sp.	tickclover	X					X		
Digitaria sanguinalis	large crabgrass						X		
Eleocharis sp.	spikerush				X		X		
Elymus canadensis	Canada wildrye					X			X
Eragrostis sp.	lovegrass	X	X		X	X			X
Erigeron sp.	horseweed	X			X	X	X		X
Eriogonum annuum	annual wild-buckwheat	X	X		X	X	X	X	X
Euphorbia sp.	spurge						X		X
Gaillardia sp.	gaillardia						X		
Gutierrezia dracunculoides	common broomweed	X							
Haplopappus ciliatus	wax goldenweed	X	X			X	X	X	X
Helianthus annuus	sunflower	X					X		X
H. petiolaris	prairie sunflower	X					X		X
Heterotheca sp.	camphorweed	X	X				X	X	X
Hordeum pusillum	little barley	X					X		
Indigofera sp.		X							
Juglans nigra	black walnut				X				

TABLE I (continued)

Plants		Vegetative Type							
Scientific Name	Common Name	Native Pasture	Sand-sage Grassland	Upland Forest	Riparian	Cottonwoods	Weed Fields	Windbreak	Roadside
Juniperus virginiana	eastern redcedar	X	X	X	X			X	
Lepidium densiflorum	greenflower pepperweed						X		
Leptoloma cognatum	leptoloma	X					X	X	X
Lespedeza virginica	slender lespedeza	X							X
Linum sp.	flax	X							
Maclura pomifera	osage orange							X	
Monarda sp.	beebalm	X							
Morus rubra	red mulberry				X	X		X	
Oenothera sp.	eveningprimrose						X		
Opuntia sp.	pricklypear		X						X
Oxalis stricta	common yellow woodsorrel						X		
Panicum capillare	witchgrass	X		X	X		X		X
P. oligosanthes	panicum			X	X				X
P. virgatum	switchgrass	X							
Paspalum sp.	paspalum	X	X				X	X	X
Phytolacca americana	pokeweed					X			
Plantago sp.	plantain	X	X	X				X	X
Polygonum sp.	smartweed	X					X		X
Populus deltoides	eastern cottonwood		X		X	X			
Prunus angustifolia	chickasaw plum	X	X	X		X		X	X
Quercus marilandica	blackjack oak	X	X	X					X
Q. stellata	post oak			X					
Rhus aromatica	fragrant sumac	X	X	X	X				X
R. glabra	smooth sumac				X	X		X	X
Robinia pseudo-acacia	black locust							X	
Rudbeckia hirta	hairy coneflower	X							

TABLE I (continued)

Plants		Vegetative Type							
Scientific Name	Common Name	Native Pasture	Sand-sage Grassland	Upland Forest	Riparian	Cottonwoods	Weed Fields	Windbreak	Roadside
Salix nigra	black willow				X	X			
Salsola Kali	Russian thistle	X	X						X
Setaria geniculata	knotroot foxtail						X		X
Setaria sp.	foxtail						X		
Solanum elaeagnifolium	silverleaf nightshade								X
S. Torreyi	nightshade								X
Solanum sp.	nightshade	X					X		
Sorghastrum nutans	Indian grass	X							
Sorghum halepense	johnsongrass		X				X		X
Specularia perfoliata	Venus lookingglass	X					X		
Sporobolus cryptandrus	sand dropseed	X	X	X			X		X
Strophostyles sp.	wildbean						X		
Symphoricarpus orbiculatus	buckbrush	X		X					X
Tamarix gallica	French tamarisk				X				
Tradescantia sp.	spiderwort		X						
Ulmus americana	American elm		X		X	X			
U. pumila	Siberian elm							X	
Vernonia Baldwinii	western ironweed	X				X	X		X
Vicia sp.	vetch						X		X
Viola Kitaibeliana	johnnyjumpup violet						X		
Yucca glauca	small soapweed		X						

The topography is rolling to dune-like. The soils are typically developed from Quarternary parent material which is found overlying the Permian Red Beds.

The stabilized dune type includes the heavily vegetated sand dunes which occur on the north side of the North Canadian River. A dune-like relief is characteristic of this area. The vegetation is included under "Sand-sage Grassland" type (Table I). The soils are generally of a loose sandy nature and are subject to blowing where vegetational protection is removed.

The number of acres of agricultural land, tallgrass type (pasture), post oak-blackjack oak type, bottomland type, sand-sage grassland type (including the dune areas) present on the study area are shown in Table II.

Land-Use

Transects I and III contain mainly agricultural lands in which the principal crop is wheat, although sorghum, cotton, alfalfa, barley, and millet are also grown. Some of this land consists of pasture on which livestock is an important industry. Livestock is chiefly beef; a few sheep and hogs are raised also.

Transect II consists mainly of the eastern and western sections of the management area. The U.S. Army Corps of Engineers constructed Canton Reservoir for irrigation and flood control by impounding the North Canadian River. The construction of the dam was completed in 1948. The hunting area consists of 16,677 acres (approximately 26 square miles) and differs from the surrounding area in that it contains extensive crop plantings and habitat improvements for wildlife.

TABLE II

ACREAGE OF LAND TYPES PRESENT ON THE THREE TRANSECTS
IN NORTHWEST OKLAHOMA, 1968

TRANSECT I

	Acres per Section Section Number											Total Acres	% of Total
	1	2	3	4	5	6	7	8	9	10	11		
Native Pasture	28.5	134.1	56.0	98.9	199.3	103.6	126.2	159.6	146.1	240.2	194.2	1486.7	21.1
Sand-sage Grassland	134.2	14.5										148.7	2.1
Upland Forest	293.1	141.7	357.2	319.8	186.7	203.9	308.0	328.4	227.5	186.2	305.3	2857.8	40.6
Riparian Cottonwoods													
Weed Fields	30.6	12.5	51.2		18.0	5.7			25.2		68.3	211.5	3.0
Windbreak													
Lovegrass Pasture		126.3	42.1		38.6	43.6	12.5		51.3	13.2	16.3	343.9	4.9
Homestead	4.4	2.0	2.0	2.1	5.0	3.3	1.7	2.9	1.9	1.9	4.4	31.6	0.4
Orchard					5.4	6.7						12.1	0.2
Wheat	129.2	133.4	70.8	107.6	162.9	183.9	81.0	137.2	79.2	80.4	43.9	1209.5	17.2
Barley													
Sorghum				19.0								19.0	0.3
Millet									10.0			10.0	0.1
Cowpeas													
Cotton			30.1							23.1		53.2	0.8
Alfalfa													
Haygrazer	20.0	75.5	30.6	55.3	24.1	78.3	110.6	11.9	98.8	95.0	7.6	607.7	8.6
Watermelon				37.3		11.0						48.3	0.7
Water			Pres	Pres	Pres	Pres	Pres			Pres	Pres	---	---
Total	640	640	640	640	640	640	640	640	640	640	640	7040.0	100.0

TABLE II (continued)

TRANSECT II

	Acres per Section Section Number								Total Acres	% of Total
	12	13	14	15	16	17	18	19		
Native Pasture		126.5	72.1	118.3	167.9	75.6	135.9	83.7	780.0	15.2
Sand-sage Grassland	393.3	315.4	345.6	313.2					1367.5	26.7
Upland Forest		6.0			76.2	19.5	84.5		186.2	3.6
Riparian	5.0	3.2	7.5	5.4	24.4	80.9	64.6	97.9	288.9	5.6
Cottonwoods	216.0	105.6	121.0	81.6	201.9	258.4	125.7	171.8	1282.5	25.0
Weed Fields	4.0								4.0	0.1
Windbreak								4.0	4.0	0.1
Lovegrass Pasture										
Homestead		1.0			4.0	1.0			6.0	0.1
Orchard										
Wheat		33.3		29.2	110.2	63.2	53.7	17.7	307.3	6.0
Barley							41.6		41.6	0.8
Sorghum	12.2	36.7	84.3	42.5	14.0	61.4	58.8	234.9	544.8	10.6
Millet	1.3	4.1		31.0	22.2	20.0	33.2	15.0	126.8	2.5
Cowpeas		8.2	9.5	18.8	19.2	20.0	11.0	15.0	101.7	2.0
Cotton										
Alfalfa	8.2						5.2		13.4	0.3
Haygrazer						40.0	25.8		65.8	1.3
Watermelon										
Water	Pres	Pres	Pres	Pres	Pres	Pres	Pres	Pres		
Total	640	640	640	640	640	640	640	640	5120.0	99.9

TABLE II (continued)

TRANSECT III

	Acres per Section Section Number								Total Acres	% of Total
	20	21	22	23	24	25	26	27		
Native Pasture	220.7	38.6	248.1	245.6	133.6	258.6	141.5	193.4	1480.1	28.9
Sand-sage Grassland										
Upland Forest				3.7	4.7	39.4			47.8	0.9
Riparian Cottonwoods	55.9	25.8	35.6	34.0	116.1	30.7	128.4	123.2	549.7	10.7
Weed Fields				11.4	9.9				21.3	0.4
Windbreak		5.7	8.0		2.0			10.0	25.7	0.5
Lovegrass Pasture							71.4	29.9	101.3	2.0
Homestead	7.4		4.5	1.0	2.0		4.0	1.0	19.9	0.4
Orchard										
Wheat	299.3	521.6	287.7	336.0	345.8	230.1	217.3	282.5	2520.3	49.2
Barley					21.4				21.4	0.4
Sorghum	6.8	14.2							21.0	0.4
Millet		13.7							13.7	0.3
Cowpeas										
Cotton										
Alfalfa	17.2	20.4							37.6	0.7
Haygrazer	32.7		56.1	8.3	4.5	81.2	77.4		260.2	5.1
Watermelon										
Water	Pres	Pres	Pres		Pres	Pres	Pres	Pres		
Total	640	640	640	640	640	640	640	640	5120.0	99.9

It also includes a 4900-acre reservoir, which forms the southern boundary over most of this transect. Sorghum, millet, cowpeas, and some wheat and barley are grown throughout the management area. Sixty per cent of these crops is harvested by sharecroppers, and the rest is retained for wildlife use. No grazing is permitted on the management area.

Most of the wheat and barley in the study area were planted between September 15 and October 15 of the year preceding this study. The grains were harvested in mid-June, and their stubble was mulched in late June, July, and August. Other crops were planted in mid-summer. Maturation dates of crops grown on the study area are listed in Table III.

TABLE III

DATES OF CROP MATURATION ON THE STUDY AREA IN NORTHWEST OKLAHOMA, 1968

Crop	Date of Maturity
wheat (*Triticum aestivum*)	June 10 to 20
barley (*Hordeum vulgare*)	June 8 to 15
millet, German (*Setaria italica*)	mid-August
alfalfa (*Medicago sativa*)	mid-August
cowpeas (*Vigna sinensis*)	mid-September
haygrazer (*Sorghum vulgare* x *S. sudanense*)	September 20 to October 20
millet, Red Fortune (*Setaria* sp.)	September 28 to October 10
sorghum (*Sorghum vulgare*)	October 1 to November 1

Transect Comparisons in Summary

Transects I and III are 3 miles north and south of Transect II, respectively, and contain mainly agricultural lands in which wheat is the principal crop. Transect II consists of the eastern and western sections of the management area and differs from the other transects in that it contains crop plantings, habitat improvements for wildlife, and a 4900-acre reservoir on the southern border.

The vegetational and land-use patterns of each transect are presented in Table II. Transect I consists of 40.6 per cent upland forest, whereas this vegetational type represents only 3.6 and .9 per cent, respectively, of Transects II and III. Transect II has considerably more sand-sage grassland and cottonwoods than the other transects. Total wheat acreage is greatest on Transect III. Wheat occupies 17.2, 6.0, and 49.2 per cent, respectively, of Transects I, II, and III.

The transects, therefore, are in close proximity and have similar vegetational and land-use types. However, the proportions of these vegetational and land-use types vary considerably among the transects.

Climate

Oklahoma has a temperate climate which is subject to extreme fluctuations (Bruner, 1931). Western Oklahoma is marked by low, irregular rainfall, high summer temperatures, strong winds, high rate of evaporation, and late summer drought. The temperature is favorable for plant development and there is about a 210-day growing season (Bruner, 1931). The average monthly temperatures and precipitation in the study area during 1968 are presented in Table IV. Table V gives

the average yearly temperatures and precipitation for the study area from 1960 to 1968.

TABLE IV

AVERAGE MONTHLY TEMPERATURE AND TOTAL MONTHLY PRECIPITATION ON THE STUDY AREA IN NORTHWEST OKLAHOMA, 1968[a]

Month	Average Temperature (°F)	Total Precipitation (in)
January	37.1	.45
February	38.8	.54
March	52.4	.55
April	59.5	1.76
May	65.9	4.36
June	77.4	.64
July	80.6	3.95
August	81.1	4.21
September	72.0	1.68
October	64.3	.87
November	46.0	4.24
December	35.7	.57

[a]Records compiled by U.S. Department of Commerce (1969).

TABLE V

AVERAGE YEARLY TEMPERATURE AND ANNUAL PRECIPITATION ON THE STUDY AREA IN NORTHWEST OKLAHOMA, 1960-1968[a]

	YEAR								
	1960	1961	1962	1963	1964	1965	1966	1967	1968
Average Temperature (^{o}F)	58.4	-	60.3	61.6	61.1	61.2	59.6	60.4	59.2
Annual Precipitation (in)	35.89	35.37	26.47	21.40	25.97	29.40	15.64	31.38	23.80

[a]Records compiled by U.S. Department of Commerce (1969).

CHAPTER IV

RESULTS AND DISCUSSION

Characteristics of Collected Doves

Five hundred and forty-six doves were collected from June through October, 1968. The age and sex composition and the distribution of this sample by transect and time period are presented in Table VI. The proportion of immature doves comprising the sample increased from 5.1 per cent in June to 59.4 per cent in October.

Dove weights were recorded (Table VII). The average weight of adult males (124 ± 9.4 g) was greater than the average weight of females (117 ± 6 g). There was no apparent difference in adult weights between time periods. However, weights of immature doves increased from June (79 ± 15.4 g) to (October 108 ± 14.6 g), with the greatest increase occurring in July.

Dove Foods During the Period of Study

In the total of 546 doves, 494 (90.5 per cent) had consumed sufficient quantities of food ($>.05$ cc) for volumetric analysis. Seeds of 57 plant species from 22 families were present in their crops (Table VIII). By volume, gramineae comprised 66.5 per cent of total food consumption of the dove. Agricultural crops comprised 61.2 per cent of the total volume, with wheat representing 55.7, millet 2.6, and sorghum 2.6 per cent, respectively (Table IX).

TABLE VI

AGE AND SEX COMPOSITION OF 546 DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

Transect	Month					Total
	Jun	Jul	Aug	Sep	Oct	
Transect I						
Adult ♂	13	17	20	13	10	73
Adult ♀	12	1	2	15	6	36
Immature	2	21	23	15	11	72
Total	27	39	45	43	27	181
Transect II						
Adult ♂	17	24	14	8	1	64
Adult ♀	4	8	5	7	1	25
Immature	1	13	28	31	31	104
Total	22	45	47	46	33	193
Transect III						
Adult ♂	9	18	15	15	11	68
Adult ♀	1	11	5	8	10	35
Immature	0	15	17	22	15	69
Total	10	44	37	45	36	172
TOTAL	59	128	129	134	96	546

TABLE VII

WEIGHTS (g) OF 546 DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

Month	Adult ♂		Adult ♀		Immatures	
	Number	Mean Wt.	Number	Mean Wt.	Number	Mean Wt.
June	39	125 ± 7.9	17	118 ± 11.0	3	79 ± 15.4
July	59	122 ± 8.8	20	116 ± 7.3	49	101 ± 14.9
August	49	124 ± 10.5	12	117 ± 12.2	68	106 ± 10.7
September	36	128 ± 9.9	30	118 ± 8.6	68	113 ± 14.9
October	22	125 ± 9.5	17	119 ± 10.7	57	113 ± 13.3
Overall Average		124 ± 9.4		117 ± 9.6		108 ± 14.6

TABLE VIII

PLANT FOODS OF 546 DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

Family Aizoaceae	
Mollugo verticillata	carpetweed
Family Amaranthaceae	
Amaranthus sp.	pigweed
Family Boraginaceae	
Lithospermum sp.	gromwell
Family Capparidaceae	
Cristatella Jamesii	cristatella
Family Chenopodiaceae	
Chenopodium album	common lambsquarters
Cycloloma atriplicifolium	winged pigweed
Family Commelinaceae	
Commelina erecta	dayflower
Tradescantia ohiensis	spiderwort
Family Compositae	
Ambrosia psilostachya	western ragweed
A. trifida	giant ragweed
Haplopappus ciliatus	wax goldenweed
Helianthus annuus	sunflower
H. petiolaris	prairie sunflower
Iva sp.	sumpweed
Family Cyperaceae	
Carex sp.	sedge
Cyperus sp.	flatsedge
Eleocharis sp.	spikerush

TABLE VIII (continued)

Family Euphorbiaceae	
Acalypha sp.	copperleaf
Croton glandulosus	tropic croton
Croton sp.	croton
Euphorbia dentata	spurge
E. marginata	snow-on-the-mountain
Euphorbia sp.	spurge sp.
Family Geraniaceae	
Geranium carolinianum	Carolina geranium
Family Gramineae	
Digitaria sanguinalis	large crabgrass
Hordeum vulgare	barley
Leptoloma cognatum	leptoloma
Panicum capillare	witchgrass
P. lanuginosum var. *Lindheimeri*	panicum
Paspalum floridanum	Florida paspalum
P. setaceum var. *stramineum*	sand paspalum
Paspalum sp.	paspalum
Secale sp.	rye
Setaria geniculata	knotroot foxtail
S. italica	German millet
Setaria sp.	red-fortune millet
Setaria sp.	foxtail
Sorghum halepense	johnsongrass
S. sudanense	sudangrass
S. vulgare	sorghum
Triticum aestivum	wheat
Family Leguminosae	
Cassia fasciculata	partridgepea
Desmanthus illinoensis	bundleflower
Desmodium sp.	tickclover
Strophostyles leiosperma	wildbean
Vicia sp.	vetch
Family Onagraceae	
Oenothera laciniata	cutleaf eveningprimrose

TABLE VIII (continued)

Family Oxalidaceae	
Oxalis stricta	common yellow woodsorrel
Family Papaveraceae	
Argemone sp.	pricklepoppy
Family Phytolaccaceae	
Phytolacca americana	pokeweed
Family Polygonaceae	
Polygonum convolvulus	wild buckwheat
P. pennsylvanicum	Pennsylvania smartweed
Family Sapotaceae	
Bumelia lanuginosa	gum bumelia
Family Ulmaceae	
Celtis reticulata	netleaf hackberry
Family Umbelliferae	
Spermolepis inermis	spermolepis
Family Violaceae	
Viola sp.	violet
Family Zygophyllaceae	
Kallstroemia sp.	caltrop

TABLE IX

QUANTITATIVE AND QUALITATIVE COMPARISONS OF FOODS INGESTED BY DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

Food Item	Per cent by Occurrence 546 Crops	Per cent by Volume 494 Crops
PLANT FOODS		
wheat	71.6	55.7
pigweed	57.6	1.7
sand paspalum	40.8	.7
cutleaf eveningprimrose	43.4	1.4
tropic croton	43.5	6.4
sunflower	40.2	6.6
wildbean	47.6	2.7
croton	26.9	7.6
large crabgrass	23.8	1.4
foxtail	24.1	1.4
witchgrass	26.0	.4
Carolina geranium	21.4	.3
panicum	16.3	.1
western ragweed	11.5	.3
winged pigweed	9.9	.1
gromwell	9.9	.2
dayflower	9.9	.1
sorghum	9.2	2.6
millet	6.4	2.6
johnsongrass	7.1	.3
pricklepoppy	7.8	.2
pokeweed	8.8	0
flatsedge	6.2	0
spurge sp.	7.0	.3
violet	4.0	2.0
spurge	3.7	0
wax goldenweed	3.1	0
rye	3.5	0
wild buckwheat	2.6	0
sudangrass	2.7	.9
vetch	2.7	.1
sedge	3.3	0
Pennsylvania smartweed	2.9	0
snow-on-the-mountain	2.7	1.8
common yellow woodsorrel	2.0	0
common lambsquarters	2.7	.1

TABLE IX (continued)

Food Item	Per cent by Occurrence 546 Crops	Per cent by Volume 494 Crops
PLANT FOODS (continued)		
netleaf hackberry	3.1	0
spiderwort	1.3	.2
giant ragweed	1.5	0
knotroot foxtail	1.5	.1
leptoloma	.7	0
copperleaf	.5	0
barley	.4	.3
tickclover	.7	0
gum bumelia	.4	0
carpetweed	10.8	0
partridgepea	.5	0
cristatella	.4	0
spikerush	.2	0
paspalum	.2	0
Florida paspalum	.2	0
bundleflower	1.3	.5
spermolepis	.2	0
sumpweed	.2	0
caltrop	.5	0
unknown	14.5	.6
green vegetation	.7	0
buds	.4	0
ANIMAL FOODS		
snails (Gastropoda)	10.8	.1
insects	3.7	0
Coleoptera	2.0	0
Hymenoptera	.4	0
Diptera	1.1	0
Lepidoptera	.2	0
bone	.1	0
OTHER		
grit	44.0	.2

Forb or weed seeds represented 32.6 per cent of the total volume. Of these, the most important were croton (7.6 per cent), tropic croton (6.4 per cent), and sunflower (6.6 per cent). Twenty-five other plant species represented 12.0 per cent of the total foods consumed, with the remaining seed species present in only trace amounts. Unknown seeds comprised 0.6 per cent of the total volume.

The frequency of foods of the 546 doves collected during the period of investigation are also represented in Table IX. Wheat seeds were present in greatest frequency (71.6 per cent). Pigweed, wildbean, tropic croton, cutleaf eveningprimrose, sand paspalum, and sunflower seeds were found in 57.6, 47.6, 43.5, 43.4, 40.8, and 40.2 per cent of the crops, respectively, representing 1.7, 2.7, 6.4, 1.2, 0.7, and 6.6 per cent of total volume consumed, respectively. This indicates that these seeds were consumed frequently, but in small quantities.

The frequency of animal foods occurring in dove crops was also determined. Snails occurred in 10.8 per cent of the crops, representing 0.1 per cent of the total volume. Four orders of insects (Coleoptera, Hymenoptera, Diptera, and Lepidoptera) were cumulatively present in 3.7 per cent of the crops, but in trace amounts. A bone fragment occurred in one crop. Grit occurred in 44.0 per cent of the crops, but provided only 0.2 per cent of the total volume.

Temporal Trends in Dove Diet

Doves exhibited seasonal variability in food habits (Tables X and XI). Based on volume of food consumed and frequency of occurrence, wheat was the most important source of food during the months when doves were most abundant in northwest Oklahoma. Tropic croton,

sunflower, wildbean, croton, sorghum, millet, and violet seeds were the other important foods, in terms of volume, consumed by doves. Figure 3 illustrates the frequencies of occurrence of wheat, sorghum, millet, sunflower, croton, tropic croton, pigweed, and wildbean in dove crops during the study. These same foods are shown by volume in Figure 4. Throughout much of the season, pigweed, sand paspalum, large crabgrass, witchgrass, and Carolina geranium occurred in relatively high frequency in the diet of the dove, but were usually present in trace amounts.

In June, wheat (61.5 per cent) and violet seeds (16.0 per cent) were the most important foods by volume. Since waste wheat became available during the last part of June, it can be assumed that proportionally more wheat was consumed in June than during subsequent months. Many of the ingested seeds of tropic croton, sunflower, croton, and sorghum were produced in the previous year. Millet, present in 1.7 per cent of the doves, was taken in only trace amounts.

Consumption of agricultural crops was greatest in July, with wheat comprising 73.6 per cent of the total volume. Violet seeds occurred in trace amounts in 1.6 per cent of the crops. This decline in violet seed consumption corresponds with the decrease in availability of this seed in July. Tropic croton, sunflower, croton, sorghum, and millet increased slightly in volume consumed.

Wheat was also the important food in August and September. It occurred in 86.0 per cent of the crops in August with 68.3 per cent of the total volume and in 73.1 per cent of the crops in September with 60.6 per cent of the total volume. Croton increased to 5.6 per cent

TABLE X

MONTHLY COMPARISONS OF FOOD QUANTITIES INGESTED BY DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

	Monthly Percentage				
	Jun	Jul	Aug	Sep	Oct
Food Item	57 Crops	109 Crops	120 Crops	119 Crops	89 Crops
PLANT FOODS					
wheat	61.4	73.6	68.3	60.6	14.7
pigweed	.9	.3	.5	3.0	2.6
sand paspalum	1.1	.9	1.1	.3	.8
cutleaf eveningprimrose	.4	3.2	2.1	.7	0
tropic croton	1.7	6.9	7.4	4.2	11.9
sunflower	2.8	4.2	4.4	3.3	19.2
wildbean	3.0	2.2	3.3	3.6	.8
croton	.3	1.8	5.6	9.0	17.0
large crabgrass	.1	0	0	3.9	.6
foxtail	1.8	.9	1.3	2.3	.3
witchgrass	.1	0	.5	.9	0
Carolina geranium	.9	.1	.3	.2	0
panicum	.5	.1	.3	0	0
western ragweed	.1	.2	.2	.1	.9
winged pigweed	0	0	.2	.2	0
gromwell	.2	.3	.5	0	0
dayflower	.1	0	.1	.1	0
sorghum	2.2	1.3	.1	1.4	8.9
millet	0	0	0	.1	14.0
johnsongrass	.4	.1	.3	.6	0
pricklepoppy	.1	.4	.2	.1	0
pokeweed	0	0	0	.1	0
flatsedge	0	0	.1	0	0
spurge sp.	0	0	0	.1	1.2
violet	16.0	0	0	0	0
spurge	.1	.1	0	0	0
wax goldenweed	.1	0	0	0	.1
rye	.1	0	0	0	0
wild buckwheat	0	0	0	0	0
sudangrass	2.6	0	0	1.5	.4
vetch	0	.3	.1	.1	0
sedge	0	0	0	0	0
Pennsylvania smartweed	0	0	0	0	0
snow-on-the-mountain	.2	1.2	0	1.4	6.1
common yellow woodsorrel	0	0	0	0	0
common lambsquarters	.1	0	0	.1	.1

TABLE X (continued)

Food Item	Monthly Percentage: Jun 57 Crops	Jul 109 Crops	Aug 120 Crops	Sep 119 Crops	Oct 89 Crops
PLANT FOODS (continued)					
netleaf hackberry	.1	0	0	0	0
spiderwort	.3	.9	0	0	0
giant ragweed	0	0	0	0	0
knotroot foxtail	0	0	0	.2	0
leptoloma	.1	0	0	0	0
copperleaf	.1	0	0	0	0
barley	0	0	0	1.0	0
tickclover	0	0	0	0	0
gum bumelia	0	0	0	0	0
carpetweed	0	0	0	0	0
partridgepea	0	0	0	0	0
cristatella	0	0	0	0	0
spikerush	0	0	0	0	0
paspalum	0	0	0	0	0
Florida paspalum	0	0	0	0	0
bundleflower	0	0	2.4	0	0
spermolepis	0	0	0	0	0
sumpweed	0	0	0	0	0
caltrop	0	0	0	0	0
unknown	2.1	.2	.3	.6	.1
green vegetation	0	0	0	0	0
buds	0	0	0	0	0
ANIMAL FOODS					
snails (Gastropoda)	0	.2	.1	0	0
insects	0	0	0	0	0
bone	0	0	0	0	0
OTHER					
grit	.1	.2	.5	.2	.2

TABLE XI

MONTHLY FREQUENCY OF OCCURRENCE OF FOODS OF DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

	Monthly Percentage				
	Jun	Jul	Aug	Sep	Oct
Food Item	59 Crops	128 Crops	129 Crops	134 Crops	96 Crops
PLANT FOODS					
wheat	79.7	81.3	86.0	73.1	32.2
pigweed	67.8	50.0	45.0	70.9	60.4
sand paspalum	62.7	35.9	52.7	36.6	34.4
cutleaf eveningprimrose	33.9	58.6	70.5	29.9	11.5
tropic croton	52.5	35.9	60.5	38.1	33.3
sunflower	23.7	30.5	49.6	36.6	56.3
wildbean	54.3	32.8	56.6	38.1	14.6
croton	20.3	21.9	31.0	34.3	32.3
large crabgrass	13.6	2.3	14.7	44.0	42.7
foxtail	16.9	15.6	38.8	23.1	21.9
witchgrass	11.9	16.5	45.7	22.4	26.0
Carolina geranium	52.5	19.5	24.0	15.7	9.4
panicum	32.2	18.0	20.9	10.4	6.3
western ragweed	16.9	10.2	10.9	10.4	12.5
winged pigweed	22.0	11.7	10.9	9.0	0
gromwell	8.5	15.6	13.2	4.5	6.3
dayflower	27.1	7.0	13.2	7.5	2.1
sorghum	8.5	7.8	2.3	9.0	20.8
millet	1.7	1.6	0	2.2	30.2
johnsongrass	15.3	4.7	7.8	7.5	4.2
pricklepoppy	6.8	10.2	7.8	8.2	4.2
pokeweed	5.1	5.5	13.2	11.9	5.2
flatsedge	8.5	6.3	10.9	1.5	5.2
spurge sp.	0	.8	.8	9.0	25.0
violet	30.5	1.6	0	.7	1.0
spurge	1.7	3.1	3.1	5.2	4.2
wax goldenweed	1.7	.8	0	3.0	11.5
rye	8.5	2.3	6.2	.7	2.1
wild buckwheat	1.7	1.6	3.1	3.0	3.1
sudangrass	3.4	2.3	0	5.2	3.1
vetch	5.1	3.1	3.1	3.0	0
sedge	3.4	3.9	3.9	1.5	4.2
Pennsylvania smartweed	0	1.6	2.3	5.2	4.2
snow-on-the-mountain	6.8	1.6	0	3.0	5.2
common yellow woodsorrel	15.3	0	0	0	2.1
common lambsquarters	1.7	1.6	3.1	4.5	2.1

TABLE XI (continued)

Food Item	Monthly Percentage				
	Jun	Jul	Aug	Sep	Oct
	59 Crops	128 Crops	129 Crops	134 Crops	96 Crops
PLANT FOODS (continued)					
netleaf hackberry	5.1	.8	8.5	.7	1.0
spiderwort	6.8	.8	1.6	0	0
giant ragweed	3.4	3.1	.8	.7	0
knotroot foxtail	1.7	.8	3.1	1.5	0
leptoloma	5.1	0	.8	0	0
copperleaf	3.4	.8	0	0	0
barley	0	0	.8	.7	0
tickclover	0	0	1.6	.7	1.0
gum bumelia	1.7	0	0	0	1.0
carpetweed	0	0	.8	0	1.0
partridgepea	0	.8	.8	.7	0
cristatella	0	0	.8	.7	0
spikerush	0	0	.8	0	0
paspalum	0	0	.8	0	0
Florida paspalum	0	0	0	0	1.0
bundleflower	0	.8	3.9	0	1.0
spermolepis	0	0	0	.7	0
sumpweed	0	0	0	0	1.0
caltrop	0	1.6	0	.7	0
unknown	10.2	10.2	22.5	14.9	11.5
green vegetation	1.7	1.6	.8	0	0
buds	0	0	1.6	0	0
ANIMAL FOODS					
snails (Gastropoda)	18.6	13.3	12.4	6.0	7.3
insects	8.5	3.1	5.4	2.2	1.0
Coleoptera	3.4	2.3	3.9	0	1.0
Hymenoptera	0	0	0	1.5	0
Diptera	3.4	.8	1.6	.7	0
Lepidoptera	1.7	0	0	0	0
bone	0	.8	0	0	0
OTHER					
grit	59.3	49.2	58.9	26.9	31.3

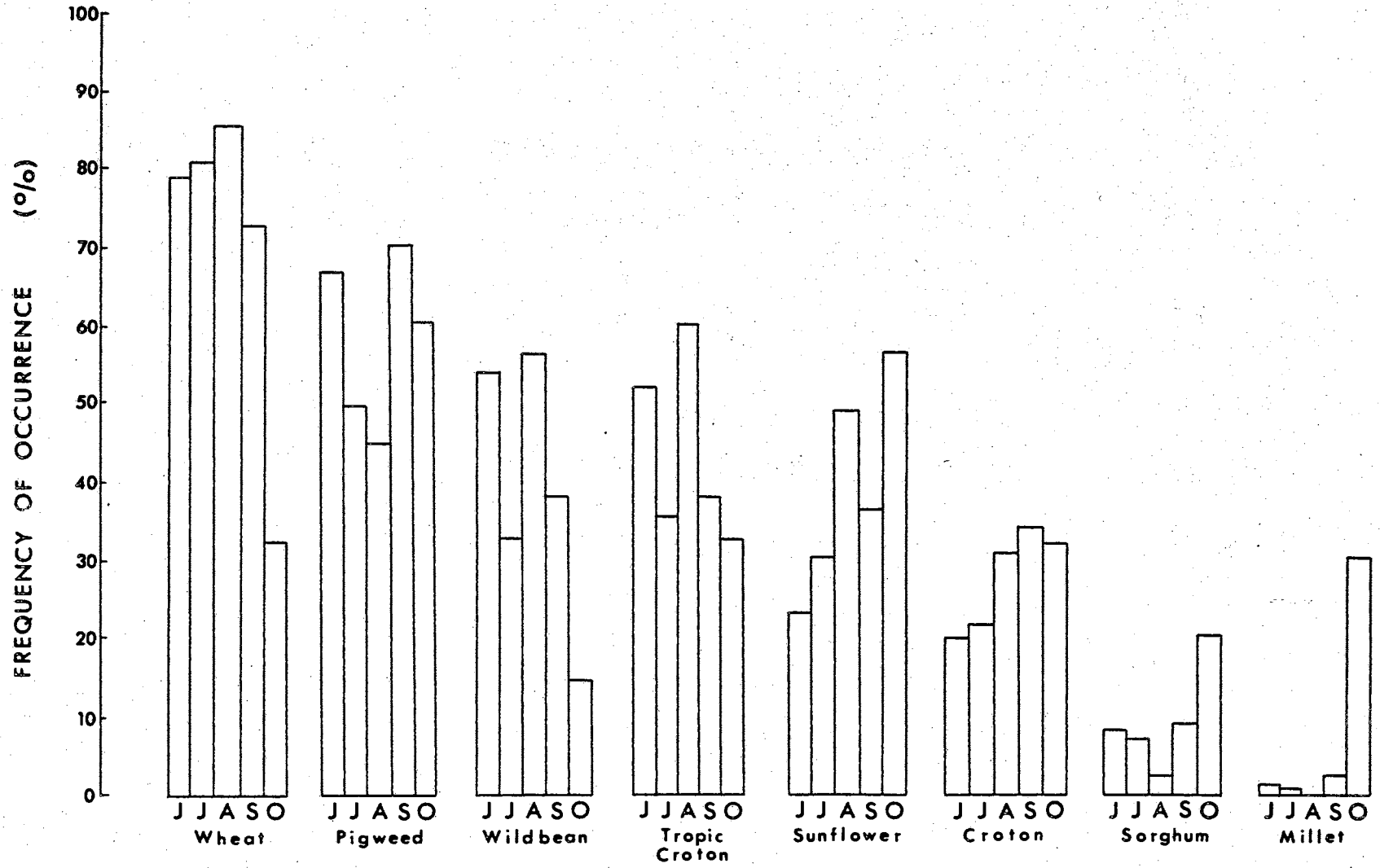

Figure 3. Monthly Frequency of Occurrence of Principle Foods of Doves Collected in Northwest Oklahoma, June through October, 1968.

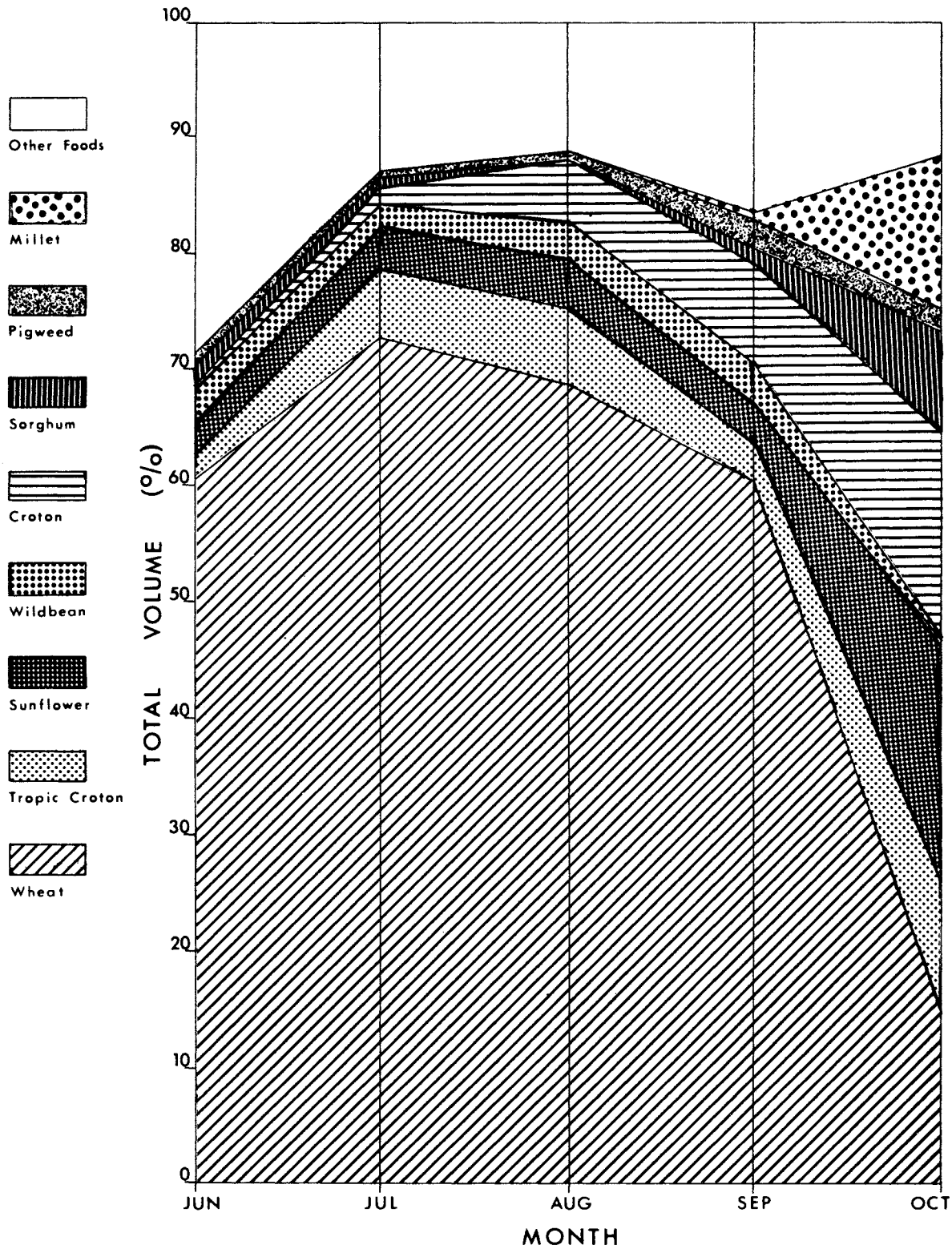

Figure 4. Relative Volumetric Proportions of the Principle Foods Ingested Monthly by Doves Collected in Northwest Oklahoma, June Through October, 1968.

by volume in August and 9.0 per cent in September. Other food items made only minor changes in volume and frequency of occurrence during August and September.

By October, wheat comprised only 14.7 per cent by volume and 32.3 per cent by frequency. Sunflower seeds were the most important food (19.2 per cent by volume and 56.3 per cent by frequency). Croton, sorghum, and tropic croton, and millet also contributed greatly to the diet of the dove. Agricultural grains, therefore, comprised 37.6 per cent of total food volume in October.

In this study, dove food habits centered on wheat and the agricultural practices involved in wheat harvest. Wheat consumption was highest following wheat harvest, with the addition of waste wheat to the food supply, and decreased with time. Other foods were consumed in various amounts during the study with the greatest increase in consumption of non-agricultural foods occurring in October. It is difficult to determine, however, if differences in food consumption by doves resulted from food availability and distribution or from food preference of doves.

Comparative Trends in Dove Diet by Transect

Although dove food habits vary with the location of investigation, the three transects were similar enough and in such close proximity that differences in food habits were difficult to determine. The mobility of doves probably brought birds from adjacent transects to feed in the same intermediate areas. Birds collected along Transect II,

for example, watered on that transect but probably obtained food on the adjacent lands since very few doves were observed feeding on this transect.

Although the acreage of wheat constituted 17.2, 6.0, and 49.2 per cent of Transect I, II, and III, respectively, the per cent of total food intake attributed to wheat was similar over the three transects (Table XII). This tends to indicate that doves on Transect III consumed wheat when it was widely distributed, doves on Transect II moved to adjacent areas to obtain it, and doves on Transect I probably concentrated more on the few wheat fields that were present.

Differences in the consumption of millet by doves along the three transects were pronounced. Acreage of millet was 0, 2.5, and 0.3 per cent of the total land area of Transect I, II, and III, respectively. Millet was 1.1, 14.5, and 2.9 per cent in frequency and 0, 7.2, and 0 per cent of total food volume in dove crops collected on Transect I, II, and III, respectively (Table XIII). The millet on Transect III was harvested before maturity and, therefore, was not available for use by doves. The small amount of millet found in the doves from Transect I was probably consumed on the roadside as spillage or in adjacent areas having millet.

Johnnyjumpup violets were abundant in June in two weed fields on Transect I, but were less common on Transects II and III. This is reflected in the data for Transect I which show violets comprising 6.5 per cent of total food consumption with a frequency of 6.1 per cent. Although violets had a frequency of 3.1 per cent and 2.9 per cent in doves from Transect II and III, respectively, the seeds were present in only trace amounts.

TABLE XII

COMPARISON BY TRANSECT OF FOOD QUANTITIES INGESTED BY DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

	Percentage by Transect		
	I	II	III
Food Item	163 Crops	180 Crops	151 Crops
PLANT FOODS			
wheat	53.8	56.2	58.2
pigweed	3.1	1.3	.4
sand paspalum	.8	.6	.7
cutleaf eveningprimrose	1.5	1.4	.5
tropic croton	5.7	3.5	10.3
sunflower	7.3	4.1	8.7
wildbean	2.0	3.7	2.4
croton	11.4	5.1	6.8
large crabgrass	1.9	.2	0
foxtail	1.3	1.9	.9
witchgrass	.1	.9	.1
Carolina geranium	.3	.3	.2
panicum	.2	0	.1
western ragweed	.3	.1	.3
winged pigweed	.2	2.0	0
gromwell	.2	0	.3
dayflower	0	.1	0
sorghum	1.0	2.5	4.1
millet	0	7.2	0
johnsongrass	.1	.7	0
pricklepoppy	0	.1	.3
pokeweed	0	0	0
flatsedge	0	0	0
spurge sp.	0	.6	0
violet	6.5	0	0
spurge	0	0	0
wax goldenweed	0	0	0
rye	0	0	0
wild buckwheat	0	0	0
sudangrass	0	2.3	.1
vetch	0	.1	.1
sedge	0	0	0
Pennsylvania smartweed	0	0	0
snow-on-the-mountain	0	1.2	4.0
common yellow woodsorrel	0	0	0
common lambsquarters	0	0	.1

TABLE XII (continued)

Food Item	Percentage by Transect I 163 Crops	II 180 Crops	III 151 Crops
PLANT FOODS (continued)			
netleaf hackberry	0	0	0
spiderwort	.4	0	0
giant ragweed	0	0	0
knotroot foxtail	0	.2	0
leptoloma	0	0	0
copperleaf	0	0	0
barley	0	.9	0
tickclover	0	0	0
gum bumelia	0	0	0
carpetweed	0	0	0
partridgepea	0	0	0
cristatella	0	0	0
spikerush	0	0	0
paspalum	0	0	0
Florida paspalum	0	0	0
bundleflower	0	0	1.6
spermolepis	0	0	0
sumpweed	0	0	0
caltrop	0	0	0
unknown	.4	1.0	.1
green vegetation	0	0	0
buds	0	0	0
ANIMAL FOODS			
snails (Gastropoda)	0	0	0
insects	0	0	0
bone	0	0	0
OTHER			
grit	.2	.1	.3

TABLE XIII

FREQUENCY OF OCCURRENCE BY TRANSECT OF FOODS OF DOVES COLLECTED IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

Food Item	Percentage by Transect I 181 Crops	II 193 Crops	III 172 Crops
PLANT FOODS			
wheat	69.6	67.9	77.9
pigweed	64.1	59.6	48.8
sand paspalum	48.1	29.5	45.9
cutleaf eveningprimrose	53.6	46.1	29.7
tropic croton	52.5	36.8	41.9
sunflower	42.0	34.7	44.8
wildbean	60.8	44.0	37.8
croton	26.5	23.0	30.8
large crabgrass	25.4	24.9	20.9
foxtail	21.5	17.1	34.9
witchgrass	26.5	21.2	30.8
Carolina geranium	34.8	11.4	18.6
panicum	18.8	12.4	18.0
western ragweed	10.5	10.4	14.0
winged pigweed	8.8	13.5	7.0
gromwell	11.6	4.7	14.0
dayflower	9.9	13.5	5.8
sorghum	7.7	8.8	11.0
millet	1.1	14.5	2.9
johnsongrass	2.2	11.9	7.0
pricklepoppy	3.9	9.8	9.9
pokeweed	7.2	9.3	9.9
flatsedge	5.0	4.1	9.9
spurge sp.	6.1	9.8	4.7
violet	6.1	3.1	2.9
spurge	2.2	2.6	6.4
wax goldenweed	2.8	1.0	5.8
rye	2.2	4.7	3.7
wild buckwheat	1.1	2.1	4.7
sudangrass	1.1	3.1	4.1
vetch	2.8	3.1	2.3
sedge	2.2	2.4	5.2
Pennsylvania smartweed	3.3	1.6	4.1
snow-on-the-mountain	1.1	4.7	2.3
common yellow woodsorrel	2.8	1.6	1.7
common lambsquarters	2.2	2.6	3.5

TABLE XIII (continued)

Food Item	Percentage by Transect I 181 Crops	II 193 Crops	III 172 Crops
PLANT FOODS (continued)			
netleaf hackberry	6.1	1.6	1.7
spiderwort	2.8	1.0	0
giant ragweed	0	3.1	1.2
knotroot foxtail	1.7	1.6	1.2
leptoloma	.6	1.6	0
copperleaf	0	.5	1.2
barley	0	1.0	0
tickclover	1.1	0	1.2
gum bumelia	.6	.5	0
carpetweed	8.3	15.5	8.1
partridgepea	1.1	.5	0
cristatella	.6	.5	0
spikerush	0	0	.6
paspalum	.6	0	0
Florida paspalum	0	.5	0
bundleflower	.6	.5	2.9
spermolepis	0	0	.6
sumpweed	0	0	.6
caltrop	.6	0	1.2
unknown	16.0	13.5	14.0
green vegetation	.6	1.0	.6
buds	0	.5	.6
ANIMAL FOODS			
snails (Gastropoda)	8.3	15.5	8.1
insects	3.4	6.2	1.2
Coleoptera	2.2	3.1	.6
Hymenoptera	.6	.5	0
Diptera	.6	2.1	.6
Lepidoptera	0	.5	0
bone	0	.5	0
OTHER			
grit	45.3	38.9	48.3

Although the volume of other foods consumed by doves varied slightly among the transects, these variations can probably be attributed to random variations and to differences in seed availability. It is understandable, therefore, that a species in basically similar habitats in close proximity would have similar food habits.

Comparative Trends in Dove Food Habits Between Sex and Age Groups

In Illinois, Oberheu and Klimstra (1961) found the ranking in importance of foods consumed by doves similar for juveniles and adults of both sexes. Their study indicated that males consumed more corn than did females and that adult birds seemed to prefer foxtail grasses over spurges, whereas the reverse was true for juveniles. They concluded that these differences might be attributed to food preferences by these groups.

Doves collected in this study were classified as adult male, adult female, or immature. The per cent of the total volume that each food item constituted was determined for each group (Table XIV). Slight differences, possibly due to random variation and unequal sample sizes, occurred between the three groups in the amount of most foods taken. Wheat, croton, sunflower, and tropic croton were the foods consumed in greatest volume by each group, although only wheat consistently ranked highest among the groups.

Wheat comprised 56.2, 45.7, and 58.5 per cent of the total food volume of adult males, adult females, and immatures, respectively. This low wheat consumption by females might be explained by their possible tendency to remain closer to the nest while feeding, thereby

TABLE XIV

COMPARATIVE QUANTITIES OF FOODS INGESTED BY DOVES BY SEX AND AGE GROUPS IN NORTHWEST OKLAHOMA, JUNE THROUGH OCTOBER, 1968

Food Item	Percentage by Sex & Age Groups		
	Adult ♂	Adult ♀	Immatures
	190 Crops	84 Crops	220 Crops
PLANT FOODS			
wheat	56.2	45.7	58.5
pigweed	1.8	1.2	1.5
sand paspalum	.9	.8	.5
cutleaf eveningprimrose	1.5	1.7	.7
tropic croton	6.9	12.3	3.5
sunflower	6.7	5.3	6.8
wildbean	2.8	2.9	2.6
croton	8.3	10.7	5.6
large crabgrass	.9	1.0	1.9
foxtail	1.0	.7	2.0
witchgrass	.7	.2	.3
Carolina geranium	.5	.3	.1
panicum	.2	.2	.1
western ragweed	.6	.1	0
winged pigweed	.2	.4	1.6
gromwell	.3	.2	0
dayflower	.1	.2	0
sorghum	2.8	4.0	1.8
millet	0	0	6.0
johnsongrass	.4	0	.4
pricklepoppy	.2	.3	0
pokeweed	0	.1	0
flatsedge	0	0	0
spurge sp.	.1	.1	.5
violet	2.2	4.6	.8
spurge	.1	0	0
wax goldenweed	0	0	0
rye	0	0	0
wild buckwheat	0	0	0
sudangrass	2.0	.1	.2
vetch	.1	0	.1
sedge	0	0	0
Pennsylvania smartweed	0	0	0
snow-on-the-mountain	.5	2.7	2.6
common yellow woodsorrel	0	0	0
common lambsquarters	.1	.2	0

TABLE XIV (continued)

Food Item	Percentage by Sex & Age Groups: Adult ♂ 190 Crops	Adult ♀ 84 Crops	Immatures 220 Crops
PLANT FOODS (continued)			
netleaf hackberry	0	.1	0
spiderwort	.5	0	0
giant ragweed	0	0	0
knotroot foxtail	0	.4	0
leptoloma	0	0	0
copperleaf	0	0	0
barley	0	0	.8
tickclover	0	0	0
gum bumelia	0	0	0
carpetweed	0	0	0
partridgepea	0	0	0
cristatella	0	0	0
spikerush	0	0	0
paspalum	0	0	0
Florida paspalum	0	0	0
bundleflower	.1	2.9	0
spermolepis	0	0	0
sumpweed	0	0	0
caltrop	0	0	0
unknown	.7	.2	.6
green vegetation	0	0	0
buds	0	0	0
ANIMAL FOODS			
snails (Gastropoda)	.1	.1	0
insects	0	0	0
bone	0	0	0
OTHER			
grit	.3	.3	.2

depending more upon weed seeds nearer to the nest for food. Similarly, this might account for females consuming more bundleflower and tropic croton than adult males or immatures. It is thus difficult to determine if these differences are due to preference or to limitations caused by other needs. The large amount of wheat consumed by immatures was partly the result of the concurrence of hatching and wheat harvest.

Although millet comprised 6.0 per cent by volume of total foods consumed by immatures on Transect II in October, no millet in more than trace amounts was found in the adult birds examined. However, since 93.9 per cent of the doves collected along this transect in October were immatures, it is likely that a larger sample would have revealed some millet consumption in the adult diet.

Data Analysis

An analysis of variance was used to determine the relationship between food habits of the mourning dove and each sampling area and time interval. Analysis of variance is a process for partitioning a total sum of squares into components associated with recognized sources of variation. According to Steele and Torrie (1960), two assumptions underlie the analysis of variance; treatment and environmental effects are additive; experimental errors are random, independently and normally distributed about a zero mean, and have a common variance.

Due to the large number of missing observations (i.e., relatively few seed species are present in a crop) for each bird, the analysis of variance was performed using the abbreviated Doolittle method (Steele

and Torrie, 1960). The abbreviated Doolittle method permits determination of the partial regression coefficients and the sum of squares attributable to regression. It also supplies constants necessary for determining the standard errors of the partial regression coefficients. The following model was used in the analysis:

$$Y = \bar{u} + T_i + P_j + (TP)_{ij} + \text{Error}$$

where Y = average volume of a particular food item

$\bar{u}$ = effect due to the mean

T_i = effect due to the i^{th} transect

P_j = effect due to the j^{th} time period

$(TP)_{ij}$ = effect due to the transect-time period interaction

Error = effect due to random error

The analysis was conducted on the average volume of the following variables: total food, total food except wheat, wheat, millet, and croton. A significant "F" (calculated "F" $\geq$ tabulated "F") indicates that all the treatments do not belong to a population with a common $\bar{u}$; i.e., there is an effect due to transect, time period, or transect-time period interaction. If the "F" value was not significant (calculated "F" $\leq$ tabulated "F"), the evidence would be against rejecting the null hypothesis; i.e., there would be no effect due to transect, time period, or their interaction.

The total volume F_{cal} for $R(T,P/T,P,\bar{u})$, the reduction of the sum of squares due to the transect-time period interaction after removing the sum of squares due to the effect of transect, period, and mean, was significant at the .05 confidence level (Table XV). This

indicates that the effects of transect and time on total volume are not additive but interact, making it statistically difficult to attribute differences to either the transects or to the time periods.

Figure 5 illustrates changes in average volume of the five variables for each transect and time period. Figure 5A indicates that the responses in average total volume over transects and time periods are not the same. The response for Transect II in September is probably high, since more birds than usual were collected at prime feeding times on this transect. Taking this into consideration, there appears to be relatively high food consumption in June, a decrease in July, a fluctuation in August and September, and a slight increase in October.

Seasonal variations in volume of food consumed are likely due to a combination of factors. In June, immatures comprised 5.1 per cent of the sample, while in July, 38.3 per cent of the sample were immatures. Due to the smaller food-holding capacity of immatures, it was expected that the average volume of food in doves collected in July would be less than the volume of food in those collected in June. The relatively high average volume in October could be related to either the lower temperature (Table IV) or the fact that most of the doves had adult food-holding capacity. Food availability and dove preferences also affect food consumption levels. The fluctuation in volume of all food items except wheat was also explicable due to a combination of these same factors.

Table XV and Figure 5 (B,C,E) indicate that transect-time interaction was also present for wheat, croton, and for the total volume

TABLE XV

ANALYSIS OF VARIANCE FOR FIVE VARIABLES
USING THE DOOLITTLE PROCEDURE

Source	Degrees of Freedom	Sums of Squares	Mean Squares	$F_{Cal.}$	$F_{Tab._{.05}}$
		Total Volume			
Total	494	10112.7780			
$R(\bar{u})$	1	4527.9736			
$R(T/\bar{u})$	2	3.0467			
$R(P/T,\bar{u})$	4	273.2841			
$R(T,P/T,P,\bar{u})$	8	278.3673	34.7959	3.3135	1.94
Error	479	5030.1063	10.5013		
		Volume of All Food Items Except Wheat			
Total	494	5574.5693			
$R(\bar{u})$	1	961.2525			
$R(T/\bar{u})$	2	7.4671			
$R(P/T,\bar{u})$	4	394.3873			
$R(T,P/T,P,\bar{u})$	8	152.3374	19.0422	2.2471	1.94
Error	479	4059.1250	8.4742		
		Wheat			
Total	494	3276.2089			
$R(\bar{u})$	1	1316.6844			
$R(T/\bar{u})$	2	7.1809			
$R(P/T,\bar{u})$	4	214.0956			
$R(T,P/T,P,\bar{u})$	8	75.6716	9.4590	2.7252	1.94
Error	479	1662.5764	3.4709		

TABLE XV (continued)

Source	Degrees of Freedom	Sums of Squares	Mean Squares	$F_{Cal.}$	$F_{Tab.}$ .05
		Millet			
Total	494	250136.0100			
R($\bar{u}$)	1	586.1369			
R(T/$\bar{u}$)	2	1022.4832			
R(P/T,$\bar{u}$)	4	1520.4438			
R(T,P/T,P,$\bar{u}$)	8	2608.3036	326.0380	0.6390	1.94
Error	479	244398.6425	510.2268		
		Tropic Croton			
Total	494	598.0299			
R($\bar{u}$)	1	24.4494			
R(T/$\bar{u}$)	2	2.3379			
R(P/T,$\bar{u}$)	4	17.1758			
R(T,P/T,P,$\bar{u}$)	8	43.4179	5.4272	5.0907	1.94
Error	479	510.6489	1.0661		

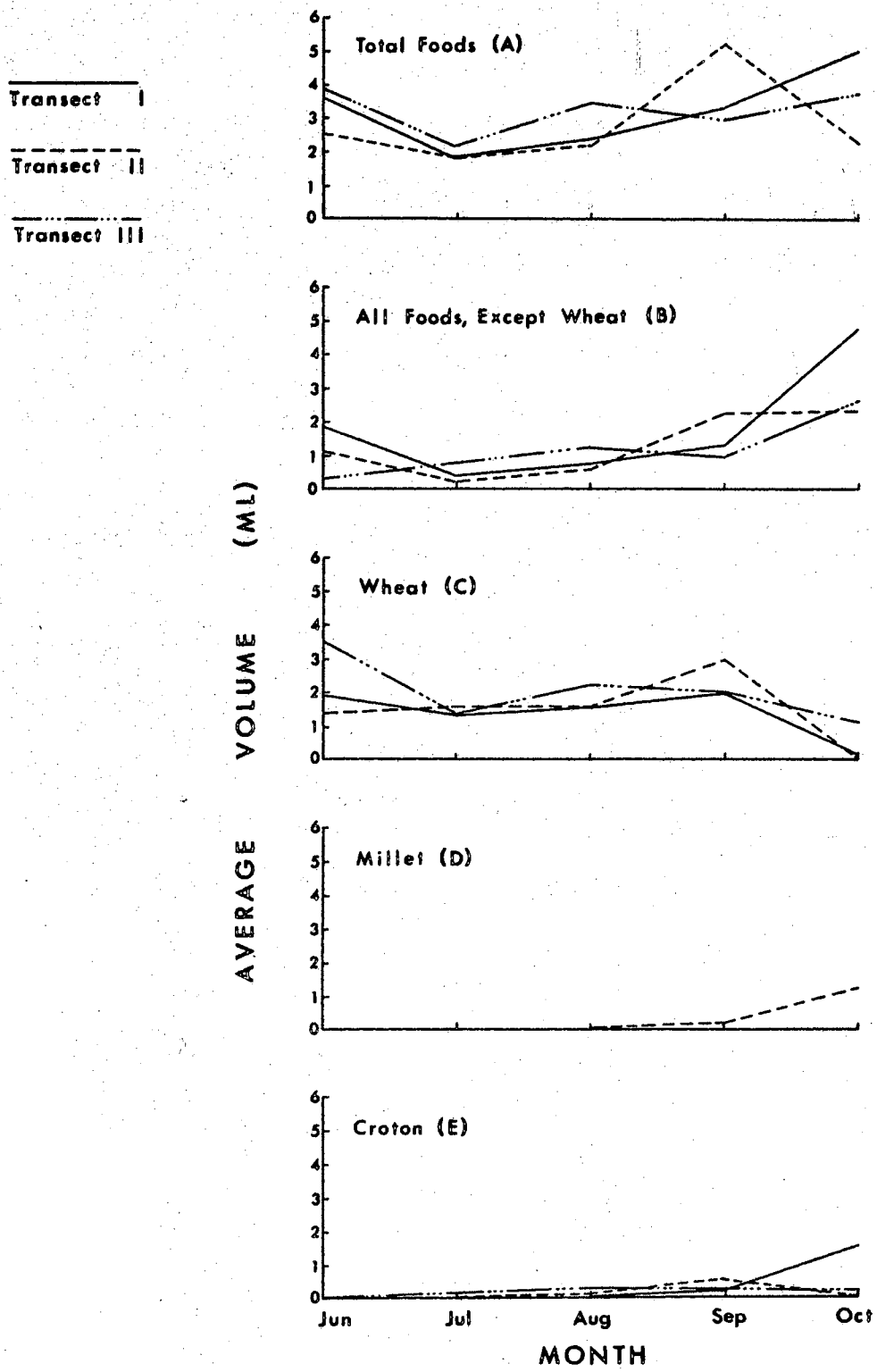

Figure 5. Average Volume by Month of (A) Total Foods, (B) All Foods, Except Wheat, (C) Wheat, (D) Millet, and (E) Croton in Doves Collected on Three Transects in Northwest Oklahoma.

of all foods except wheat. The volume of each of these variables in doves collected on Transect II in September was probably high because more doves were obtained here during prime dove feeding times.

The volume of wheat consumed was high for June, July, August, and September. It was, however, low in October when less wheat was present and other seeds including sunflower were available. Although croton was not eaten in June other than in trace amounts, greater quantities were consumed in subsequent periods. The cause of variations in croton consumption over transects was not known, although it is likely related to the amount and distribution of croton over each transect and to the availability of other foods.

The test between transect and time for average volume of millet consumed by doves was not significant, indicating that interaction was not present. However, this is misleading since the only millet consumed in more than trace amounts occurred in September and October on Transect II. Due to such few observations, the variance was underestimated. Therefore, since an assumption of equal variance was not met, the analysis was unreliable.

Changes in volume of total foods, all foods except wheat, wheat and croton were not attributed to either transect or time, but rather to interaction between the two. This interaction could be overestimated due to the large number of missing observations which led to an underestimate of the true error.

Although certain trends in food habits over time and space were noted in the previous sections, there are statistical limitations due to unbalanced data, unequal variance, and transect-time interaction. These limitations do not permit conclusive statistical summation of

the results. It appears that many factors affect results in food habit studies. Some of these factors may be: (1) availability and distribution of different seeds, (2) per cent of the population represented by different age and sex classes, (3) temperature, (4) time and place of collection, and (5) food preferences of the animal being investigated. Although an extremely large sample would be needed to detect statistical differences between many variables over time and space, trends can be noted with smaller samples.

Dove Food Habits Reported in Other Studies

A review of the literature reveals a general similarity in feeding habits among mourning doves throughout the range inhabited by the species (Korschgen, 1955). All studies show that mourning doves subsist mainly on weed and cultivated crop seeds. Animal foods are taken occasionally, but usually in trace amounts.

Table XVI lists the important foods by volume of studies from representative parts of the country. Seeds of cultivated plants were the most important food in six of these studies. Also, in ten of the studies seeds of cultivated plants were ranked as major food items. Most of the foods important in terms of volume were also important in frequency of occurrence (Table XVII).

Wheat was the most important dove food based on volume in New York (Lehner, 1965) and Illinois (Oberheu and Klimstra, 1961). It ranked second in consumption by doves in California (Browning, 1962), Missouri (Korschgen, 1955), Iowa (McClure, 1943), and Colorado (Ward, 1964), and ranked fifth in North Carolina (Cummings and Quay, 1953). Wheat was reported to be among the five most important foods in

TABLE XVI

RELATIVE IMPORTANCE OF DOVE FOODS BASED ON VOLUME REPORTED IN OTHER STUDIES

Authority	Period	Locality	Food and Rank				
			1	2	3	4	5
Beckwith (1959)[a]	October	Southeastern Florida	pricklepoppy (*Argemone* sp.)	ragweed (*Ambrosia* sp.)	croton (*Croton* sp.)	paspalum (*Paspalum* sp.)	bristlegrass (*Setaria* sp.)
Browning (1962)	September	Merced Co., California	turkey mullein (*Eremocarpus* sp.)	wheat (*Triticum* sp.)	sunflower (*Helianthus* sp.)	sorghum (*Sorghum* sp.)	buckthorn weed (*Amsinckia* sp.)
Chamberlain (1965)	September-October	Central Virginia	corn (*Zea* sp.)	spurge (*Euphorbia* sp.)	pokeweed (*Phytolacca* sp.)	ragweed (*Ambrosia* sp.)	sorghum (*Sorghum* sp.)
Cummings and Quay (1953)	Late Summer-Fall	North Carolina	crabgrass (*Digitaria* sp.)	corn (*Zea* sp.)	foxtail (*Setaria* sp.)	paspalum (*Paspalum* sp.)	wheat (*Triticum* sp.)
Dillon (1961)	September-October	Texas	sorghum (*Sorghum* sp.)	oneseed croton (*Croton* sp.)	annual sunflower (*Helianthus* sp.)	browntop panicum (*Panicum* sp.)	woolly croton (*Croton* sp.)
Knappen (1938)	September	Southeastern United States	crabgrass (*Digitaria* sp.)	cowpeas (*Vigna* sp.)	bull paspalum (*Paspalum* sp.)	glandular croton (*Croton* sp.)	buckwheat (*Fagopyrum* sp.)
Korschgen (1955)	May-September	Missouri	corn (*Zea* sp.)	wheat (*Triticum* sp.)	yellow foxtail (*Setaria* sp.)	giant foxtail (*Setaria* sp.)	small wildbean (*Strophostyles* sp.)
Lehner (1965)[b]	March-October	Tompkins Co., New York	wheat (*Triticum* sp.)	corn (*Zea* sp.)	buckwheat (*Fagopyrum* sp.)	bristlegrass (*Setaria* sp.)	common ragweed (*Ambrosia* sp.)
McClure (1943)	—	Cass Co., Iowa	hemp (*Cannabis* sp.)	wheat (*Triticum* sp.)	green foxtail (*Setaria* sp.)	spotted spurge (*Euphorbia* sp.)	yellow foxtail (*Setaria* sp.)
Oberheu and Klimstra (1961)	September	Central & Southern Illinois	wheat (*Triticum* sp.)	corn (*Zea* sp.)	yellow foxtail (*Setaria* sp.)	giant foxtail (*Setaria* sp.)	green foxtail (*Setaria* sp.)
Ward (1964)	May-October	Colorado	sunflower (*Helianthus* sp.)	wheat (*Triticum* sp.)	pigweed (*Amaranthus* sp.)	doveweed (*Croton* sp.)	corn (*Zea* sp.)

[a] Percentages represent dry-weight proportion of total food consumed.

[b] Aggregate percentage method.

TABLE XVII

FREQUENCY OF OCCURRENCE OF DOVE FOODS REPORTED IN OTHER STUDIES

Authority	Period	Locality	Food and Rank 1	2	3	4	5
Beckwith (1959)	October	Southeastern Florida	ragweed (*Ambrosia* sp.)	paspalum (*Paspalum* sp.)	pricklepoppy (*Argemone* sp.)	croton (*Croton* sp.)	panic grass (*Panicum* sp.)
Browning (1962)	September	Merced Co., California	turkey mullein (*Eremocarpus* sp.)	sorghum (*Sorghum* sp.)	buckthorn weed (*Amsinkia* sp.)	red maids (*Calandrina* sp.)	wheat (*Triticum* sp.) mallow (*Sida* sp.)
Cummings and Quay (1953)	Late Summer-Fall	North Carolina	crabgrass (*Digitaria* sp.)	paspalum (*Paspalum* sp.)	galingale (*Cyperus* sp.)	foxtail (*Setaria* sp.)	pokeweed (*Phytolacca* sp.)
Dillon (1961)	September-October	Texas	oneseed croton (*Croton* sp.)	annual sunflower (*Helianthus* sp.)	sorghum (*Sorghum* sp.)	prostrate amaranth (*Amaranthus* sp.)	browntop panicum (*Panicum* sp.) johnsongrass (*Sorghum* sp.)
Korschgen (1955)	May-September	Missouri	corn (*Zea* sp.)	wheat (*Triticum* sp.)	yellow foxtail (*Setaria* sp.)	fall panicgrass (*Panicum* sp.)	small wildbean (*Strophostyles* sp.)
Lehner (1965)	March-October	Tompkins Co., New York	wheat (*Triticum* sp.)	bristlegrass (*Setaria* sp.)	corn (*Zea* sp.)	buckwheat (*Fagopyrum* sp.)	common ragweed (*Ambrosia* sp.)
McClure (1943)	—	Cass Co., Iowa	hemp (*Cannabis* sp.)	green foxtail (*Setaria* sp.)	yellow foxtail (*Setaria* sp.)	wheat (*Triticum* sp.)	prostrate pigweed (*Amaranthus* sp.)
Oberheu and Klimstra (1961)	September	Central & Southern Ill.	yellow foxtail (*Setaria* sp.)	wheat (*Triticum* sp.)	common crabgrass (*Digitaria* sp.)	nodding spurge (*Chamaesyce* sp.)	corn (*Zea* sp.)
Ward (1964)	May-October	Colorado	sunflower (*Helianthus* sp.)	pigweed (*Amaranthus* sp.)	wheat (*Triticum* sp.)	witchgrass (*Panicum* sp.)	spurges (*Euphorbia* sp.)

frequency of occurrence in these same areas, with the exception of North Carolina in which it ranked seventh. It appears that wheat is one of the most important dove foods throughout the country.

Many studies indicated that dove use of various foods was determined largely by seasonal availability. Although it is difficult to distinguish between dove preference and food availability, it is apparent that cultivated grains make up an important part of the dove's diet. As the cultivated crops vary from one part of the country to another, the food habits of the dove change accordingly.

CHAPTER V

SUMMARY

This research was conducted to determine quantitatively and qualitatively foods consumed by doves, seasonal trends in their diet, extent of dove usage of agricultural crops, and effect of local ecological conditions and land-use on dove food habits. Five hundred and forty-six doves were collected from three east-west transects in northwest Oklahoma between June and October, 1968. Of these, 494 doves had consumed sufficient quantities of food for volumetric analysis.

In this study, dove food habits centered on wheat and the agricultural practices involved in wheat harvest. Wheat consumption was highest following wheat harvest, with the addition of waste wheat to the food supply, and decreased with time. Other foods were consumed in various amounts during the study with the greatest increase in consumption of non-agricultural foods occurring in October. It is difficult to determine, however, if differences in food consumption by doves resulted from food availability and distribution or from food preference of doves.

For the period June through October, seeds of 57 plant species from 22 families were represented in the diet of the dove. Agricultural crops comprised 61.2 per cent of the total volume, with wheat representing 55.7 per cent, millet 2.6 per cent, and sorghum 2.6 per

cent, respectively. Forb and weed seeds represented 32.6 per cent of the total volume. Of these, the most important were croton, tropic croton, and sunflower.

Wheat seeds occurred in greatest frequency (71.6 per cent), although pigweed, wildbean, tropic croton, cutleaf eveningprimrose, sand paspalum, and sunflower seeds had a frequency of 40 per cent or greater. Snails occurred in 10.8 per cent of the crops, representing 0.1 per cent of the total volume. Four orders of insects (Coleoptera, Hymenoptera, Diptera, and Lepidoptera) were cumulatively present in 3.7 per cent of the crops, but in trace amounts. Grit occurred in 44.0 per cent of the crops, but contributed 0.2 per cent of the total volume.

Dove food habits exhibited some seasonal variability. Based on volume of food consumed and frequency of occurrence, wheat was the most important source of food during the months when doves were most abundant in northwest Oklahoma. Tropic croton, sunflower, wildbean, croton, sorghum, millet, and violet seeds were the other important foods in terms of volume, consumed by doves. Pigweed, paspalum, large crabgrass, witchgrass, and Carolina geranium occurred throughout much of the season in relatively high frequency in the diet of the dove, but were usually in trace amounts. Sunflower seeds were the most important food in October, being 19.2 per cent by volume and 56.3 per cent by frequency.

Although the acreage of wheat varied greatly among the transects, the per cent of total food intake attributed to wheat was similar. With the exception of millet and violet seeds, foods consumed by doves varied slightly among the transects. These variations can probably

be attributed to random variation and to difference in seed availability. It is understandable, therefore, that a species in basically similar habitats in close proximity would have similar food habits.

Small differences, possibly due to random variation and unequal sample sizes, occurred among adult males, adult females, and immatures in the amount of most foods taken. Wheat, croton, sunflower, and tropic croton, were consumed in greatest volume by each group, although only wheat consistently ranked highest among the groups. Wheat comprised 56.2, 45.7, and 58.5 per cent of the total food volume of adult males, adult females, and immatures, respectively. The low wheat consumption by females might be explained by their possible tendency to remain closer to the nest while feeding. Thus, females depend more upon the weed seeds nearer to the nest for food.

An analysis of variance following the abbreviated Doolittle procedure was used to determine the relationship between food habits of the mourning dove and each sampling area and time interval. The following model was used in the analysis:

$$Y = \bar{u} + T_i + P_j + (TP)_{ij} + \text{Error}$$

where Y = average volume of a particular food item

$\bar{u}$ = effect due to the mean

T_i = effect due to the i^{th} transect

P_j = effect due to the j^{th} time period

$(TP)_{ij}$ = effect due to the transect-time period interaction

Error = effect due to random error

The analysis was conducted on the average volume of the following variables: total food, total food except wheat, wheat, croton, and

millet. The analysis of variance indicated that transect-time interaction occurred for the first four variables. This interaction may be overestimated due to the large number of missing observations which might lead to an underestimation of the true error. Changes in volume of millet by transect and time indicates interaction was not present. However, due to too few observations, this analysis was considered to be unreliable.

Although trends in food habits over time and space were noted, there are statistical limitations due to unbalanced data, unequal variance, and transect-time interaction. These limitations do not permit conclusive statistical summation of the results. It appears that many factors affect results in food habit studies. Some of these factors are: (1) availability and distribution of different seeds, (2) per cent of the population represented by different age and sex classes, (3) temperature, (4) time and place of collection, and (5) food preference of the animal being investigated. Although an extremely large sample would be needed to detect statistical differences between many variables over time and space, trends can be noted with smaller samples.

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VITA

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