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Disease and Habitat Change as Factors Associated with Mourning Dove Population Decline

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DISEASE AND HABITAT CHANGE AS FACTORS ASSOCIATED WITH MOURNING DOVE POPULATION DECLINE

by

William D. Ostrand

A thesis submitted in partial fulfillment
of the requirements for the degree

of

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Logan, Utah

1994

DEDICATION

To my loving daughter, S. Emily Ostrand.

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ABSTRACT

Disease and Habitat Change as Factors Associated with
Mourning Dove Population Decline

by

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Utah State University, 1995

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Department: Fisheries and Wildlife

The western mourning dove (*Zenaida macroura*) population has been declining since 1966. Data collected in 1951-52, in Fillmore, Utah, provided us a baseline for comparison with our study in the same area. Our approach was to determine whether a local population decline had occurred since the original data were collected, assess if trichomoniasis has impacted the local population, determine if changes in habitat structure affect foraging site selection, quantify changes in habitat, identify which habitats doves preferred, ascertain whether doves had responded to habitat change by changing food habits, and assess if changes in habitat were responsible in part for the local population decline. We found that population counts declined 72% and 82% from 1952 to 1992 and 1993, respectively. We determined that trichomoniasis was not an factor in the decline. We observed that doves preferred foraging habitat characterized by a short and open structure and will not forage in the taller, denser vegetation that now dominates the study area. The most dramatic change in habitat was an 82% decline of land in winter wheat production. In 1951-52 and 1992-93, doves consumed wheat in greater frequency and volume than any other food item. Habitats selected for foraging were wheat fields following harvest, feedpens, hay storage yards, and weedy patches. Of these habitats, area in wheat fields and number of feedpens had changed extensively. The decline in wheat availability, either at harvested fields or feedpens, appears to have contributed to the local population decline. We used regression analysis to test the statewide relationship between the decline in the mourning dove population index, area in winter wheat production, and the number of farms with cattle and obtained significant results ($\underline{R}^2$ = .42, $\underline{P}$ = 0.001).

(64 pages)

CHAPTER I

INTRODUCTION

Mourning doves (Zenaida macroura) are one of the most abundant birds in the United States (Robbins et al. 1986), with a fall breeding population estimated to have been 475 million (Tomlinson et al. 1988). In some years more mourning doves were harvested by hunters in the United States than all other game birds combined (Tomlinson et al. 1988). In addition, their high non-consumptive value is demonstrated by their recognition as an international religious and peace symbol (Baskett and Sayre 1993).

Based on banding data, Kiel (1959) concluded that the United States contained three independent mourning dove populations. In response, the western, central, and eastern management units were adopted by the United States Fish and Wildlife Service in 1960 (Tomlinson et al. 1988). The suitability of the boundary between the central and western management units was confirmed by Braun (1979). Management decisions were made separately for each unit rather than collectively for the nation's entire population (Tomlinson et al. 1988).

The mourning dove population has declined at a rate of -2.7% in the western management unit since 1966. The reason for the decline is unknown (Dolton 1991); however, loss of nesting habitat, changes in agricultural practices that altered habitat, pesticides and other environmental toxins, disease, and mortality from hunting have been suggested (Reeves et al. 1993). Large-scale banding studies have been conducted that address the impact of hunting (Tomlinson et al. 1988). We were unable to locate literature that described investigations into other possible causes of decline, but other studies currently are in progress.

Our research utilized Dahlgren's (1955) work, conducted in the Fillmore, Ut. area in 1951-52, as a baseline for comparison. Dahlgren (1955) investigated population size, reproductive success, nest site selection and availability, food habits, hunter success, disease (trichomoniasis), and predation. We utilized Dahlgren's original study site and replicated several of his techniques to allow direct comparisons of data. We quantified a decline of 72% and 82% from 1952 to 1992 and 1993, respectively.

The following chapters address 3 of the possible causes of population decline suggested by Reeves et al. (1993): loss of nesting habitat, changes in agriculture, and disease. Chapter II, *Trichomoniasis as a Factor in Mourning Dove Population Decline in Utah*, addresses whether trichomoniasis is a possible factor in the local population decline. Chapter III, *Selection of Foraging Habitat by Mourning Doves in Utah: A Structural Approach*, describes mourning dove foraging habitat preference in terms of physical structure and makes strong inference on how changes in habitat structure at the Fillmore study site have impacted the local population. Chapter IV, *Changes in Habitat as a Factor in Mourning Dove Population Decline in Utah*, presents data that documents the local population decline, describes the results of several methods that investigated change in habitat and agriculture, gives results of food habits studies, and gives conclusions about causes of the decline. The following chapters thus provide an insight into the causes of a local mourning dove population decline.

LITERATURE CITED

Baskett, T. S., and M. W. Sayre. 1993. Characteristics and importance. Pages 1-6 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

Braun, C. E. 1979. Migration routes of mourning doves west of the continental divide in the central management unit. Wildl. Soc. Bull. 7(2):94-97.

Dahlgren, R. B. 1955. Factors affecting mourning dove populations in Utah. M.S. Thesis. Utah State Univ., Logan. 93pp.

Dolton, D. D. 1991. Mourning dove breeding population status, 1991. U.S. Fish Wildl. Serv., Laurel, Md. 14pp.

Kiel, W. H. 1959. Mourning dove management units a progress report. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Wildl. 42.

Reeves, H. M., R. E. Tomlinson, and J. C. Bartonek. 1993. Population characteristics and trends in the stern management unit. Pages 341-378 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The breeding bird survey: its first fifteen years, 1965-1979. U.S. Fish Wildl. Serv., Resour. Pub. 157. 196pp.

Tomlinson, R. E., D. D. Dolton, H. M. Reeves, J. D. Nichols, and L. A. McKebben. 1988. Migration, harvest, and population characteristics of mourning doves banded in the stern management unit: 1964-1977. Fish and Wildl. Tech. Rep. 13, U.S. Fish Wildl. Serv., Washington, D.C. 101pp.

CHAPTER II

TRICHOMONIASIS AS A FACTOR IN MOURNING DOVE POPULATION DECLINE IN FILLMORE, UTAH[1]

Kiel (1959) concluded from banding data that North America contains three independent mourning dove populations. As a result of his work, western, central, and eastern dove management units were established by the U.S. Fish and Wildlife Service in 1960 (Tomlinson et al., 1988). Analyses of population data collected annually for mourning doves indicated a significant downward trend during the last 28 years in the western management unit (Dolton and Kendall, 1993). Reeves et al. (1993) suggested lower productivity, hunting, changes in habitat, effects of pesticides and herbicides, and trichomoniasis as possible causes of the decline.

Trichomoniasis is caused by a transmissible flagellated protozoan parasite that infects several species of birds, including most Columbiformes of North America. The protozoa Trichomonas gallinae is present in nearly all rock doves (Columba livia) without producing clinical signs of disease (Tudor, 1991). T. gallinae varies greatly in its relative virulence (Stabler and Herman, 1951) with virulent strains linked to epizootics in mourning doves (Haugen and Keeler, 1952; Sileo, 1970). Several epizootics involving trichomoniasis have been documented throughout the range of mourning doves (Barnes, 1950;

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[1]Coauthored by William D. Ostrand, John A. Bissonette, and Michael R. Conover.

Stabler and Herman, 1951; Haugen and Keeler, 1952; Haugen, 1952; Hunt, 1966; Straus, 1966; Greiner and Baxter, 1974). The pathogen is spread by direct transmission through the crop milk of infected adults to nestlings (Haugen and Keeler, 1952; Kietzmann, 1988); however, Kietzmann (1988) demonstrated, under laboratory conditions with ring doves (Streptopelia risoria), that a common watering site could also function as a vector.

Infection levels of T. gallinae in mourning doves have ranged from 4% to 58% without observing clinical signs of disease in the population (Straus, 1966; Sileo, 1970; Rupiper and Harmon, 1988), suggesting that infection and mortality rates are not tightly linked. Similarly, Sileo (1970) reported an epizootic in which the rate of infection increased as the rate of morbidity decreased. Infection with nonvirulent strains can result in subsequent resistance to lethal strains (Kocan and Knisley, 1970); however, Sileo (1970) observed that with strains of differing virulence, protective immunity was not evident in all circumstances.

Dahlgren (1955) monitored the mourning dove population in Fillmore, Utah, 1951-1952, and investigated several factors thought to affect the population, including trichomoniasis. His work provided excellent baseline data for assessing the causes of population change. We replicated Dahlgren's (1955) population monitoring and quantified a decline of 72% and 82% from 1952 to 1992 and 1993, respectively. We sought to determine if trichomoniasis was negatively influencing the mourning dove population. We reasoned that if we could not find a high proportion of doves showing clinical signs of disease that the population was not being affected.

We captured mourning doves during two summers with collapsible funnel traps using millet (Sorghum bicolor) for baiting (Reeves et al., 1968) in an agricultural area 2 kilometers northwest of Fillmore, Utah, 1 June to 1 September, 1992 and 1993. Clinical signs of the disease were diagnosed by the presence of mouth lesions. Lesions were detectable as raised, yellowish, purulent, independent or confluent, caseous, rough masses on the mucous membranes (Tudor, 1991). All birds handled or found dead were examined. We collected mucus samples from trapped birds and cultured the samples in Diamond's CPLM medium which was prepared following methods described by McLoughlin (1966) and Diamond (1957). Categorical data were collected on the presence or absence of infection for adults and hatching-year doves. Two by two contingency tables were used for chi-squared goodness of fit and cross product (odds) ratio analyses (Fienberg, 1989).

Of 121 birds examined in 1992 for clinical symptoms, only one exhibited symptoms of trichomoniasis. None of the 109 doves examined in 1993 showed disease symptoms. We took 78 oral swabs in 1992 and 77 in 1993; rates of infection of T. gallinae were 21% and 14%, respectively (Table *II-1*). The rates of infection for hatching-year and adult doves were not significantly different ($P < 0.05$) between years. The infection rates of hatching-year birds

Table *II-1*. Rates of infection of Trichomonas gallinae for mourning doves (Zanaida macroura) in Fillmore, Utah 1992 and 1993.

	Hatching-year			Adults			All doves		
Year	#[a]	# +[b]	%[c]	#	# +	%	#	# +	%
1992	44	13	30	34	3	9	78	16	21
1993	36	6	17	41	5	12	77	11	14
Total	80	19	23	75	8	11	155	27	17

[a] sample size

[b] number of birds infected,

[c] rates of infection

compared to adults for the 2 years were significantly different ($P < 0.05$). Cross product (odds) ratios indicated that hatching-year birds were 2.6 times as likely to be infected as adults.

Like Dahlgren (1955) we found no evidence of an epizootic occurring in the Fillmore study area. Our observed frequencies of infection were within the range reported in other studies (Straus, 1966; Sileo, 1970; Rupiper and Harmon, 1988). The higher incidence of infection among hatching-year doves is also consistent with previously reported levels in nonepizootic populations (Straus, 1966; Sileo, 1970; Rupiper and Harmon, 1988). We concluded that trichomoniasis was not contributing to the Fillmore mourning dove population decline.

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LITERATURE CITED

Barnes, W. B. 1950. Trichomoniasis in mourning doves in Indiana. Indiana Audubon Quarterly 29:8.

Dahlgren, R. B. 1955. Factors affecting mourning dove populations in Utah. M.S. Thesis, Utah State University, Logan, Utah, 93 pp.

Diamond, L. S. 1957. The establishment of various Trichomonads of animals and man in axenic cultures. Journal of Parasitology 43:488-490.

Dolton, D. D., and W. L. Kendall. 1993. Mourning dove breeding population status 1993. U.S. Fish and Wildlife Service, Laurel, Maryland, 16 pp.

Fienberg, S. E.. 1989. The analysis of cross-classified categorical data. MIT Press, Cambridge, Massachusetts, 198 pp.

Greiner, E. C., and W. L. Baxter. 1974. A localized epizootic of trichomoniasis in mourning doves. Journal of Wildlife Diseases 10:104-106.

Haugen, A. O. 1952. Trichomoniasis in Alabama mourning doves. The Journal of Wildlife Management 16:164-169.

_____, and J. Keeler. 1952. Mortality of mourning doves from trichomoniasis in Alabama during 1951. Transactions, Seventeenth North American Wildlife Conference 17:141-151.

Hunt, D. B. 1966. Diseased mourning doves. Western Bird Bander 41:43.

Kiel, W. H. 1959. Mourning dove management units a progress report. Special Scientific Report - Wildlife Number 42. U.S. Fish and Wildlife Service, Washington, D.C., 24 pp.

Kietzmann, G. E. 1988. Host-parasite interactions of Trichomonas gallinae. Ph.D. Thesis, Iowa State University, Ames, Iowa, 142 pp.

McLoughlin, D. K. 1966. Observations on the treatment of Trichomonas gallinae in pigeons. Avian Diseases 10:288-290.

Reeves, H. M., A. D. Geis, and F. C. Kniffin. 1968. Mourning dove capture and banding. Special Scientific Report 117. U.S. Fish and Wildlife Service, Washington, D.C., 63 pp.

_____, R. E. Tomlinson, and J. C. Bartonek. 1993. Populations characteristics and trends in the stern management unit. In Ecology and management of the mourning dove, T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi (eds.). Stackpole Books, Harrisburg, Pennsylvania, pp. 341-378.

Rupiper, D. J., and W. M. Harmon. 1988. Prevalence of Trichomonas gallinae in central California mourning doves. California Fish and Game 74:239-240.

Sileo, L., Jr. 1970. The incidence and virulence of Trichomonas gallinae (Rivolta) in mourning dove (Zenaida macroura, Linnaeus) populations in southern Arizona. Ph.D. Thesis, University of Arizona, Tucson, Arizona, 34 pp.

Stabler, R. M., and C. M. Herman. 1951. Upper digestive tract trichomoniasis in mourning doves and other birds. Transactions, Sixteenth North American Wildlife Conference 16:145-163.

Straus, M. A. 1966. Incidence of Trichomonas gallinae in mourning dove, Zenaidura macroura, populations of Arizona. M.S. Thesis, University of Arizona, Tucson, Arizona, 44 pp.

Tomlinson, T. E., D. D. Dolton, H. M. Reeves, J. D. Nichols, and L. A. McKibben. 1988. Migration, harvest, and population characteristics of mourning doves banded in the stern management unit: 1954-1977. Fish and Wildlife Technical Report 13. U.S. Fish and Wildlife Service, Washington, D.C., 101 pp.

Tudor, D. C. 1991. Pigeon health and disease. Iowa State University Press, Ames, Iowa, 244 pp.

CHAPTER III

SELECTION OF FORAGING HABITAT BY MOURNING DOVES IN UTAH: A STRUCTURAL APPROACH[1]

Mourning doves are distributed from southern Canada to Central America (Aldrich 1993). During the 1989 North American Breeding Bird Survey, mourning doves occurred on 1,254 of 1,344 routes, ranking second in frequency of occurrence (Droege and Sauer 1990). As suggested by the survey, mourning doves used a wide variety of habitats (Martin and Sauer 1993, Reeves et al. 1993, Tomlinson and Dunks 1993). We were unable to locate studies that specifically described foraging habitat; however, Lewis (1993) summarized the results of several food habits studies and showed mourning doves consumed a wide variety of seeds. His results suggested plant species composition of foraging patches varied greatly. Lewis (1993:181) stated that doves foraged where food was "visible or readily accessible in light ground cover." The large number and wide distribution of habitats utilized by mourning doves suggested to us that doves may make habitat selections based on structure rather than plant species composition.

Structure, the arrangement of objects in the environment (McCoy and Bell 1991), as the mechanism in habitat selection by birds, has been discussed extensively in the literature. MacArthur and MacArthur (1961) and

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[1]Coauthored by William D. Ostrand, John A. Bissonette, and Michael R. Conover.

MacArthur et al. (1962) made successful avian diversity predictions based on habitat structural variables. Robinson and Holmes (1982) observed that food resources and vegetative structure interact to enhance and constrain the ways forest birds can successfully forage. Wakeley (1978) and Bechard (1982) observed that foraging hawks were constrained to structurally open harvested fields even when more densely vegetated habitats had higher prey populations. Lima (1993) reviewed predation escape tactics of North American birds and concluded that in habitat selection, the evaluation of predation risk is based on the compatibility of an individual's escape tactic to habitat structure. Structure can both constrain foraging and influence predation risk. Watts (1990) hypothesized that harriers (Circus cyaneus) selected open-structured foraging habitats because of increased hunting efficiency. He found that song sparrows (Melospiza melodia) and savannah sparrows (Passerculus sandwichensis) selected habitats with more complex structure to reduce predation risk from harriers.

Our objective was to determine if mourning doves discriminated between habitats with different structural characteristics when food was equally available. If differences in habitat use were observed, we intended to isolate the structural variables used in decision making. We further planned to determine if predation risk was a factor in foraging habitat selection. In grassland habitats similar to our study site, Cody (1968) found that vegetation height and density were the structural variables segregating the habitats of most grassland birds. Mourning doves are primarily granivorous ground feeders (Lewis 1993) and detritus may interfere with their foraging. To evaluate the importance of ground cover, we included it as a variable.

We thank all the individuals who provided assistance throughout this study. Funding for this study was provided by the Utah Division of Wildlife Resources at the initiative of J. A. Roberson. S. E. Ostrand, T. D. Cook, P. M. Meyers, and F. D. Gregory assisted in establishing the experimental blocks and data collection. A. B. Johnson and D. C. McMahon provided logistical support in Fillmore, Ut. S. L. Durham and T. A. Crowl gave advice and assistance with statistical analyses. P. E. Budy composed graphics.

STUDY AREA

This study was conducted in eastern Millard County, Ut. near the community of Fillmore. Annual precipitation averaged 37.5 cm. Average monthly temperatures for July and August were 25.1° C and 24.1° C, respectively (U.S.D.A. Soil Conservation Service [SCS], Fillmore Office, unpubl. data). The elevation at Fillmore was 1,740 m with several small hills rising from the flat valley floor within the study area. Major agriculture crops were alfalfa on irrigated and wheat on nonirrigated land. Wheat production has decreased greatly over the last 40 years and has been replaced by fallow grasslands due to land enrolled in the U.S.D.A.'s Conservation Reserve Program (CRP) (U.S.D.A. SCS, Fillmore Office, unpubl. data). These CRP fields were used as the study sites. Vegetation cover at study sites was dominated by common rye (Secale cereale) (52-98%) followed by tall wheatgrass (Thinopyrum elongatum) (2-48%).

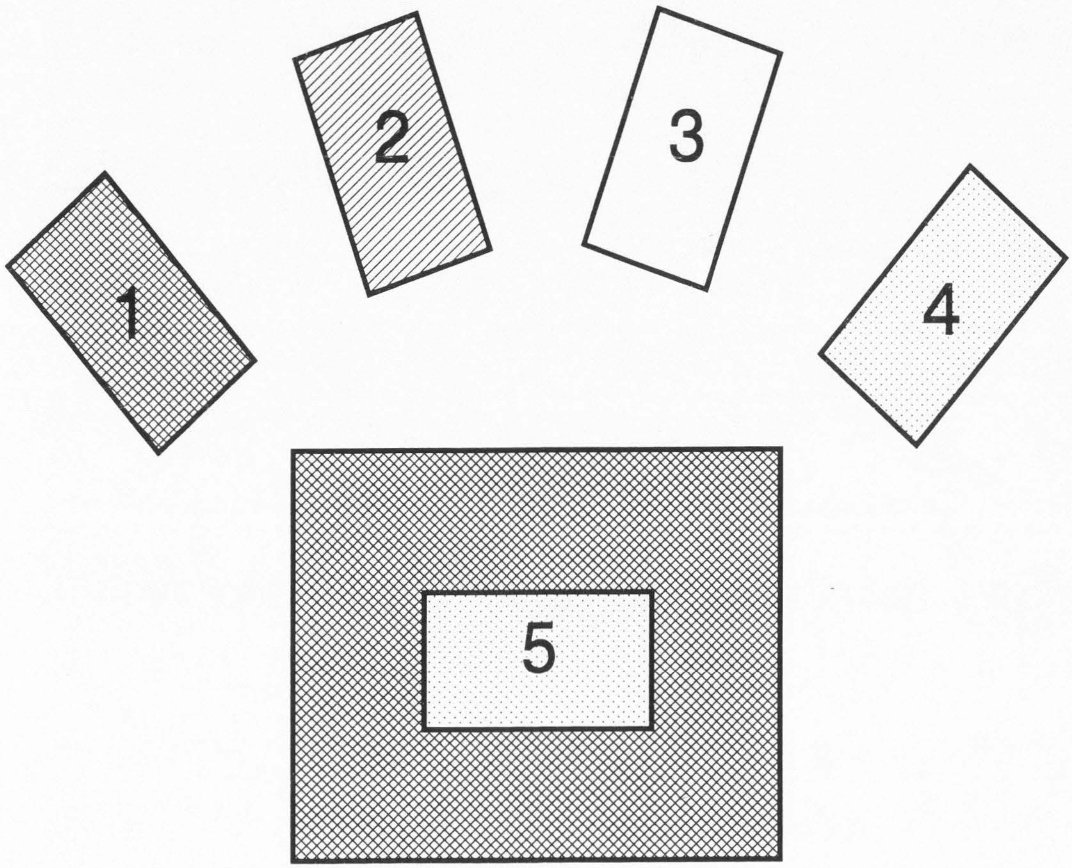
METHODS

We used a randomized block experimental design (Zar 1984). We selected 5 experimental blocks within 200 m of features that we knew attracted mourning doves: water, feedpens, or wheat fields. All blocks were ≥ 1.5 km apart and located on land that was part of the CRP.

At each block, we established 5 treatment plots. Plots were 10 X 20 m. Four of the plots were arranged in an arc around a plot with a mowed buffer (Fig 1.). All plots within a block were ≥ 10 m apart. Five treatments were used: bare ground with a 10-m buffer of mowed grass (bare ground with buffer), bare ground with no buffer (bare ground), mowed grass with litter not removed (cut), mowed grass with litter removed (cut and raked), and a control in which the vegetation structure was unaltered (control). It was our objective to have significant difference in grass height between the control and all other treatments, less litter and grass cover in the bare ground treatments, and differences in litter coverage between the cut and the cut and raked treatments. Grass was mowed with a power mower, litter was removed with a hand rake, and the vegetation was removed by scraping the soil. We included both bare ground with buffer and bare ground plots to determined if habitat selection was influenced by a perceived predation risk from ground predators. If ground predation had serious selective pressure, we expected doves to prefer areas with a larger viewing area. If ease of foraging was the only criterion used in choosing patches, then the bare ground plots should have attracted the most doves and we should have seen no difference between bare ground plots with and without the buffer. Cut and raked versus cut comparisons were established to determine the influence of the presence of detritus on forage site selection. Cut treatments most closely resembled harvested wheat fields and comparison with the control allowed an assessment of whether the replacement of wheat fields with grass has influenced the selection of foraging habitat. Treatments were assigned to experimental plots randomly with the exception of the central plot, which was bare ground with buffer at all blocks (Fig. *III-1*).

Initially 11 kg of millet and 11 kg of wheat were spread over each plot with a hand-crank seed/fertilizer spreader. Grain availability in the plots was determined initially and periodically thereafter by counting seeds in 3 randomly placed 10-cm^2 subplots within each treatment. We observed that seed availability was reduced by 50% after 3 weeks of trials and spread an additional 11 kg of wheat on each plot.

We determined mean grass height by randomly selecting 75 points within each plot and measuring the height of the nearest blade of grass. We quantified proportions of ground cover for each plot by randomly selecting 105 points within each plot and recording whether the sites were covered with litter or standing vegetation, or were bare ground. Single factor randomized block



		Grass Height(cm)	% Bare Ground	%Standing Grass	%Litter
1	Cut	12.4b	8c	32b	60a
2	Cut and raked	10.4cb	33b	23bc	44ab
3	Control	39.2a	5c	55a	40b
4	Bare ground	7.1d	62a	5c	33b
5	Bare ground with buffer	8.4cd	62a	10c	28b

analysis of variance (ANOVA) and Ryan-Einot-Gabriel-Welsch multiple range post-hoc tests were performed on data for each structural variable (SAS Inst. Inc. 1988:549-640).

We selected a fixed viewing point for each site from where all plots within the block could be observed. Experimental trials were conducted by observing a block for a 0.5-hr period and recording the number of birds foraging in each plot. We conducted 2 experimental trials simultaneously per day, beginning at 07:30. Experimental trials were conducted 5 days a week for 5 weeks, 7 July-11 August 1993. One week of data collection was lost due to rebaiting. Data were averaged for each of the 5 observation weeks and analyzed using a randomized block ANOVA with repeated measures, and the Ryan-Einot-Gabriel-Welsch post-hoc test (SAS Inst. Inc. 1988:549-640).

RESULTS

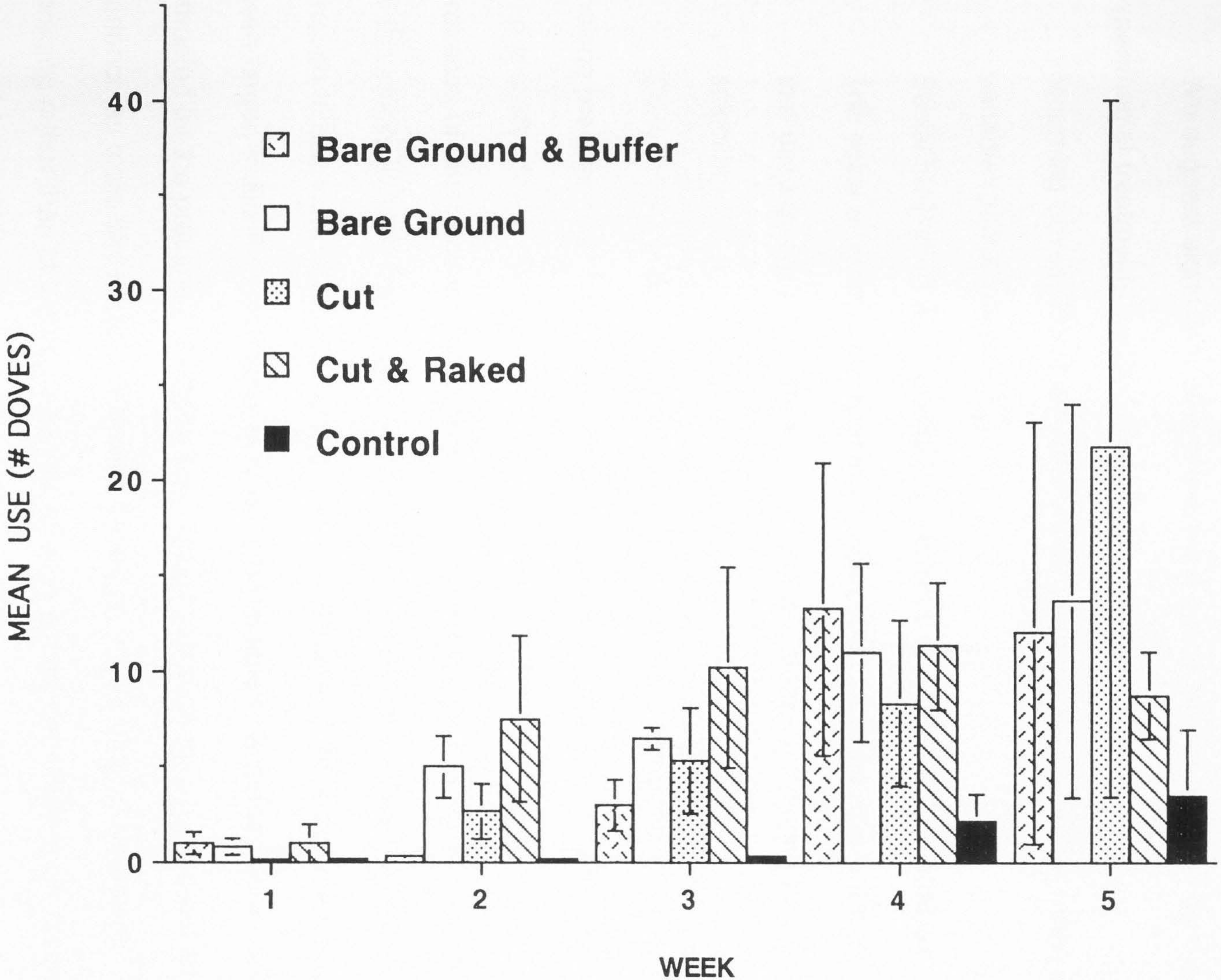
One block attracted only a few doves during the last 2 weeks of trials and therefore was not included in the analyses. Another of the blocks was significantly different ($\underline{P} < 0.05$) from other plots in grass height, proportion bare ground, and proportion litter. This block was also dropped from further analyses. After deletions, 28 trials and 647 dove observations remained in the data set.

We reasoned the structural variables evaluated by doves in making choices must show significant difference between the control and treatments. Hence we conducted ANOVA on habitat structure data to determine if our habitat manipulations met the design objectives for treatments (Fig. *III-1*). Grass height and density was highest in the control followed by the 2 cut treatments, and least in the bare ground treatments as intended. The higher mean of litter in the cut versus the control showed cutting added litter to the plots. Our structural manipulations met our objectives.

We found that number of birds foraging varied among treatments and over time (Fig. *III-2*). The general statistical model for the ANOVA was highly significant ($P = 0.003$). The independent variables, block, treatment, and time were all significant ($P = 0.004$, 0.004, and 0.0001, respectively). The interactive term, treatment X time, was not ($P = 0.75$). Mean use for cut and raked, bare ground, cut, bare ground with buffer, and the control were 7.68a, 6.64a, 6.64a, 4.54ab, and 1.04b, respectively (means sharing a common letter are not significantly different at $P < 0.10$).

DISCUSSION

We found a significant relationship between habitat structure and foraging site selection by mourning doves. Doves clearly discriminated between the control plots versus treatment plots, with less clear differences exhibited between treatments. Our results are consistent with Cody's (1968) observation that vegetation height and density were the structural variables evaluated by grassland birds in resource partitioning. Avoidance of the control plots appears related to the taller and denser grass structure that impaired


Bare Ground & Buffer
Bare Ground
Cut
Cut & Raked
Control
MEAN USE (# DOVES)
WEEK
0
10
20
30
40
1
2
3
4
5

escape from predators by flight, impaired food detection and collection, or a combination of these 2 factors.

We suggest significant differences were not observed between the experimental treatments for the following alternative hypotheses:

1. Mourning doves do not discriminate foraging habitat within the range of variable manipulation.
2. Social facilitation was contributing variance and affected the analysis.
3. The scale at which the experiment was conducted was different than that used by mourning doves in making decisions on foraging habitat selection.

Cody (1981) suggested that social facilitation is a confounding factor in making predictions of habitat use based on structure. During the last 2 weeks of our study, doves may have been making choices based more on the presence of other doves than on structure. At that time, birds were attracted to the blocks in such large numbers that the individual plots were not large enough to accommodate all doves. If the spatial scale of the experiment had been larger, individual treatments may have been able to accommodate doves attracted by the presence of others, and social facilitation may have reduced variance as more birds made decisions based on where other doves were foraging rather than structure. Analysis of such a data set would show clearer differences of the use of treatments but may not be representative of choices doves made based on structure.

The trend in our data suggested doves were selecting cut and raked treatment plots. Use of other manipulated treatments was not perceptibly different. Preference for the cut and raked plots may have indicated a trade-off between perceived predation risk associated with structure and the enhancement or constraint of foraging due to structure. When we observed foraging in these plots, we noted doves were harder to detect against the broken background of soil and grass. The coloration of mourning doves, black spots on a slate grey background, was cryptic when contrasted with bare soil and scattered vegetation. The choice of cut and raked plots suggested selection was influenced by a need to reduce risk and increase foraging efficiency.

Bare ground with buffer plots did not attract more birds than bare ground plots. Hence a wider viewing area did not appear to be a factor in habitat selection. This may indicate that predation from ground predators was not an influence in habitat selection. Alternately, the bare ground plots may have provided a sufficiently large area in which a dove could observe an approaching predator and the large unobstructed viewing area associated with the bare ground and buffer plot offered little additional protection.

MANAGEMENT AND RESEARCH IMPLICATIONS

In our study area, most wheat fields have been replaced with fallow grasslands which we used as the control in our experiment. Our treatments, particularly the cut and raked plots, structurally resembled harvested wheat fields. Our experiment has shown that doves selected habitats with shorter and less dense vegetation. These results suggest that conversion of wheat fields to grass has resulted in a structural change in habitat that renders it unsuitable for foraging by mourning doves. Hence mourning doves may be an avian species that has been hurt by the conversion of cultivated wheat fields into grasslands under CRP.

We expect foraging habitat structure of mourning doves to be similar throughout their range. We believe a structual approach will enable biologists to accurately model mourning dove foraging habitat and facilitate dove management.

LITERATURE CITED

Aldrich, J. W. 1993. Classification and distribution. Pages 47-56 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

Bechard, M. J. 1982. Effect of vegetative cover on foraging site selection by ferruginous hawks. Condor 84:153-159.

Cody, M. L. 1968. On the methods of resource division in grassland bird communities. Am. Nat. 102:107-147.

_____. 1981. Habitat selection in birds: the roles of vegetation structure, competitors, and productivity. BioSci 31:107-112.

Droege, S., and J. R. Sauer. 1990. North American breeding bird survey annual summary 1989. Biol. Rep. 90(8). U.S. Fish and Wildl. Serv., Washington, D.C. 16pp.

Lewis, J. C. 1993. Foods and feeding ecology. Pages 181-204 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

Lima, S. L. 1993. Ecological and evolutionary perspectives on escape from predatory attack: a survey of North American birds. Wilson Bull. 105:1-47.

MacArthur, R. H., and J. W. MacArthur. 1961. On bird species diversity. Ecology 42:594-598.

_____, _____, and J. Preer. 1962. On bird species diversity II. Prediction of bird censuses from habitat measurements. Am. Nat. 96:167-174.

Martin, F. W., and J. R. Sauer. 1993. Population characteristics and trends in the eastern management unit. Pages 281-304 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

McCoy, E. D., and S. S. Bell. 1991. Habitat structure: the evolution and diversification of a complex topic. Pages 3-27 in S. S. Bell, E. D. McCoy, and H. R. Mushinsky, eds. Habitat structure, the physical arrangement of objects in space. Chapman and Hall, New York, N.Y.

Reeves, H. M., R. E. Tomlinson, and J. C. Bartonek. 1993. Population characteristics and trends in the western management unit. Pages 341-378 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

Robinson, S. K., and R. T. Holmes. 1982. Foraging behavior of forest birds: the relationships among search tactics, diet, and habitat structure. Ecol. 63:1918-1931.

SAS Institute Inc. 1988. User's guide. Release 6.03 ed. SAS Inst. Inc, Cary, N.C. 1,028pp.

Tomlinson, R. E., and J. H. Dunks. 1993. Population characteristics and trends in the western management unit. Pages 305-340 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

Wakeley, J. S. 1978. Factors affecting the use of hunting sites by ferruginous hawks. Condor 80:316-326.

Watts, B. D. 1990. Cover use and predator-related mortality in song and savannah sparrows. Auk 107:775-778.

Zar, J. H. 1984. Biostatistical analysis. Prentice-Hall, Inc., Englewood Cliffs, N.J. 717pp.

CHAPTER IV

CHANGES IN HABITAT AS A FACTOR IN MOURNING DOVE POPULATION DECLINE IN UTAH[1]

Mourning doves are one of the most abundant birds in the United States (Robbins et al. 1986), with a fall breeding population estimated at 475 million birds (Tomlinson et al. 1988). In some years more mourning doves were harvested by more hunters in the United States than all other game birds combined (Tomlinson et al. 1988).

Based on banding data, Kiel (1959) concluded that three independent mourning dove populations existed in the United States. In response, the United States Fish and Wildlife Service (USFWS) adopted the eastern, central, and western mourning dove management units in 1960 (Tomlinson et al. 1988). Analyses of population data collected annually indicated a significant downward trend since 1966 in the western management unit (Dolton and Kendall 1993). The reason for the decline is unknown (Dolton 1991); however, loss of nesting habitat, changes in agricultural practices that altered habitat, pesticides and other environmental toxins, disease, and mortality from hunting have been suggested (Reeves et al. 1993).

Our study utilized Dahlgren's (1955) work, conducted in the Fillmore, Ut. area in 1951-52, as a baseline for comparison. Dahlgren (1955)

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[1]Coauthored by William D. Ostrand, Paul M. Meyers, John A. Bissonette, and Michael R. Conover.

investigated population size, reproductive success, nest site selection and availability, food habits, hunter success, disease (trichomoniasis), and predation. This chapter examines changes in the Fillmore dove population and the possible association with changes in habitat and food habits. Our approach was to determine if the local population had declined, quantify habitat changes, identify habitats selected by mourning doves, ascertain if doves have responded to changes in habitat by changing their food habits, assess whether changes in habitat have affected the local population, and determine if patterns observed in Fillmore could be extended to explain the statewide population decline in Utah.

We wish to thank the individuals who provided assistance throughout this study. Funding for this study was provided by the Utah Division of Wildlife Resources at the initiative of J. A. Roberson. S. E. Ostrand and T. D. Cook assisted in data collection. A. B. Johnson and D. C. McMahon provided logistical support in Fillmore. S. L. Durham gave advice on statistical analyses. P. E. Budy composed graphics.

STUDY AREA

This study was conducted in eastern Millard County, Ut. Aerial photo interpretation examined an area of 5,080 ha that included most of the community of Fillmore (Township 21 S Range 5 W sections 1, 12, 13, 24 and Township 21 S Range 4 W sections 3-10 and 15-22). Annual precipitation averaged 37.5 cm. Average monthly temperatures for July and August were

25.1° C and 24.1° C, respectively. Winds were predominantly from the southwest and commonly attained velocities of 50 km/hr (U.S.D.A. Soil Conservation Service [SCS], Fillmore, Ut. Office, unpubl. data). The elevation at Fillmore was 1,740 m with several small hills rising from the flat valley floor within the study area. Native vegetation areas were dominated by juniper (Juniperus utahensis), sagebrush (Artemisia spp.), yellow-brush (Chrysothamnus spp.), cheatgrass (Bromus tectorum), and tumbleweed (Salsola kali) (Dahlgren 1955). Major agriculture crops were alfalfa and wheat on irrigated and nonirrigated land, respectively. Wheat production has decreased greatly over the last 40 years and has been replaced by fallow grasslands administered under the SCS crop reduction program (CRP)(SCS, Fillmore, Ut. Office, unpubl. data).

METHODS

Changes in Mourning Dove Population

We replicated Dahlgren's (1955) population studies. Methods were similar to the standard annual calling counts, overseen by the USFWS (Dolton 1991), differing only in that only 3 coo listening stops, rather than 20, were conducted along a single 36-km road transect. Counts were conducted 3 times a week beginning 27 April 1992 and 28 April 1993 and ending 11 September 1992 and 9 September 1993. We replicated the transect 54 times each season. Although Dahlgren also conducted counts 3 times per week, the sampling dates and time intervals between samples were not consistent between years. We therefore were unable to use pairwise comparisons between data sets. We compared Dahlgren's (1955) data with ours by computing the area under the graphical representation of the populations (Fig. *IV-1*). The data obtained from calling counts were a series of discrete numbers; therefore to estimate areas we reduced the curves to a series of rectangles. Each rectangle corresponded to a replicate of the calling count. We determined the area of each rectangle by multiplying the number of birds seen on each replicate by 1/2 the time interval, measured in days, between the previous and following observations. For the first and last transect of the year, the time interval began or ended, respectively, on the day the transect was conducted. The summation of the area of the rectangles was our estimate of the area under the curve. Areas were compared as percent change. We used Pearson pairwise correlations (Wilkinson 1990) to compare the seasonal patterns of population change between years.

Changes in Human Population and Agriculture

We obtained data on the human population and on agricultural practices for Millard County and Fillmore Ut. from U.S. Census publications (U.S. Bureau of the Census 1952, 1956, 1989, 1992) and Utah Department of Agriculture reports (Utah Department of Agriculture 1992).

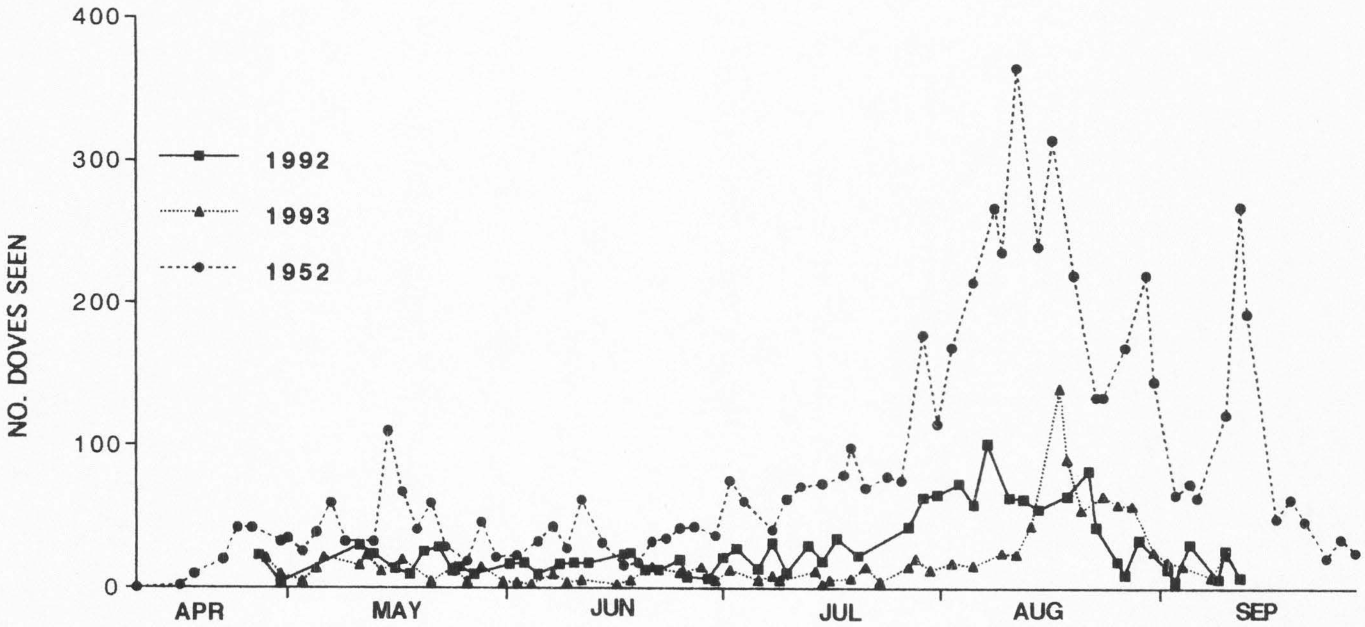


Fig. *IV-1.* Calling count data from 1952, 1992, and 1993 for the Fillmore, Utah study site.

Changes In Habitat

Dahlgren (1955) did not attempt to map or describe the landscape of the study area; however, aerial photographs taken in 1952 (U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service photographs) provided habitat documentation. We compared these photos to aerial photographs taken in 1993 (U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service photographs). Extensive ground checking was conducted to confirm the interpretation of the 1993 photographs. Data from both 1993 and 1952 photographs were transferred to 1:24,000 base maps and then digitized.

Habitat Use

We determined habitat use and calculated electivity indices to examine the implications of habitat change. Habitat use was determined by the use of 3 different line transects (Anderson et al. 1979).

During 37 of the calling counts in 1992 and 54 in 1993, we characterized the habitat where each dove was observed. Indices were calculated for the 36 calling counts following 8 June 1993 because the numbers of birds seen on calling counts in 1993, prior to then, were insufficient to calculate valid electivity indices (Lechowicz 1982).

An additional 13.3-km driving transect was established to observe foraging habitat selection. We drove $\leq$ 16 km/hr and only counted doves seen foraging. Doves seen on the ground were assumed to be foraging. Stops were made whenever necessary to confirm observations. In 1992 we drove this transect 3 times a week, once each in the morning, midday, and late afternoon. We sampled from 2 June to 4 September and obtained 21 replicates. In 1993 this transect was driven twice a week, once each in the morning and afternoon. We sampled from 1 May to 31 August and obtained 32 replicates out of a possible 34. We extended the transect 6.2 km to include nonirrigated winter wheat fields, sagebrush, and juniper habitats on 7 July 1993. Data from the original transect were summed to obtain the number of birds observed foraging in each habitat each season. We analyzed the extended transect data separately as pre- and post-wheat harvest data sets. Four replicates preceded the 29 July wheat harvest and 8 were conducted from 29 July to 31 August 1993.

We walked transect lines to determine if doves used the interior of habitat patches differently than could be observed from roads. Two transects through irrigated agricultural fields (4.0 km) and a third through sagebrush, juniper, and grass vegetation (0.8 km) were replicated 6 times each season, 9 June-2 September 1992 and 16 May-12 August 1993. On 12 June 1993 we added 2 lines (1.8 km) to include nonirrigated winter wheat and grassland vegetation and sampled them 5 times.

We collected data on habitat availability for all transects by measuring the linear distance that each habitat intersected the transect line. Total doves per habitat was determined for each calling count replicate. We summed the foraging transect data for the season. We used Chesson's alpha, a normalized ratio of proportional use/proportional availability (Chesson 1978), to calculate electivity. Values > 1/n (n = number of habitats) indicated preference, < 1/n = avoidance. The number of habitats encountered by each transect differed in type and number, resulting in different 1/n values. We encountered too few mourning doves during the walking transects to calculate Chesson's alpha (Lechowicz 1982); therefore, these data are presented as distance walked through each habitat type and the total number of birds seen foraging in the respective habitats.

Food Habits

We duplicated Dahlgren's (1955) methods for determining food habits by collecting birds by gun and analyzing the crop contents. Because of the population decline and concern about potential impact on other phases of the study, birds were collected on the study area only outside the nesting season of June to early August. During June and July, mourning doves were collected $\geq$ 10 km from the study area. To remove bias associated with collecting birds while feeding, doves were taken at watering areas at dusk. We were unable to determine exactly where Dahlgren (1955) collected doves.

Contents of each crop were segregated by seed species. The volume of each species was determined by water displacement (Armstrong and Noakes 1981). Monthly volume totals and percent frequency of occurrence were calculated for all food items. Confirmation of identifications of food items was made at the Utah Department of Agriculture Seed Laboratory in Salt Lake City, Ut. Comparisons of monthly and cumulative food item species lists for 1952-53 vs. 1992-93 were made for using an index of similarity (Odum 1971). We compared the 1952-53 vs. 1992-92 frequency of occurrence of individual food items with the Fisher exact probability test (Zar 1984).

Statewide Population Decline

We used regression (Zar 1984) to determined if the variables identified to be factors in the Fillmore decline were associated with the statewide decline. Data were obtained data from Utah Department of Agriculture reports (Utah Department of Agriculture 1973, 1979, 1985, 1988, and 1993) and the USFWS (Dolton and Kendall 1993).

RESULTS

Changes in Mourning Dove Population

Dove counts for 1992 and 1993 were consistently below values from 1952 (Fig. 1). The counts declined 72%, 82%, and 34% from 1952 to 1992, 1952 to 1993, and 1992 to 1993, respectively. Correlation $\underline{r}$ values were 0.65, 0.66, and 0.42 between 1952 to 1992, 1952 to 1993, and 1992 to 1993, respectively.

Changes in Human Population and Agriculture

Data on human population indicated a 3% increase from 1950 to 1990. The greatest downward changes in agriculture in Millard County during the same period were an 82% decrease in land in winter wheat production and a 61% decrease in the number of farms with cattle. Land under irrigation, number of cattle, land in spring wheat, and land in alfalfa all increased (Table *IV-1*).

Changes in Habitat

The greatest change of land use based on aerial photograph study in the area was the conversion of dry land wheat fields to grass lands (Table 2). Total km of riparian vegetation which was used for nesting (Dahlgren 1955, P. M. Meyers, W. D. Ostrand, M. R. Conover, and J. A. Bissonette, Dept. of Fish. and Wildl., Ut. State Univ., unpubl. data) did not change. Little change also occurred in the composition of riparian vegetation: shrub (14.9 km in 1950 vs. 14.2 km in 1993), tree (3.5 km in 1950 vs. 3.8 km in 1993), grass (3.0 km in 1950 vs. 3.3 km in 1993), juniper (4.5 km in 1950 vs. 4.5 km in 1993), and concrete riparian (0 km in 1950 vs. 0.2 km in 1993).

Habitat Utilization

Our data analyses from the 3 transect methods provided complementary information. The calling count data indicated that doves were

Table *IV-1.* Population and agricultural statistics for 1950's and 1990's for Millard County, Utah.[a]

	1950	1990
Fillmore population	1,890[b]	1,956[c]
Total farmland (ha)	198,942[d]	194,400[e]
No. farms	1,133[d]	630[e]
$\bar{x}$ farm size (ha)	177[d]	309[e]
Irrigated land (ha)	31,485[d]	37,834[e]
No. cattle	36,637[d]	55,000[f]
No. farms with cattle	933[d]	367[e]
Winter wheat (ha)	13,376[d]	2,430[f]
Spring wheat (ha)	817[d]	1,013[f]
Alfalfa (ha)	13,325[d]	24,219[f]

[a] Data presented are for years most relevant to the Fillmore studies.

[b] 1950 data (U.S. Bureau of the Census 1952).

[c] 1990 data (U.S. Bureau of the Census 1992).

[d] 1949 data (U.S. Bureau of the Census 1956)

[e] 1987 data (U.S. Bureau of the Census 1989)

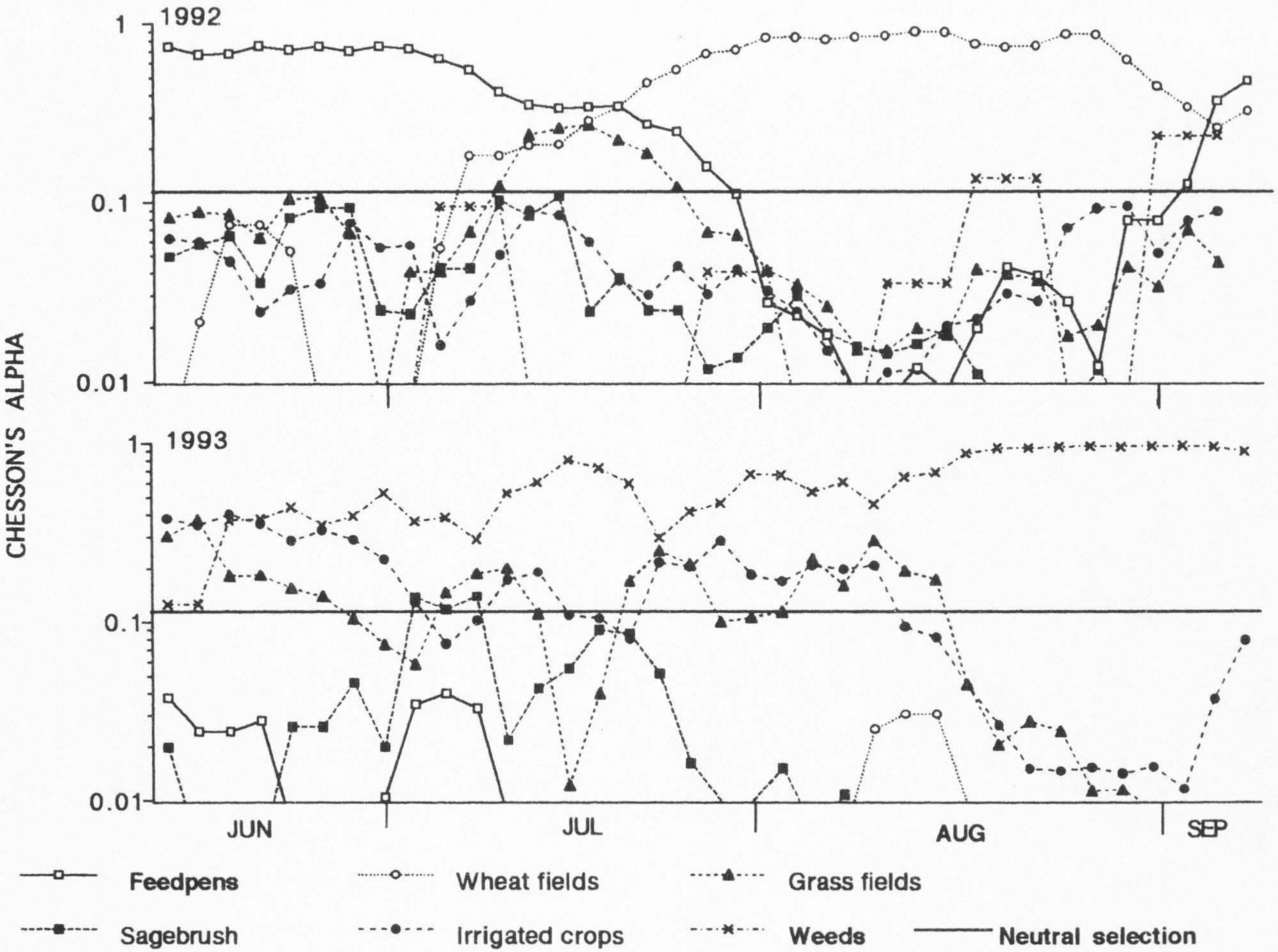
[f] 1991 data (Utah Department of Agriculture 1992)

Table *IV-2*. Changes in habitats (ha) in agricultural and range land near Fillmore, Utah 1950 to 1993.

	Area 1950	Area 1993
Dry land wheat	1,378	184
Sagebrush	1,041	368
Irrigated crops	899	483
Juniper	378	378
Urban	255	310
Grass	1,129	3,457
Total	5,080	5,080

seen at feedpens during the first part of the 1992 season and switched in mid-July to newly harvested fields of irrigated spring wheat (Fig. *IV-2*). Indices for all other habitats indicated avoidance most of the season. The peak number of doves observed coincided with the wheat harvest (Fig. *IV-1*). In 1993 a cold spring resulted in a delayed growing season and a late wheat harvest. Once harvested, the irrigated spring wheat fields were quickly burned and disced, and were unusable to doves. The late spring also resulted in an abundance of weeds in disturbed patches and ditches that consistently attracted doves.

Chesson's alpha (Chesson 1978) values calculated from foraging transect data indicated that doves were using feedpens and hay storage yards. We observed negligible foraging in grass, sagebrush, irrigated crops, and trees and shrubs. Alpha values calculated from the extended transect


1992
1993
CHESSON'S ALPHA
1
0.1
0.01
JUN
JUL
AUG
SEP
Feedpens
Wheat fields
Grass fields
Sagebrush
Irrigated crops
Weeds
Neutral selection

data for pre- and post-harvest of nonirrigated winter wheat harvest were 0.0 0.37, 0.86 0.44, and 0.13 0.21 for wheat, feedpens, and weeds, respectively. Values > 0.11 indicated selection. We observed negligible foraging in hay storage yards, sagebrush, irrigated crops, grass, trees and shrubs, and juniper while conducting this transect.

Walking transects confirmed the observations of the 2 driven transect methods (Table *IV-3*). Doves did not forage in the interior of irrigated fields of alfalfa, barley, and corn or in juniper, grasslands, growing wheat fields, and wheat fields that were harvested the previous year and fallow during the current year.

Food Habits

Wheat had the highest mean percent frequency of occurrence and percent volume in both 1951-52 and 1992-93 (Table *IV-4*). Beeplant (*Cleome* sp.) was an important food item in 1951-52 and nearly dropped from use in 1992-93. Indices of similarity were 0.66, 0.33, 0.38, 0.47, and 0.40 for May, June, July, August, and September, respectively. The mean index for May, August, and September when doves were collected on the study site was 0.40, indicating a 60% change in species composition of food items.

Table *IV-3.* Data on foraging obtained by walking transects through habitats in agricultural and range land near Fillmore, Utah.

	1992		1993	
Habitat type	Km walked[a]	Doves seen[b]	Km walked[a]	Doves seen[b]
Alfalfa	18.1	0	20.3	0
Barley	4.1	0	1.8	0
Corn	0.09	0	0.0	0
Grass	9.6	0	11.6	0
Sagebrush	1.5	6	1.5	0
Feedpens	0.1	3	0.1	19
Weeds	0.08	5	0.1	2
Juniper	3.5	0	3.0	1
Wheat[c]	0.0		1.8	0
Old wheat stubble[d]	0.0		2.8	0
Harvested wheat[e]	0.0		.6	5

[a] Total distance walked through each habitat type during the season.

[b] Total number of mourning doves seen foraging in each habitat type for the season.

[c] Nonirrigated fields of growing winter wheat.

[d] Wheat fields that had been harvested the previous season and were fallow during the current season.

[e] Wheat fields that had been harvested during the current season.

Table 4. Monthly comparison of selected components of mourning dove diets between 51-52 and 92-93 near Fillmore, Utah. The percent frequency of occurrence of each food item is given over the percent of total volume.

Species	May **51-2** n=11	May **92-3** n=10	June[a] **51-2** n=10	June[a] **92-3** n=10	July[a] **51-2** n=12	July[a] **92-3** n=11	Aug **51-2** n=13	Aug **92-3** n=20	Sep **51-2** n=7	Sep **92-3** n=6	$\bar{x}$[b] **51-2** n=31	$\bar{x}$[b] **92-3** n=36
Wheat	45.5[c]	100	30.0	10.0	91.7[c]	63.6	84.6	65.0	51.1	66.7	65.1	72.2
	37.5	89.0	42.7	4.7	75.6	60.7	78.4	57.9	17.6	56.8	58.0	67.9
Sunflower	36.4	20.0	20.0		41.7		38.5	55.0	42.6	66.7	38.5	47.2
Helianthus sp.	40.7	4.9	0.4		2.3		9.5	6.6	30.0	15.4	26.7	9.0
Beeplant	36.4		50.0[c]		16.7			5.0	72.3[c]		36.2[c]	1.7
Cleome sp.	17.7		26.2		0.2			0.2	48.3		22.0	0.1
Pigweed	54.5	40.0	70.0[c]		41.7	9.1	69.2	20.0	38.3		54.0[c]	20.0
Amarantus spp.	0.5	2.1	18.7		0.1	0.8	8.6	0.1	0.4		3.2	0.7
Pricklepoppy	9.1	20.0			16.7	27.3	15.4	20.0	2.1	50.0	12.3	30.0
Argemone sp.	tr.	0.7			tr.	18.3	1.7	0.9	tr.	8.9	0.6	3.5
Knotweed	18.2				33.3		23.1		6.4		15.9[c]	
Polygonum spp.	0.4				0.2		0.7		tr.		0.4	
Rye			20.0	40.0		18.2		35.0		66.7		33.9[c]
			6.7	20.0		14.5		26.5		14.5		13.7

[a] 92-93 data for these months was collected outside the study area.

[b] Means of frequency of occurrence and % volume for May, August, and September.

[c] These pairs of % frequency of occurrence are significantly ($P < 0.05$) different based on Fisher exact test.

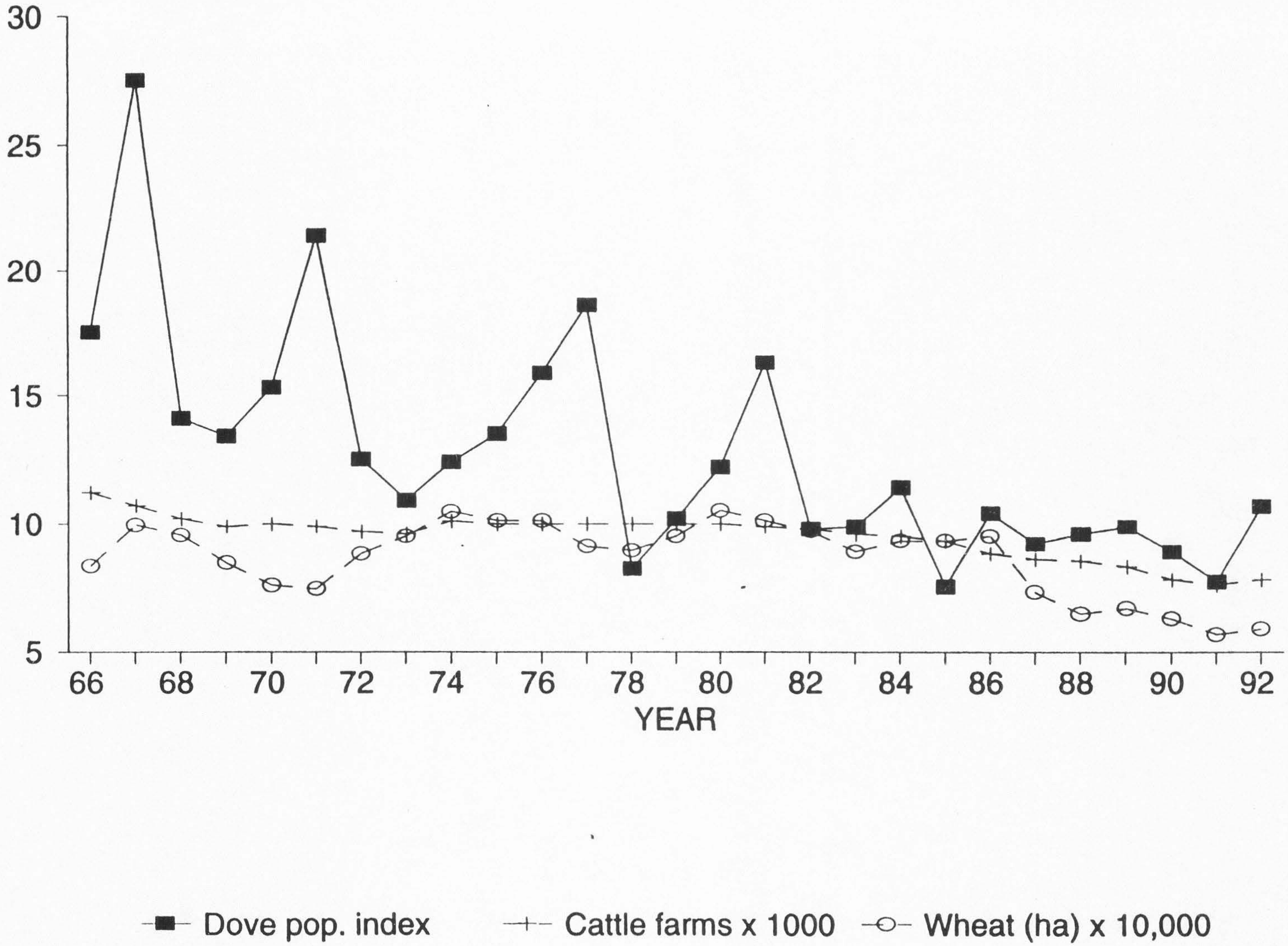
Statewide Population Decline

We compared statewide data on land area in winter wheat production, number of farms with cattle, and mourning dove population indices (Fig. *IV-3*). Regression of land area in winter wheat production as the independent variable (X_1) and the index of the Utah dove population as the dependent variable (Y) was not siginificant ($Y = .35X_1 + 5.24$, $r^2 = 0.08$, $P = 0.155$). We obtained siginificant results by replacing the independent variable (X_1) with the number of farms with cattle (X_2) ($Y = 3.12X_2 - 16.89$, $R^2 = 0.37$, $P = 0.001$). Multiple regression analysis of these data improved the r^2 value ($Y = - 0.48X_1 + 4.57X_2 - 20.42$, $R^2 = 0.44$, $P = 0.001$).

DISCUSSION

Dahlgren (1955) and Meyers et al. (P. M. Meyers, W. D. Ostrand, M. R. Conover, and J. A. Bissonette, Dept. of Fish. and Wildl., Ut. State Univ.,unpubl. data) found that doves nested in shrubby riparian vegetation. Our aerial photograph interpretation indicated that large changes in riparian habitat had not occurred. It is unlikely that change in nesting habitat had affected the local population.

The results of habitat use analyses indicated that recently harvested wheat fields, feedpens, weedy patches, and hay storage yards were used heavily by doves for foraging. A major reduction in the availability of any of these habitats could potentially contribute to the observed local population decline. Weedy patches within the study area occurred along roadside


30
25
20
15
10
5
66
68
70
72
74
76
78
80
82
84
86
88
90
92
YEAR
Dove pop. index
Cattle farms x 1000
Wheat (ha) x 10,000

ditches, abandoned railroad grades, and dredged irrigation ditches. Aerial photographs indicated that these landscape features had not changed in size since 1952. Hay storage yards are holding sites for alfalfa prior to shipping or use. Change in the size or number of hay storage yards could not be directly quantified from photographs; however, Millard County census data indicated an 81% increase of land in alfalfa production, suggesting a similar increase in hay storage yards was probable. Given these data we concluded that there does not appear to have been a decline in the number of weedy patches, or hay storage yards. Change in the number of feedpens could not be quantified from photographs; however, census data for Millard County indicated a 50% increase in cattle numbers and a 61% decrease in the number of farms with cattle, suggesting feedpen numbers have decreased while the ratio of animal/feedpen has increased. Land in winter wheat production has changed extensively.

Our food habits data indicated that wheat was still consumed in greatest frequency and volume. Hence mourning doves have not responded to the decline in wheat availability by switching to alternative food items. Wheat fields were used only by mourning doves from harvest in July to migration in September, yet Dahlgren's (1955) and our food habits data indicated that doves foraged on wheat during the entire season. When available, farmers in our study area used wheat for feed at feedpens. We observed that doves foraged at feedpens where wheat had been used particularly during the early part of the season when food availability was most limited. We expect that during Dahlgren's (1955) study when more wheat was grown and there were more feedpens, more was available to doves during the entire year.

Most wheat fields have been replaced by grass vegetation. Our data indicated that grass habitats are used little by mourning doves. We (W. D. Ostrand, J. A. Bissonette, M. R. Conover, Dept. of Fish. and Wildl., Ut. State Univ., unpubl. data) also found that the conversion of wheat fields to grass habitats resulted in structural changes rendering the land unavailable for foraging even when ample forage was present. Meyers et al. (P. M. Meyers, W. D. Ostrand, M. R. Conover, and J. A. Bissonette, Dept. of Fish. and Wildl., Ut. State Univ., unpubl. data) found that the onset of nesting at the Fillmore study site was 2 weeks later in 1992-93 than reported by Dahlgren (1955). They hypothesized that food/nutrient limitation or exposure to environmental toxins may have been responsible for the delayed nesting. The Fillmore studies indicate that wheat availability, either at harvested fields or at feedpens, was a probable contributor to the mourning dove population decline. Our statewide regression analysis suggests that a food limitation due to an interaction of decreased wheat production and a decrease in the number of cattle feed pens is probable.

MANAGEMENT AND RESEARCH IMPLICATIONS

We have presented extensive data showing a relationship between wheat availability, the number of feedpens, and a decline in dove population. Our work suggests that food availability may be a major limiting factor in population recovery. Increasing early season food availability by establishing feeding stations may increase recruitment. We suggest conducting such management/research with an experimental design and careful monitoring of mourning doves' fitness to provide quantification of effectiveness.

LITERATURE CITED

Anderson, D. R., J. L. Laake, B. R. Crain, and K. P. Burnham. 1979. Guidelines for line transect sampling of biological populations. J. Wildl. Manage. 43:70-78.

Armstrong, E. R., and D. L. G. Noakes. 1981. Food habits of mourning doves in southern Ontario. J. Wildl. Manage. 45:222-227.

Chesson J. 1978. Measuring preference in selective predation. Ecology 59:211-215.

Dahlgren, R. B. 1955. Factors affecting mourning dove populations in Utah. M.S. Thesis. Utah State Univ. Logan. 93pp.

Dolton, D. D. 1991. Mourning dove breeding population status, 1991. U.S. Fish Wildl. Serv., Laurel, Md. 14pp.

_____, and W. L. Kendall. 1993. Mourning dove breeding population status, 1993. U.S. Fish Wildl. Serv., Laurel, Md. 16pp.

Kiel, W. H. 1959. Mourning dove management units-a progress report. Spec. Sci. Rep.-Wildl. 42. U.S. Fish and Wildl. Serv., Washington, D.C. 24pp.

Lechowicz, M. J. 1982. The sampling characteristics of electivity indices. Oecologia 52:22-30.

Odum, E. P. 1971. Fundamentals of ecology. W. B. Saunders Co., Philadelphia, Pa. 574pp.

Reeves, H. M., R. E. Tomlinson, and J. C. Bartonek. 1993. Population characteristics and trends in the western management unit. Pages 341-378 in T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, Pa.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The breeding bird survey: its first fifteen years, 1965-1979. U.S. Fish Wildl. Serv., Resour. Publ. 157. U.S. Fish Wildl. Serv., Washington, D.C. 196pp.

Tomlinson, R. E., D. D. Dolton, H. M. Reeves, J. D. Nichols, and L. A. McKebben. 1988. Migration, harvest, and population characteristics of mourning doves banded in the western management unit: 1964-1977. Fish and Wildl. Tech. Rep. 13, U.S. Fish Wildl. Serv., Washington, D.C. 101pp.

U.S. Bureau of the Census. 1952. 1950 census of the population, characteristics of the population, Utah, vol. II, part 44. U. S. Gov. Printing Off., Washington, D.C. 154pp.

_____. 1956. 1954 U.S. census of agriculture, Utah and Nevada, vol. I, part 31. U. S. Gov. Printing Off., Washington, D.C. 224pp.

_____. 1989. 1987 census of agriculture, Utah, vol. I, part 44. U. S. Gov. Printing Off., Washington, D.C. 241pp.

_____. 1992. 1990 census of population, general population characteristics, Utah. U. S. Gov. Printing Off., Washington, D.C. 235pp.

Utah Department of Agriculture. 1973. 1973 Utah agricultural statistics. Utah Dept. of Agriculture, Salt Lake City. 120pp.

_____. 1979. 1979 Utah agricultural statistics. Utah Dept. of Agriculture, Salt Lake City. 102pp.

_____. 1985. 1985 Utah agricultural statistics. Utah Dept. of Agriculture, Salt Lake City. 100pp.

_____. 1988. 1988 Utah agricultural statistics. Utah Dept. of Agriculture, Salt Lake City. 117pp.

_____. 1992. 1992 Utah agricultural statistics. Utah Dept. of Agriculture, Salt Lake City. 141pp.

_____. 1993. 1993 Utah agricultural statistics. Utah Dept. of Agriculture, Salt Lake City. 139pp.

Wilkinson, L. 1990. SYSTAT (user's manual). Vol. 1-4. SYSTAT, Inc., Evanston, Ill. 677pp.

Zar, J. H. 1984. Biostatistical analysis. Prentice-Hall Inc., Englewood Cliffs, N.J. 717pp.

CHAPTER V

SUMMARY

We found no evidence of an epizootic of trichomoniasis occurring in the Fillmore study area. Our observed frequencies of infection were within the range reported in other studies. We observed a higher incidence of infection among hatching-year doves, which is also consistent with previously reported levels in nonepizootic populations. We concluded that trichomoniasis was not contributing to the Fillmore mourning dove population decline.

We conducted manipulations of foraging habitat and found a significant relationship between structure and foraging site selection by mourning doves. Doves discriminated between the control plots versus treatment plots, with less clear differences exhibited between treatments. Avoidance of the control plots may have been due to the taller and denser grass that impaired escape from predators by flight, impaired food detection and collection, or a combination of these 2 factors.

In our study area, most wheat fields have been replaced with fallow grasslands that we used as the control in our experiment. Our treatments structurally resembled harvested wheat fields. Our experiment showed that doves selected habitats with shorter and less dense vegetation and when food was present. These results suggest that conversion of wheat fields to grass has resulted in a structural change in habitat that renders it unsuitable for foraging by mourning doves. Hence mourning doves may be one avian species that has been hurt by the conversion of cultivated wheat fields into grasslands.

The results of habitat use analyses indicated that recently harvested wheat fields, feedpens, weedy patches, and hay storage yards were used heavily by doves for foraging. From available data we concluded that there does not appear to have been a decline in the number of weedy patches, or hay storage yards. Of the habitat types identified as important to mourning doves, area in wheat production and the number of feedpens have changed extensively. Our food habits data, and Dahlgren's, indicated that wheat was consumed in greatest frequency and volume. Mourning doves have not responded to the decline in wheat availability by switching to alternative food items.

Wheat fields were used only by mourning doves from harvest in July, to migration in September, yet our food habits data indicated that doves foraged on wheat during the entire season. Farmers in our study area used wheat, when available, for feed at feedpens. We observed that doves foraged at feedpens where wheat had been used. We expect that during Dahlgren's study, when more wheat was grown and there were more feedpens, more wheat was available to doves during the entire year.

Most wheat fields have been replaced by grass vegetation. Our data indicated that grass habitats are used little by mourning doves. We also found that the conversion of wheat fields to grass habitats resulted in structural changes rendering the land unavailable for foraging even when ample forage was present. Our study indicates that wheat availability, either in fields or feedpens, was a probable factor in the local mourning dove population decline. We used multiple regression analysis to determine if our findings could be extended statewide and we found a significant relationship between the statewide mourning dove population index, land in winter wheat production, and the number of farms with cattle.

APPENDIX. PERMISSION TO USE MATERIAL DOCUMENTATION

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WILDLIFE DISEASE ASSOCIATION FOUNDED 1951

JOURNAL OF WILDLIFE DISEASES

7 December, 1994

Dr. William Ostrand
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Re: Manuscript No. 4758

Dear Dr. Ostrand:

Pursuant to our telephone conversation of 7 December 1994, you have permission to use the article "Trichomoniasis as a factor in mourning dove population decline in Utah" by Ostrand et al. as part of your thesis. The article is scheduled for publication in the January 1995 issue (Vol. 31, No. 1) of the Journal of Wildlife Diseases. Please acknowledge publication of the manuscript in the Journal of Wildlife Diseases in your thesis.

Thank you for your attention to this matter.

Sincerely,

Richard G. Botzler

RGB/ls

12 December 1994

I grant permission for William D. Ostrand to include the chapter entitled "Changes in Habitat as a Factor in Mourning Dove Population Decline in Utah" in his M.S. Thesis.

Paul M. Meyers