J. Field Ornithol., 69(2):192–200

CHANGES IN LAND USE AS A POSSIBLE FACTOR IN MOURNING DOVE POPULATION DECLINE IN CENTRAL UTAH

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Abstract.—Mourning Dove (*Zenaida macroura*) population indices for the western United States have declined significantly since 1966. Based on data collected in 1951–1952, in Fillmore, Utah, we examined whether there had been a local decline in the dove population index since the original data were collected. We then determined whether habitat had been altered, identified which foraging habitats doves preferred, and assessed whether changes in land use could be responsible, in part, for a decline in the local population index. We found that dove population indices declined 72% and 82% from 1952–1992 and 1952–1993, respectively. The most dramatic change in habitat was an 82% decline in land devoted to dry land winter wheat production and a decline in livestock feed pens. Doves foraged primarily in harvested wheat fields, feed pens, and weedy patches. We hypothesize that a decrease in wheat availability during the spring and the consolidation of the livestock industry have contributed to a population decline of Mourning Doves in central Utah.

CAMBIOS EN EL USO DE TERRENOS COMO POSIBLE FACTOR EN EL DESCENSO POBLACIONAL DE *ZENAIDA MACROURA* EN LA PARTE CENTRAL DE UTAH

Sinopsis.—Los indices poblacionales de la tórtola *Zenaida macroura* se han reducido significativamente desde el 1966. Basados en datos básicos tomados entre 1951–1952 en Fillmore, Utah, examinamos si habia ocurrido una reducción local en la poblacion de del área. Luego identificamos que habitats preferian las tortolas para alimentarse, determinamos si el habitat habia sido alterado y evaluamos si los cambios podian ser los responsables del descenso de los indices de la poblacion local. Encontramos que los indices poblacionales se redujeron en 72% y 82% desde 1952–1992 y 1952–1993, respectivamente. El cambio mas dramatico en el habitat fue una reduccion de 82% en los terrenos utilizados para la produccion de trigo invernal y una reduccion en los comederos para ganado. Las tortolas forajean principalmente en campos de trigos cosechados, comederos de ganado y parches con yerbajos. Es nuestra hipotesis, que la reduccion en la disponibilidad de trigo durante la primavera y la consolidación de la industria de la ganaderia han contribuido al descenso de la poblacion de tortolas en la parte central de Utah.

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 at 475 million individuals (Tomlinson et al. 1988). However, the U.S. Fish and Wildlife Service's Mourning Dove call-count survey indicates that there has been a significant decline in population indices in the western United States since 1966 (Dolton and Kendall

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1993). Causes for the decline are unknown (Dolton 1991), but loss of nesting habitat, changes in agricultural practices, pesticides, environmental toxins, disease, and excessive hunting have been suggested as possible factors (Reeves et al. 1993).

Dahlgren's (1955) study, of Mourning Doves in Fillmore, Utah in 1951–1952, provided us the opportunity to compare current populations and habitat with those that existed before documentation of the dove population decline (Dolton and Kendall 1993). Dahlgren (1955) investigated a number of parameters including population index, reproductive success, nest-site selection and availability, and food habits. We examined changes in the dove population index in the study area and the possible association with changes in land use. Our objectives were to: (1) determine whether the local dove population index had declined, (2) quantify habitat changes and, (3) identify habitats selected by Mourning Doves for foraging.

STUDY AREA

This study was conducted in a 5080-ha area in eastern Millard County, Utah and included the community of Fillmore. This area encompassed the sites where Dalhgren (1955) conducted his study. Elevation at Fillmore was 1740 m with several small hills rising from the flat valley floor. Native vegetation was dominated by juniper (*Juniperus utahensis*), sagebrush (*Artemisia* spp.), yellow-brush (*Chrysothamnus* spp.), cheatgrass (*Bromus tectorum*), and Russian-thistle (*Salsola kali*) (Dahlgren 1955). Major agricultural crops were alfalfa and wheat on irrigated and non-irrigated land, respectively. Land planted in wheat has decreased greatly since 1951 and has been replaced by fallow grasslands (U.S. Dept. Agri. Soil Conserv. Serv., Millard Co. Off., Utah, unpubl. data) dominated by introduced species, common rye (*Secale cereale*), and tall wheatgrass (*Thinopyrum elongatum*) (Ostrand 1994).

METHODS

Human population and agricultural changes.—We obtained data on the human population of Millard County and Fillmore, Utah from U.S. Census publications (U.S. Bur. Census 1956, 1992). Agricultural data were obtained from U.S. Census (U.S. Bur. Census 1952, 1989) and Utah Department of Agriculture reports (Utah Dept. Agric. 1992).

Land use and habitat changes.—Dahlgren (1955) did not attempt to map or describe the landscape of the study area. We used aerial photographs taken in 1952 by the U.S. Department of Agriculture's Agricultural Stabilization and Conservation Service to identify earlier habitat conditions and compared these with photographs taken in 1993. We conducted extensive ground-truthing to confirm the interpretation of the 1993 photographs. Photographs from 1952 could not be ground truthed. However, by using the habitat interpretation derived from the 1993 photographs we were able to develop a comparative classification of the 1952 photo-

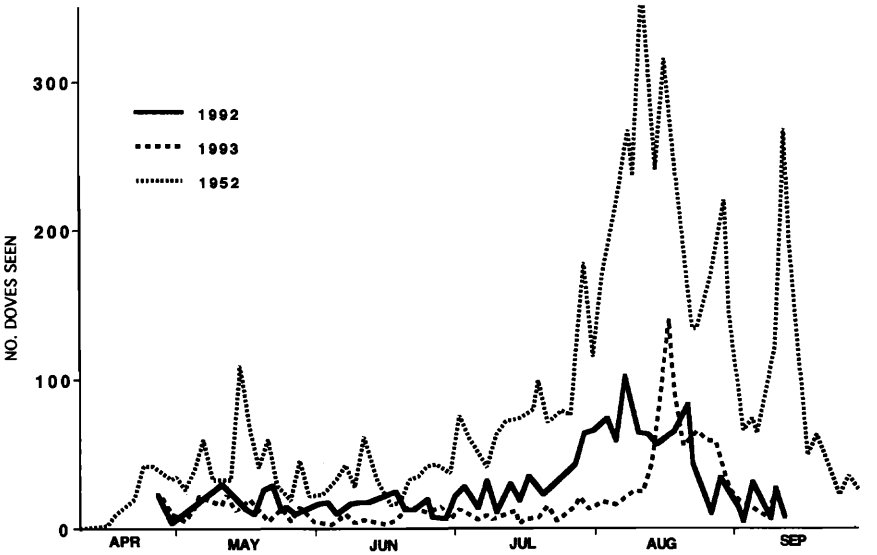

FIGURE 1. Dove population index data from 1952, 1992, and 1993 for the Fillmore, Utah, study site. Data have been smoothed with a running average.

graphs. We transferred data from both 1993 and 1952 photographs to 1: 24,000 base maps, which were digitized.

Study site population index.—We replicated Dahlgren's (1955) population studies. His methods were similar to the standard annual calling counts overseen by the U.S. Fish and Wildlife Service (Dolton 1991), except that Dahlgren (1955) and our study conducted only three listening stops, rather than 20, along a single 36-km road transect. We used the same transect route and stopped at the same locations as Dahlgren (1955). Because of the small number of listening stops per transect, we did not compare calling data. Our comparisons were based on the total number of doves seen while driving and while at listening stops. Counts were conducted three times/wk beginning 27 Apr. 1992 and 28 Apr. 1993 and ending 11 Sep. 1992 and 9 Sep. 1993. With the exception of four counts, all data were collected by the same individual. We replicated the transect counts 54 times each season. Dahlgren (1955) sampled earlier and later in the season than we did because doves were present in the study area longer. We compared Dahlgren's (1955) data for the entire season with ours by computing the area under the line drawings that represent count data plotted over time for each year (Fig. 1). Areas were compared as percent change among years.

Habitat selection.—We characterized the habitat where each dove was observed during the last 37 population-index transects in 1992 and the last 36 in 1993 and calculated Chesson's alpha resource selection indices, a normalized ratio of proportional use/proportional availability (Chesson

1978, Lechowicz 1982). Data from early season transects were not used to calculate selection indices because of inadequate sample sizes (Lechowicz 1982).

In a separate transect study focusing on foraging, we established a 13.3-km driving transect (Anderson et al. 1979) to observe selection of foraging habitat. We selected the driving transect from the available road system to sample the greatest possible area of the available habitat within the study area. We drove 1–16 km/h and counted only doves seen on the ground, which we assumed were foraging. We stopped when necessary to confirm identification of either birds or habitat. In 1992, we drove this transect three times/wk, with a morning, midday, and late afternoon replicate. We sampled from 2 June–4 September and obtained 21 replicates. In 1993, we extended the transect 6.2 km to include more non-irrigated winter wheat fields, sagebrush, and juniper habitats. Non-irrigated winter wheat was planted biannually with a fallow season separating years of production. Depending on the individual grower, winter wheat fields may have remained in stubble for a year following harvest or may have been disced shortly after harvest. In contrast, the irrigated spring wheat fields were planted, harvested, burned, and disced annually. This transect was driven twice/wk, with a morning and afternoon replicate. Four replicates preceded the wheat harvest, 7–29 July, and eight followed, 29 July–31 August. Data from 1992 were summed to obtain the number of birds observed foraging in each habitat. We analyzed the 1993 data as pre- and post-winter wheat harvest data sets.

We established walking transects to determine if doves used the interior of habitat patches differently than the edges we observed during roadside counts. This method also allowed us to search intensively for doves in habitats in which they were less observable because of dense vegetation. Transects were chosen by defining several possible lines that would sample the desired habitats and then randomly selecting among the possible transects. Two transects through irrigated agricultural fields (4.0 km) and a third through sagebrush, juniper, and grass vegetation (0.8 km) were repeated six times each season, 9 Jun.–2 Sep. 1992 and 16 May–12 Aug. 1993. In 1993, we added two transects (1.8 km) to include more non-irrigated winter wheat and grassland vegetation. We sampled these last two transects five times.

We collected data on habitat availability for all transects by measuring the linear distance each habitat was intersected by a transect. Total doves per habitat were determined for each execution of the population index transect. We summed foraging transect data for the season and used Chesson's alpha to calculate a season electivity (Chesson 1978, Lechowicz 1982). Values $>1/n$ (n = no. of habitats) indicated preference; values $<1/n$ indicated 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

TABLE 1. Land use (ha), as determined by aerial photo interpretation, of the study site located near Fillmore, Utah, in 1950 and 1993.

Land use	1950	1993
Non-irrigated winter wheat	1378	184
Sagebrush	1041	368
Irrigated crops	899	483
Juniper	378	378
Urban	255	310
Grassland	1129	3357
Total	5080	5080

presented as distance walked through each habitat type and the total number of birds seen foraging in each habitat.

RESULTS

Changes in human population and agriculture.—The number of humans in Fillmore increased 3% from 1950 to 1990. Total farmland changed little (from 198,942 to 194,400 ha), but land planted in non-irrigated winter wheat dropped 82% (from 13,376 to 2,430 ha) and the number of farms with cattle dropped 61% (from 933 to 367). During the same period, cattle numbers increased from 36,637 to 55,000; land under irrigation and in alfalfa also increased.

Changes in land use and habitat in the study site.—Our interpretation of aerial photographs indicated the greatest change in land use was conversion of dry land wheat fields to grasslands (Table 1). Total km of riparian vegetation, used for nesting by doves (Dahlgren 1955), did not change. Little change 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 ditches (0 km in 1950 vs. 0.2 km in 1993).

Changes in the Mourning Dove population index on the study site.—Dove counts for 1992 and 1993 were consistently below those of 1952 (Fig. 1). Declines were 72% and 82% for 1952–1992 and 1952–1993, respectively.

Habitat selection.—The population index transect data indicated that doves frequented livestock feed pens during the first part of the 1992 season and switched in mid-July to newly harvested fields of irrigated spring wheat (Fig. 2). Indices for all other habitats indicated non-selection most of the season. The peak number of doves observed coincided with the irrigated spring wheat harvest (Fig. 1). In 1993, a wet spring (U.S. Dept. Agri. Soil Conserv. Serv., Millard Co. Off., Utah, unpubl. data) 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 no longer used. Weeds growing in disturbed patches and ditches consistently attracted doves.

Chesson's alpha (Chesson 1978, Lechowicz 1982) values calculated

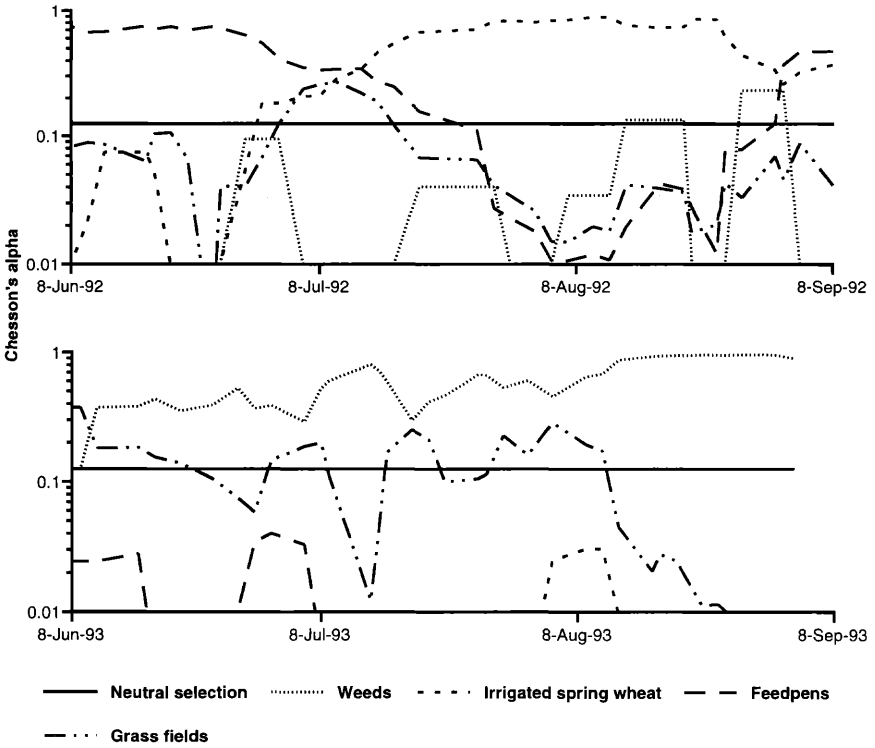

FIGURE 2. Habitat selection during 1992 and 1993, calculated using Chesson's alpha. Data were obtained by observing the habitats where mourning doves were seen during population index transects in agricultural and rangeland near Fillmore, Utah. Data have been smoothed with a running average.

from foraging transect data for hay storage yards, feedpens, weeds, and sagebrush during 1992 were 0.67, 0.20, 0.10, and 0.01 respectively. Values >0.14 indicated selection. We observed negligible foraging in grass irrigated crops, and trees and shrubs. Non-irrigated winter wheat fields were not sampled in 1992. Pre- and post-wheat harvest values calculated from 1993 data were 0.0, 0.37; 0.86, 0.44; and 0.13, 0.21 for wheat, feed pens, and weedy patches, respectively. Values >0.11 indicated selection. While surveying these transects we observed little foraging in hay storage yards, sagebrush, irrigated crops, grass, trees and shrubs, and juniper.

Walking transects confirmed observations of the two driven transect methods (Table 2). Doves were not observed foraging in juniper stands, grasslands, growing wheat fields, and fallow wheat fields harvested the previous year, or in the interior of alfalfa, barley and corn fields.

DISCUSSION

We realize that our data describe two point estimates made 40 years apart that may provide a incomplete picture of changes in habitat or

TABLE 2. Data on foraging obtained on walking transects through habitats in agricultural and rangeland near Fillmore, Utah, 1992 and 1993.

Habitat type	1992		1993	
	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	0.1	0	0.0	0
Grass	9.6	0	11.6	0
Sagebrush	1.5	6	1.5	0
Feed pens	0.1	3	0.1	19
Weeds	0.1	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		0.6	5

[a] Distance walked through each habitat type during the season.
[b] No. of Mourning Doves seen foraging in each habitat type for the season.
[c] Non-irrigated fields of growing winter wheat.
[d] Non-irrigated winter 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.

population indices. This information is provided as a basis for formulating future hypotheses for experimental research. Furthermore we cannot discount that local populations declines are due to factors that are occurring at courser scales, and that the apparent local relationship between habitat change and dove populations is coincidental. However, local changes that have occurred are extensive. In 1992–1993, dove counts in the study site were only a fraction of the number observed there during Dahlgren's (1955) study and similar change has occurred in available foraging habitat.

Dahlgren (1955) and Meyers (1995) found that doves nested in shrubby riparian vegetation and that ground nesting was infrequent. Our interpretation of aerial photography indicated that major changes in riparian habitat have not occurred. Thus, it is unlikely that changes in nesting habitat has caused the apparent decline in local population index.

A reduction in the availability of foraging habitats could potentially contribute to the observed local decline in the population index. We found that weedy patches, recently harvested wheat fields, and feed pens were used heavily by doves for foraging. Weedy patches within the study area occurred along roadside ditches, abandoned railroad grades, and dredged irrigation ditches. During 1993, coincidental with a wet Spring, weed growth was vigorous and our data from our population-index transect indicated preferential use of this habitat. Aerial photographs indicated that these landscape features had not changed in extent and location since 1952. Although weeds may contribute greatly to available forage during years when they produce an abundant seed crop, the lack of

change in extent suggests that this habitat is not associated with the local population decline. Land in non-irrigated winter wheat declined since the 1950s and is a possible factor in the decline in the population index. The change in the number of feed pens could not be quantified from photographs. However, census data for Millard County (U.S. Bur. Census 1952, 1989, Utah Dept. Agric. 1992) indicated a 50% increase in cattle numbers and a 61% decrease in the number of farms with cattle, suggesting that feed pen numbers may have decreased while the ratio of animals/feed pen has increased.

Our foraging transect data indicates that Mourning Doves forage in non-irrigated winter wheat fields from harvest in July to migration in September, yet Dahlgren's (1955) study indicated that doves foraged on wheat during the entire season. This apparent disparity can be explained by our observations that doves foraged at feed pens where wheat had been used as livestock forage, 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 feed pens, more wheat was available to doves throughout the year. Most wheat fields have been replaced by fallow grassland. Our data indicate that grass habitats were little used by Mourning Doves. The conversion of wheat fields to grass habitats resulted in structural changes rendering the land less available to foraging by doves even when ample food was present (Ostrand 1996). The Mourning Dove population index may have been adversely affected by the conversion of cultivated land into grassland.

Rather than causing adult mortality, a shortage of wheat in the spring at feed pens may be limiting dove populations by reducing their reproductive potential. Meyers (1995) found that the onset of nesting at the Fillmore study site was 5–10 days later in 1992 and 1993 than reported by Dahlgren (1955), and that dove productivity was lower. Food and nutrient limitation or exposure to environmental toxins may have been responsible for the delayed nesting (Meyers 1995). Because doves are multibrooded, a delay in initiating egg production could cause a decrease in the number of young a pair could fledge yearly.

ACKNOWLEDGMENTS

We thank individuals who provided assistance throughout this study. Funding 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 logistic support in Fillmore. S. L. Durham gave advice on statistical analyses. P. E. Budy composed graphics. This paper was substantially improved by review comments from G. S. Drew, D. E. Miller, and J. H. Schulz.

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Received 20 Sep. 1996, accepted 14 Feb. 1997.