COLORADO PARKS & WILDLIFE

Mourning Dove Studies in Colorado, 1964–1974

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COVER PHOTOS

Top: Mourning dove (Jim Gammonley)

Bottom, left to right: 1) adult mourning dove about to be banded, 2) doves in a baited trap, 3) wing of an immature dove, 4) dove with leg band (Jim Gammonley)

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MOURNING DOVE STUDIES IN COLORADO, 1964-1974

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EXECUTIVE SUMMARY

Mourning doves (*Zenaida macroura*) were trapped and banded in Colorado through a cooperative state and federal program from 1964 through 1974. Primary objectives were to investigate migration patterns and mortality rates. We trapped and banded 31,523 doves, mostly free flying, in the study interval, whereas only 2,702 had been banded prior to 1964 (1913-1963). Distribution of bandings in the 1964-1974 interval was about 6,800 on the eastern prairies, 6,200 west of the Continental Divide, and about 18,500 along the foothills and intermountain valleys east of the Continental Divide. Adult males outnumbered females (57 to 43%) in trap samples, while age ratios of adults and immatures were similar (51 to 49%, respectively). Recaptures of previously banded birds were few and contributed little to overall understanding of migration paths and mortality rates. Chronology of hatching was compared between those immatures trapped and banded (14,560) and those for which wings were collected from hunters (4,792). Most early hatched young were not available to hunters during the hunting season in Colorado. Migration of early hatched young before 1 September was documented.

Age ratios in the harvest approximated 1.4 immatures per adult or 2.8 young per adult female. Hunter numbers and harvest greatly increased during the 1964-1974 period although probably not as much as indicated by the annual state survey of small game license purchasers. Analysis of 691 recoveries of doves banded in Colorado (52 from bandings in the 1913-1963 interval, 639 from bandings in the 1964-1974 period) revealed that most (451) were from within the Central Management Unit (C.M.U.) with smaller numbers (154) from other countries, and other management units (W.M.U. = 32, E.M.U. = 2). Mexico, primarily the states of Jalisco and Michoacan, was the major recovery area for non-United States recoveries (149 of 154). Colorado was the leading recovery state (352) within the United States followed by Texas (48), New Mexico (44), Arizona (18), and California (10). No more than three recoveries were reported from any other state or country. Recoveries of doves banded west of the Continental Divide were primarily to the southwest, while those banded east of the Continental Divide were recovered primarily to the south-southwest. Doves banded outside of Colorado comprised about 20% of the annual number of recoveries reported within Colorado. Most of these doves originated north and northeast of Colorado with Montana being the major state of origin. About 14% of the doves recovered in Colorado from out of state bandings were from states other than those in the Central Management Unit. Most (10 of 12) of these doves originated in the Western Management Unit. Recovery rates of doves banded in Colorado varied from 0.07 to 2.5%, depending upon age, sex, and location banded. Calculated survival rates were 34.4% for nestlings, 52.8% for immatures, and 57.0% for adults. Adult females (58.3%) had a higher survival rate than adult males (55.5%). Doves banded west of the Continental Divide had substantially lower recovery rates but similar survival rates to those banded east of the Continental Divide.

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ACKNOWLEDGMENTS

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J. Edward Kautz and H. Milt Reeves critically reviewed early drafts of the manuscript and made helpful suggestions for its improvement. Mark E. Seamans improved the sections on survival and mortality rates using current methods of analysis. James H. Gammonley, Avian Research Leader, facilitated the publication of this Special Report. We appreciate his help in making this publication possible. This is a contribution from Federal Aid to Wildlife Restoration Project W-88-R.

INTRODUCTION

Mourning doves are important migratory game birds throughout much of North America as they are widely distributed and occur in huntable numbers in most of their range (Peters 1961, Keeler 1977). This species nests throughout Colorado, primarily below 8,600 ft elevation (Bailey and Niedrach 1965) and occurs from above timberline (C.E. Braun, personal observation) to river bottoms, prairies, sagebrush (*Artemisia* spp.) semi-deserts, croplands, and urban areas during spring and fall migration. Little was known prior to this study of the timing of nesting, migration paths, wintering areas, harvest patterns, and survival and mortality rates of doves seasonally resident in Colorado. Previous studies in Colorado (Funk 1965) emphasized timing of late summer and fall migration of doves through the state. This study was initiated in 1964 because of the need to more fully understand the biology of this species. Cooperative banding studies throughout the Central Management Unit as delineated by Kiel (1959) did not get underway until after 1967 (Dunks et al. 1982). This report summarizes all banding and recovery data in two periods, 1913-1963 and 1964-1976, trapping and banding data from 1964-1974, and derived hatching dates from bandings and harvest collections from 1964 through 1974.

METHODS

Mourning doves were trapped in locations where they concentrated, including livestock feeding areas, fallow fields, edges of little used roads, harvested grain fields, near watering areas, and adjacent to roosting areas. Most doves were captured through use of 3 ft^2 cage type, welded wire funnel traps similar to the modified Kniffin dove trap described by Reeves et al. (1968) (Fig. 1). A few doves were captured though use of cannon nets (Braun 1976) incidental to capture of band-tailed pigeons (*Patagioenas fasciata*). Some doves were captured prior to 1967 in mist nets following procedures described by Reeves et al. (1968). Most doves captured were free flying but, prior to 1967, small numbers of nestlings were banded. Bait used to attract doves varied with site, but wheat (*Triticum aestivum*), millet (*Panicum* spp.), and milo (*Sorghum vulgare*) were most frequently used. Wheat appeared to attract doves more readily in most areas of the state.

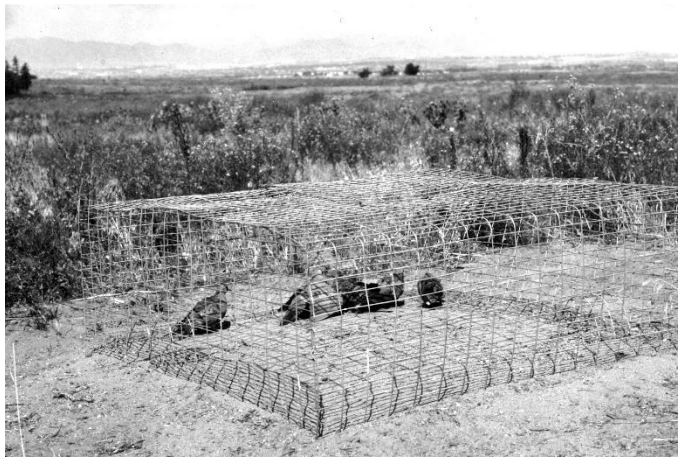

Figure 1. Mourning doves in Funnel Trap (Photograph by Ron Oakleaf).

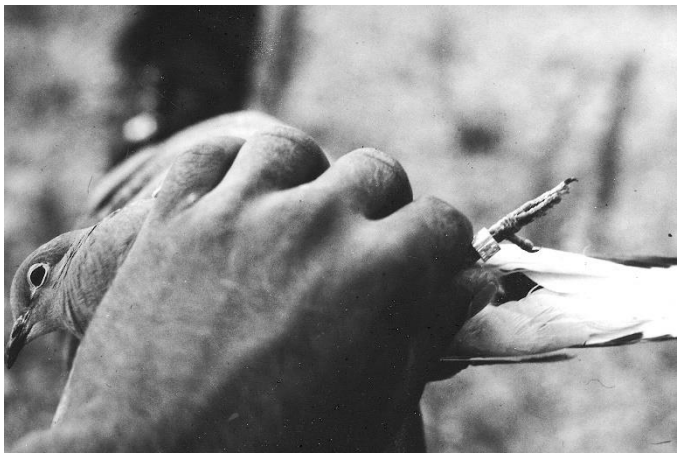

Figure 2. Mourning dove with band (Photograph by Ron Oakleaf).

All doves trapped were banded (Fig. 2) with U.S. Fish and Wildlife Service (now U.S. Geological Survey) bands, size 3A, except in 1974 when some size 3 bands were used. Doves were classified to age (HY = hatch year, or immature [Fig. 3, 4]; AHY = after hatch year, or adult

Figure 3. Immature mourning dove (Photograph by Clait E. Braun).

Table 1. Numbers of Local (hatchlings not yet fledged), immature (HY), and adult (AHY) mourning doves (U = unknown sex, M = male, F = female, Unknown = unknown age and sex) banded in Colorado, 1913-1974.

Interval	Local U	HY U	HY M	HY F	AHY U	AHY M	AHY F	Unknown	Total
1913-1920	0	0	0	0	1	0	0	0	1
1921-1930	110	26	0	0	5	5	6	4	156
1931-1940	0	6	0	0	8	1	1	1	17
1941-1950	46	2	0	0	23	2	1	1	75
1951-1960	1,136	578	0	0	296	11	2	73	2,096
1961-1963	234	7	0	0	16	8	3	89	357
Subtotal	1,526	619	0	0	349	27	13	168	2,702
1964	18	210	0	1	3	44	16	3	295
1965	13	701	0	0	4	59	25	6	808
1966	7	153	0	0	4	23	30	3	220
1967	14	1,180	0	1	19	637	378	3	2,232
1968	10	1,463	46	3	11	486	480	2	2,501
1969	40	1,056	23	10	8	1,363	890	0	3,390
1970	235	1,363	7	11	3	816	692	32	3,159
1971	107	2,475	2	1	8	1,572	1,191	0	5,356
1972	49	2,357	0	0	1	1,255	971	0	4,633
1973	0	1,764	28	31	7	1,341	1,150	88	4,409
1974	2	1,853	55	126	6	1,407	1,065	6	4,520
Subtotal	495	14,575	161	184	74	9,003	6,888	143	31,523
Total	2,021	15,194	161	184	423	9,030	6,901	411	34,225

[Fig. 5]) and sex (adult male and female, and a few immatures molting past primary 3) (Reeves et al. 1968). A few adults were classified as unknown sex each year. The primary flight feather molt of most immature doves banded was recorded for estimation of hatching dates (Allen 1963). Each year doves were trapped primarily in the June through mid-August period with goals of 1,000 birds in the eastern prairies, 2,000 along the foothills and intermountain valleys east of the Continental Divide, and 1,000 west of the Continental Divide (Ruos 1968). Colorado had a suggested quota of 2,000 birds per year prior to 1969 (Wight 1963). Collections of wings of hunter-harvested doves were made in some years to ascertain age ratios in the harvest and hatching dates of immature birds.

Distribution of recoveries and recaptures from all Colorado bandings for the 1913-1963 and 1964-1974 periods was ascertained from recovery cards obtained from the Bird Banding Laboratory, U.S. Fish and Wildlife Service (now U.S. Geological Survey), Laurel, Maryland. Records of recoveries and recaptures from doves banded outside of Colorado but recovered within the state were also obtained from the Bird Banding Laboratory. Distribution of recoveries and recaptures were grouped by dove management unit (Central, Eastern, or Western) and state.

Analysis of survival and mortality rates for doves banded in Colorado was by the relative recovery rate method (Geis 1972) for comparison with earlier studies. In addition, a live-dead recovery model (Seber 1970) was used to estimate annual survival and recovery probability. Mourning dove banding and recovery data collected in Colorado from 1967 to 1974 were used to estimate survival. Only individuals identified to age (HY or AHY) and captured and initially banded in July or August each year were used in the analysis. Program MARK (White and Burnham 1999) was used for model building and parameter estimation. A suite of competing models was developed that incorporated the following sources of variation in survival and recovery probability: individual (age; HY or AHY); spatial (banding location east or west of the Continental Divide); and temporal (constant, annual differences with no pattern, log-linear trend, and linear trend). The plausibility of models was compared using Akaike's information criterion (AIC; Burnham and Anderson 1998). Model averaging (Burnham and

Anderson 1998) was used for multi-model inference and to incorporate model selection uncertainty in estimator sampling variance.

Estimates of hunter numbers and harvest were obtained from annual state harvest surveys conducted by the Colorado Division of Wildlife (CDOW, now Colorado Parks and Wildlife).

BANDING TOTALS

Banding of mourning doves in Colorado was first reported in 1913 when one dove was banded. Through 1963, 2,702 doves were reported banded in Colorado while 31,523 were banded in the 1964-1974 period (Table 1). Most trapping and banding of doves was conducted by personnel of CDOW (24,408) and U.S. Fish and Wildlife Service (8,723) with > 100 doves being banded by only two other Federal permit holders, R. A. Ryder with 236 and D. A. Hein with 212, both of Colorado State University. The remaining 646 doves banded were by 42 different permittees over a 63-year period.

Geographic Area of Banding

Trapping and banding efforts for mourning doves were not uniform by geographic area or by time intervals. The suggested quotas of 1,000 doves west of the Continental Divide (sites at Arboles, Buford, Carbondale, and Craig) starting in 1968 were not met prior to 1971 (Table 2). Mourning doves were banded at many sites in the 1964-1974 interval but a relatively small number of sites produced the majority of those banded. Major sites

Table 2. Number of mourning doves banded by geographic area and year, 1964-1974 (CDOW and U.S. Fish and Wildlife Service only).

Year	Eastern Prairies	Foothills/Valleys east of the Continental Divide	West of the Continental Divide
1964	226	48	0
1965	105	679	0
1966	0	199	0
1967	761	1,373	0
1968	1,217	1,119	0
1969	477	2,114	703
1970	480	1,876	527
1971	1,000	2,756	1,477
1972	944	2,465	1,146
1973	780	2,619	1,000
1974	900	2,399	1,200
Totals	6,890	17,647	6,053

Table 3. Major mourning dove trapping areas in Colorado, 1964-1974 (CDOW and U.S. Fish and Wildlife Service only, excludes sites with <100 doves banded).

Eastern Prairies			Foothills and Valleys East of the Continental Divide			West of the Continental Divide		
Location	Number Banded	Years Banded	Location	Number Banded	Years Banded	Location	Number Banded	Years Banded
Vineland	3,481	8	Denver	5,984	10	Durango	2,435	6
Fort Morgan	2,810	7	Fort Collins	5,052	8	Montrose	1,632	4
Springfield	354	3	Fort Garland	2,787	5	Craig	871	4
Rocky Ford	171	4	Monte Vista	2,680	6	Meeker	733	4
			Fort Carson	468	2	Unaweep	358	2
			Longmont	318	4			
			Salida	303	5			

trapped, number of years, and number of doves banded varied (Table 3).

Age and Sex of Banded Doves

Attention was given to attaining even age (AHY, HY) and sex (AHY only) ratios in the banded samples once trapping and banding efforts intensified. However, due to time and personnel constraints, banded samples were frequently biased towards adults at some sites (trapped in June) and immatures at others (trapped in late July and August). Thus, age and sex composition of banded samples combined for all years at each site and geographic area varied (Table 4).

Differences in sex and age composition between locations within geographic areas were occasionally significant ($P < 0.05$). However, it is doubtful that differences in sex composition of the trapped samples

Table 4. Age and sex composition of banded samples of mourning doves by geographic area and location in Colorado, 1964-1974 (CDOW and U.S. Fish and Wildlife Service only). Totals by area may not correspond to those in Table 3 as doves not classified by sex (adults only) and age are not included.

	After Hatch Year (AHY)						Hatch Year (HY)		Total
Geographic Area and Location	Male[1]	%[2]	Female[3]	%[4]	Total	%[5]	Number	%[6]	Banded
Eastern Prairies									
Vineland	804	50.4	792	49.6	1,596	47.0	1,797	53.0	3,393
Fort Morgan	335	43.0	444	57.0	779	27.7	2,031	72.3	2,810
Springfield	37	67.3	18	32.7	55	15.5	299	84.5	354
Rocky Ford	7	87.5	1	12.5	8	4.7	163	95.3	171
Bonny Reservoir	8	88.9	1	11.1	9	12.2	65	87.8	74
Subtotal	1,191	48.7	1,256	51.3	2,447	36.0	4,355	64.0	6,802
Eastern Foothills/Valleys									
Denver	1,102	55.9	869	44.1	1,971	32.9	4,013	67.1	5,984
Fort Collins	2,239	60.3	1,476	39.7	3,715	73.5	1,337	26.5	5,052
Fort Garland	671	63.3	389	36.7	1,060	38.0	1,726	62.0	2,786
Monte Vista	801	54.9	658	45.1	1,459	54.4	1,221	45.6	2,680
Fort Carson	182	56.9	138	43.1	320	69.4	141	30.6	461
Longmont	138	60.0	92	40.0	230	72.3	88	27.7	318
Salida	152	58.7	107	41.3	259	87.2	38	12.8	297
Other	37	74.0	13	26.0	50	90.9	5	9.1	55
Subtotal	5,322	58.7	3,742	41.3	9,064	51.4	8,569	48.6	17,633
West of the Continental Divide									
Durango	1,118	56.3	867	43.7	1,985	81.6	449	18.4	2,434
Montrose	473	52.7	424	47.3	897	55.0	735	45.0	1,632
Craig	263	58.4	187	41.6	450	51.7	421	48.3	871
Meeker	334	59.3	229	40.7	563	76.8	170	23.2	733
Unaweep Canyon	151	66.2	77	33.8	228	63.7	130	36.3	358
Other	12	52.2	11	47.8	23	95.8	1	4.2	24
Subtotal	2,351	56.7	1,795	43.3	4,146	68.5	1,906	31.5	6,052
Total	8,864	56.6	6,793	43.4	15,657	51.4	14,830	48.6	30,487

[1]Number of adult (AHY) male doves banded.

[2]Percent of AHY doves banded that were classified as male.

[3]Number of adult (AHY) female doves banded.

[4]Percent of AHY doves banded that were classified as female.

[5]Percent of the total number of doves banded that were classified as adult (AHY).

[6]Percent of the total number of doves banded that were classified as hatch year (HY).

reflected the true ratios in local populations. It is more likely that observed differences in percentages of adult males and females trapped were related to time of day of trapping effort and patterns of bird behavior. Both sexes of mourning doves share incubation and brooding activities with males being associated with the nest from mid-morning until mid afternoon, and females from mid-afternoon until mid-morning. Consequently, during nesting males may be available for trapping in both the early morning and late afternoon periods, while females are available only during the mid-day period. Percentages of adults versus immatures in trap samples were most probably related to timing of the trapping effort in relation to the breeding and nesting period. Higher percentages of immatures were banded at sites trapped in August (Denver, Fort Garland) than at sites trapped in June (Fort Collins, Durango).

Henry et al. (1976), in a study in Missouri, demonstrated that placement of traps could bias age and sex composition of dove capture, while Lewis and Morrison (1973) documented biases in trap results from use of different types of traps and time of day. All of these factors, except time of day and type of trap, were undoubtedly involved in affecting the age and sex composition of the doves we banded (Table 4). Trapping in Colorado during the 1964-1974 interval was usually consistent with traps being checked three times per day at approximately the same times. Type of trap used did not change throughout the study.

RECAPTURES

All previously banded mourning doves recaptured were recorded each year with few exceptions. Those exceptions primarily involved repeat captures of birds known to have been banded at the same site within a few days of original banding. Only 29 mourning doves were recaptured; most (22) were originally banded in a different degree block in Colorado than the degree block of recapture. Recaptures of doves originally banded in other states included three from New Mexico and one each from Alabama, Arizona, Texas, and Utah. Detailed analyses of recaptures could not be made because of the limited data available. The longest intervals between banding and recapture were 6 (one) and 5 years (two) with most being of a duration of 1 to 3 years.

Two recaptures are of interest as one adult male banded on 21 July 1971 near Lay in northwest Colorado was recaptured on 13 August 1971 near Fort Garland (West Slope to East Slope) while another adult male banded on 2 August 1972 near Fort Garland was recaptured near Montrose on 25 June 1973 (East Slope to West Slope). All recaptures of doves banded out of state, with the exception of an adult female banded on 7 June 1973 in New Mexico and recaptured on 2 August 1973 in Colorado, were recaptured one or more subsequent years after original banding. No obvious pattern could be discerned in age and sex of those birds being recaptured out of degree block within Colorado (HY U = 9, AHY M = 8, AHY F = 1, AHY U = 1, HY M = 1, HY F = 1, LU = 1), or recaptured from bandings out of Colorado (HY U = 2, AHY F = 2, AHY M = 1, AHY U = 1, LU = 1).

HATCHING CHRONOLOGY

Primary wing molt data were recorded for 14,560 immature mourning doves newly banded and 4,792 hunter-harvested immatures during 1964-1974. Hatching dates were calculated following procedures

Table 5. Percent of wild-trapped immature mourning doves by hatch date intervals in Colorado, 1964-1974.

Hatch Interval	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	Overall %
< 1 May	1.4	0.4	0.0	0.8	0.1	1.2	0.2	0.1	0.1	0.2	0.6	0.4
1-7 May	0.5	0.3	4.0	1.7	0.8	1.1	0.4	0.8	1.9	0.7	1.5	1.1
8-14 May	3.3	0.4	7.9	4.7	4.5	6.6	1.1	2.3	5.4	2.9	5.0	3.8
15-21 May	9.0	1.0	2.0	9.7	6.5	15.9	6.1	6.3	12.2	6.9	14.0	9.4
22-28 May	15.7	13.1	13.1	13.2	10.1	10.1	9.9	13.7	14.6	16.0	17.1	13.8
29 May – 4 Jun	14.3	14.6	16.6	13.6	12.5	12.1	14.2	11.4	14.8	14.3	13.5	13.4
5-11 Jun	26.2	21.4	10.6	18.2	11.6	8.3	6.9	12.7	12.4	12.1	11.4	12.5
12-18 Jun	28.1	25.3	5.3	13.4	15.0	12.0	7.8	11.6	14.0	13.1	11.7	13.3
19-25 Jun	1.4	13.1	7.3	4.9	10.8	8.8	10.9	11.6	8.4	16.1	10.2	10.5
26 Jun – 2 Jul	0.0	2.0	0.0	3.4	12.0	8.7	14.9	12.5	6.0	13.0	7.2	9.1
3-9 Jul	0.0	2.6	0.0	4.2	9.8	6.4	15.2	8.2	5.8	4.2	6.9	7.0
10-16 Jul	0.0	3.0	0.0	4.4	4.6	6.3	7.4	7.8	3.4	0.0	0.9	4.0
17-23 Jul	0.0	0.0	0.0	6.5	1.7	2.4	4.7	0.8	1.0	0.0	0.0	1.6
24-30 Jul	0.0	0.0	0.0	1.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Sample Size	210	700	151	1,161	1,421	1,047	1,253	2,467	2,323	1,815	2,012	14,560

Table 6. Percent of hunter-harvested immature mourning doves by hatch date intervals in Colorado, 1964-1974.

Hatch Interval	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	Overall %
< 12 Jun	0.0	2.4	2.2	0.2	0.0	1.7	1.5	0.7	1.4	0.5	0.1	0.8
12-18 Jun	0.0	6.7	10.0	0.4	4.2	7.4	7.8	8.4	0.6	3.3	3.5	3.8
19-25 Jun	0.0	19.7	11.5	2.0	10.6	15.7	9.3	6.3	15.6	6.0	5.2	8.2
26 Jun – 2 Jul	0.0	2.8	1.1	0.7	0.0	0.0	3.6	9.1	2.3	1.9	3.0	2.4
3-9 Jul	0.0	15.0	10.4	5.5	12.7	14.9	14.0	16.8	7.3	8.7	11.2	9.9
10-16 Jul	10.5	15.0	14.8	9.5	17.6	14.9	17.6	13.3	16.7	10.8	8.9	12.3
17-23 Jul	26.3	13.0	8.9	18.6	14.1	12.4	12.4	10.8	12.1	6.8	9.4	10.6
24-30 Jul	26.3	11.4	13.7	22.4	16.9	14.0	13.5	17.1	7.0	15.0	11.9	14.1
31 Jul – 6 Aug	5.3	10.2	24.8	32.1	23.9	19.0	19.7	12.6	17.0	13.7	16.5	17.7
7-13 Aug	31.6	3.5	2.6	7.1	0.0	0.0	0.0	4.9	13.8	9.1	8.9	7.8
14-20 Aug	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	3.1	7.8	10.6	4.7
21-27 Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	12.9	5.3	5.3
28 Aug – 3 Sep	0.0	0.0	0.0	0.7	0.0	0.0	0.5	0.0	0.0	3.8	5.5	2.2
4-10 Sep	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Sample Size	19	254	270	548	142	121	193	286	653	1,509	797	4,792

and data published by Allen (1963) even though limited data from free-flying immature doves banded and recaptured in Colorado suggest that Allen's molt schedules may be 3 to 4 days longer than actually occurring in the wild (Petersen and Braun 1974). Hatching chronologies calculated by year for wild trapped and harvested immature mourning doves in Colorado varied by year (Tables 5, 6). Examination of the data indicates that doves hatching prior to 12 June comprise about 54% of immature doves trapped and banded (Table 5), whereas doves produced in this early period were poorly represented (< 1%) in the harvest (Table 6). Few doves hatching after 30 July were represented in trap samples as trapping normally ceased by 15-20 August. However, doves hatching after 30 July comprised about 38% of the immature doves harvested each year. These differences are significant ($P < 0.05$) and suggest real differences occur in availability of early and late hatching immatures to hunters in Colorado. Funk (1965) earlier documented that the peak of dove migration through Colorado occurred prior to 1 September. Data from wings of immature doves examined in the present study support Funk's earlier work. It can reasonably be concluded that most early hatching young doves have migrated from Colorado prior to the hunting season.

AGE RATIOS OF HARVESTED DOVES

Wings from hunter-harvested doves were not routinely collected in most years. Consequently, sample sizes ranged from few in 1968 to over 2,900 in 1973, when efforts to collect wings were increased. Intensive efforts to collect wings were made from 1972 through 1974.

Figure 4. Wing of hunter-harvested immature mourning dove with primary molt stopped at 4 (Photograph by Clait E. Braun).

Figure 5. Wing of hunter-harvested adult mourning dove with primary molt stopped at primary 3 (Photograph by Clait E. Braun).

These data (Table 7) should be viewed with caution because of small sample sizes in most years and uneven geographic distribution of the sample from within Colorado. Most samples were from eastern Colorado, either primarily southeast (i.e., Springfield) in 1964-1971,

or southcentral (i.e., Fort Carson) in 1972-1974. Neither of these areas may be representative of the total harvest in the state. Assuming that larger sample sizes most nearly approximate actual age composition of the harvest, it is noteworthy that age ratios in the 4 years (1967, 1972-1974) when over 1,000 wings were available each year, ranged from 1.0 HY:1 AHY (2 years) to 1.5:1 to 2.2 HY:1 AHY. These ratios would appear to be lower than expected given that mourning doves have multiple nests

Table 7. Age ratios of mourning doves harvested by hunters in Colorado, 1964-1974.

	Harvested Sample			
Year	AHY	HY	Total	HY per AHY
1964	62	19	81	0.3
1965	128	254	382	2.0
1966	148	344	492	2.3
1967	569	582	1,151	1.0
1968	Data not available			
1969	51	121	172	2.4
1970	37	192	229	5.2
1971	24	286	310	11.9
1972	446	654	1,100	1.5
1973	1,451	1,509	2,960	1.0
1974	368	797	1,165	2.2
Total	3,284	4,758	8,042	1.4

in each breeding season. Data from Fort Carson from 1972-1974 reveals a low immature to adult ratio (usually from 0.5 to 0.8:1) during the opening week of the hunting season with immatures predominating as the season progressed. This may indicate early migration of immatures as also indicated by banding records. If one assumes the average of 1.4:1 immatures to adult age ratio in the harvest (Table 7) is realistic and 50% of the adult harvest is comprised of females, then 2.8 young per female were produced. This ratio may be minimal due to early migration of immatures resulting from first and second nests.

HUNTER NUMBERS AND HARVEST

Harvest surveys were conducted by the Surveys Group, Wildlife Management Section, of the Colorado Division of Wildlife. Estimated number of hunters and total harvest from 1964 through 1974 derived varied (Table 8), possibly because of procedural changes in the surveys (1968 = reporting bias correction as multiples of the bag were deleted, 1972 = added multiple follow up surveys instead of one survey as in prior years, 1974 = stratification of hunters by license type). Season regulations during the 1964-1974 interval also varied. The season length was 60 days (1 September through 30 October), daily bag and possession limits were either 12 and 24 (1964-1968) or 10 and 20 (1969-1974), while shooting hours were one half hour before sunrise to sunset (1964-1969) or sunrise to sunset (1970-1974).

Table 8. Annual estimates of the number of mourning dove hunters and mourning dove harvests in Colorado, 1964-1974.

Year	Hunters	Harvest
1964	22,477	130,367
1965	19,545	137,401
1966	25,227	174,066
1967	24,593	140,180
1968	25,186	308,881
1969	25,119	323,773
1970	24,149	301,562
1971	22,033	298,767
1972	33,299	513,898
1973	31,688	484,660
1974	41,518	688,312

The procedural changes in the Small Game Hunter Survey during 1964-1974 made it difficult to accurately represent numbers of hunters and annual harvest. Hunter numbers and annual harvests increased during the 11-year period, hunters by possibly 85% and harvest by possibly 428% (Table 8). While these numbers may be accurate, they are not overly plausible. Independent surveys using 100% sampling of all hunters of several minor game species suggested the annual survey of small game hunters may have overestimated hunter numbers by as much as 30% and harvest by 100%. It is probable that numbers of mourning dove hunters were slightly overestimated (by about 10%) with actual numbers of doves harvested being moderately overestimated (by as much as 50%). Thus, we roughly estimate numbers of dove hunters and annual harvest in 1974 were about 35,000 $\pm$ 3,000 and 500,000 $\pm$ 50,000, respectively.

BAND RECOVERIES

There were 34,225 mourning doves banded in Colorado from 1913 through 1974 (Table 1). Only one major period of intensive banding occurred as 31,523 doves were banded during 1964-1974. Most bandings were of free-flying doves but 2,021 nestlings or locals (L U) were banded primarily in the 1951-1963 and 1970-1971 periods. There were 691 recoveries of doves banded in Colorado reported through 22 November 1976. Of this number, only 52 were from the 2,702 bandings prior to 1964 (1.9% of the doves banded between 1913 and 1963). All but 7 were hunting season recoveries.

The hunting season in the United States was considered to be from 1 September through 31 January (shot and found dead, 00 and 01 codes). All shot, trapped, and found dead recoveries in Mexico from 1 September through 30 May were included. Recovery rates did not change significantly between the 1913-1963 and 1964-1976 periods as 639 recoveries were reported from 31,523 bandings (2.0% of the banded sample). Of the 639 total recoveries, 54 were non-hunting season recoveries. This is a substantial decrease from the non-hunting mortalities reported in the 1913-1963 period (8.4% of all recoveries in 1964-1976 versus 13.5% in 1913-1963). This decrease could be the result of larger, more representative samples of total recoveries, or lower reporting rates of non-hunting mortalities.

Origin of Banded Doves Recovered in Colorado

Nine mourning doves banded outside of Colorado and 26 doves banded in Colorado were reported recovered in the state in the 1913-1963 interval. Thus, of 35 banded doves reported, 25.7% originated elsewhere. Point of origin (banding location) for these 9 birds was two each from New Mexico and North Dakota, and one each from Arizona, Kansas, Nebraska, South Dakota, and Texas. Only one bird was banded outside of the Central Management Unit (Arizona). This dove was recovered west of the Continental Divide in Colorado. Recoveries of birds banded outside of Colorado and recovered within the state in the 1913-1963 period were too few to ascertain the importance of migrant doves to the statewide harvest.

During the 1964-1976 interval, 88 doves banded outside of Colorado (Table 9) and 352 doves banded in Colorado (Table 10) were reported recovered in the state. Thus, of 440 banded doves reported, 20.0% originated elsewhere. This would suggest that about one-fifth of the doves harvested each year in Colorado originated from outside of the state. This may be misleading as banding activities and dove populations may not be similar between Colorado and other origin areas (Dunks et al. 1982).

Only 12 recoveries from bandings outside of the Central Management Unit were reported in the 1964-1976 period. Two originated in the Eastern Management Unit, while 10 originated in the Western Management Unit. Patterns of recoveries from bandings in these management units could not be ascertained but 3 doves banded in the Western Management Unit were recovered west of the Continental Divide in Colorado. Over 86% (86.4) of the 'foreign' recoveries in Colorado were from other states in the Central Management Unit (Table 9). Over one-half (51.3%) originated in areas directly north of Colorado (Montana and Wyoming) with lesser numbers (15.8%) originating in areas directly south of Colorado (New Mexico and Texas).

Considering the 88 out of state of banding recoveries, 54 were direct (within year of banding) and 34 were indirect (after year of banding) recoveries. Only 8 (5 indirect and 3 direct) were from bandings outside of the preseason (1 June through 31 August) banding period. One direct recovery (from Wisconsin) was received from the Eastern Management Unit, while the other recovery from this unit (Louisiana) was indirect. Seven of the 10 recoveries (all but 3 from Washington) in the Western Management Unit were indirect. If a pattern exists in direct and indirect recoveries of banded doves recovered in Colorado, it is that doves banded north (Montana and Wyoming) tend to be recovered (29 of 39) in the same year as banding, while doves banded south of Colorado (New Mexico and Texas) tend to be recovered (8 of 12) one or more years after banding.

Distribution of Recoveries

Through 22 November 1976, 691 recoveries of doves banded in Colorado were reported, of which 52 were in the 1913-1963 period and 639 were from bandings in the 1964-1974 interval. Considering only the 52 recoveries from the 1913-1963 bandings, 26 (50%) were from Colorado, 18 (34.6%) were from Mexico, 4 (7.8%) were from Texas, 2 (3.8%) were from Arizona, while 1 each were from New Mexico and Louisiana. All but 5 were found dead (5) or shot (42). Distribution of recoveries in Mexico was in the west central states with 8 from Jalisco, 4 from Michoacan, and 2 each from Guanajuato, Guerrero, and Sinaloa. Only one recovery was reported from the Eastern Management Unit, while 2 (one banded on each side of the Continental Divide) were reported from the Western Management Unit.

Distribution of the 639 recoveries from doves banded from 1964 through 1974 varied (Table 10). Of this sample, 560 were harvested, 24 were found dead, 14 were 'obtained only', 11 were caught due to injury or in traps other than for bird banding, 6 were caught by cats, 4 were caught due to disease, 3 each were the result of striking objects, vehicles, and adverse weather conditions. The remaining 11 recoveries resulted from casualties in 9 different categories.

Recoveries were clustered in the Central Management Unit (451 of 639, 70.6%) and Mexico (149, 23.3%) with lesser numbers from the Western Management unit (32, 5.0%) and Eastern Management Unit (2, 0.3%). Central American countries (4) and Canada (1) contributed little to the reported distribution of band recoveries. Colorado was the leading recovery area (55.1% of all recoveries) followed by Mexico (23.3%), Texas (7.5%), and New Mexico (6.9%). No

Table 9. Origin of banded mourning doves recovered in Colorado from out-of-state bandings, 1964-1976.

Location of Banding	Number of Recoveries in Colorado
Eastern Management Unit	
Louisiana	1
Wisconsin	1
Total	2
Western Management Unit	
Arizona	3
California	1
Nevada	2
Utah	1
Washington	3
Total	10
Central Management Unit	
Iowa	3
Kansas	1
Minnesota	1
Montana	32
Nebraska	7
New Mexico	6
North Dakota	2
Oklahoma	1
South Dakota	10
Texas	6
Wyoming	7
Total	76

other state or country provided more than 3% of the total reported recoveries.

Almost one-half (46.5%) of all recoveries were from after the year of banding (indirect). This was most notable for recoveries within Colorado (48.9%) and least (37.6%) for those from Mexico. Only one (Illinois) of two recoveries in the Eastern Management Unit was direct while 17 of 32 (53.1%) from the Western Management Unit were direct. Thus, the pattern of recoveries was similar for both direct and indirect recoveries of mourning doves banded in Colorado.

There were 3 recoveries from 293 bandings outside the primary banding period (1 June through 31 August) during 1964-1974. These three recoveries were all direct with two from within Colorado and one from Texas.

Recoveries in Mexico were examined by state of recovery. All but 9 of the 149 Mexican recoveries had discernible locations (Table 11). Of this sample of recoveries, 98 (70.0%) were from the adjacent states in

Table 10. Distribution of recoveries of mourning doves banded in Colorado, 1964-1976.

Location of Recovery	Number of Recoveries
Eastern Management Unit	
Alabama	1
Illinois	1
Total	2
Western Management Unit	
Arizona	18
California	10
Oregon	1
Utah	3
Total	32
Central Management Unit	
Colorado	352
Kansas	1
Minnesota	1
Missouri	1
New Mexico	44
Oklahoma	2
South Dakota	2
Texas	48
Total	451
Outside United States	
Canada	1
El Salvador	2
Guatemala	1
Mexico	149
Nicaragua	1
Total	154

West Central Mexico of Jalisco, Michoacan, and Guanajuato. Only one recovery was from northern Mexico (Sonora) and none was recovered south of Puebla. Thus, mourning doves banded in Colorado are not exceptionally vulnerable to hunters in Mexico until they reach presumed wintering areas. These data are similar to those reported from an earlier analysis of all mourning dove recoveries in Mexico (Blankenship and Reeves 1970).

Particular attention was given to recoveries resulting from bandings west of the Continental Divide. Sixty recoveries (Table 12) were reported from 7,107 bandings west of the Continental Divide from 1913 through 22 November 1976. Seven (from 895 bandings) were from the 1913-1963 period with the remainder, 53 (from 6,212 bandings) being from the 1964-1974 banding effort.

Table 11. State of recovery of mourning doves banded in Colorado and recovered in Mexico, 1964-1976.

State	Number of Recoveries
Jalisco	46
Michoacan	34
Guanajuato	18
Sinaloa	14
Guerrero	7
Nayarit	5
Zacatecas	4
Colima	3
Morelos	3
Puebla	3
San Luis Potosi	2
Sonora	1

Table 12. Distribution of recoveries from mourning doves banded west of the Continental Divide in Colorado, 1913-1974.

State/Country	Number of Recoveries
Mexico	20
New Mexico	12
Arizona	10
Colorado	7
California	6
Texas	4
Utah	1

These data (Table 12) differ markedly from those presented for recoveries from all bandings in Colorado (Table 10). Few West Slope banded doves were recovered in Colorado (11.7%) with most being recovered in Mexico (33.3%) and Western Management Unit states (17 of 60, 28.3%). We examined recovery locations in New Mexico and 5 of the recoveries in that state were west of the Continental Divide. Recoveries in Texas from West Slope bandings were similar (6.7% versus 7.5%) to recoveries from all doves banded in Colorado. Thus, it appears that doves banded west of the Continental Divide in Colorado move south-southwest and have some affinity with Western Management Unit states.

We further examined the affinity of mourning doves west of the Continental Divide in Colorado by reviewing the origin of 17 banded doves recovered in West Slope areas in the 1913-1976 period (but only one recovery banded prior to 1964). Seven of these recoveries were from doves banded in Colorado of which six were West Slope bandings. Three were banded in New Mexico, all of which were banded east of the Continental Divide. Two were from Arizona with one each from Minnesota, Montana, Texas, Wyoming, and Utah. The one recovery originating in Wyoming was banded west of the Continental Divide. Only 10 of the 96 outside of Colorado bandings recovered in the state were recovered west of the Continental Divide. Eleven of the 96 recoveries were from Western Management Unit states of which only 3 were recovered west of the Continental Divide. There were 47 recoveries from states bordering the Western Management Unit (Montana = 32, Wyoming = 7, New Mexico = 8) and only 5 recoveries were from the West Slope in Colorado and only two of these five recoveries were originally banded west of the Continental Divide. Thus, there were too few recoveries west of the Continental Divide in Colorado that were banded in other states, especially those west and north of Colorado, to support placing western Colorado in the Western Management Unit. More bandings are needed in West Slope areas of Wyoming and Montana to obtain definitive data on migration routes of doves banded in those areas.

MORTALITY AND SURVIVAL

Nestlings

Banding of nestling or 'local' doves (Fig. 6) was encouraged at one time with the purpose of identifying specific production areas (Kaczynski and Kiel 1963). Unfortunately, this program was plagued by high loss of bands from nestlings prior to fledging, high prefledging loss of young doves, and misinterpretation of the term 'local' by some banders (Kaczynski and Kiel 1963). Consequently, banding of nestlings has not been emphasized by State or Federal agencies in recent years.

Nestling mourning doves were banded in Colorado during 31 years in the 1913-1974 interval totaling 2,021 birds. Most, 1,526 nestling doves, were banded prior to 1964.

Recoveries from all nestling bandings totaled 37 through 22 November 1976. The direct recovery rate (23 from 2,021 bandings) was 1.1% with an overall recovery rate of 1.8%. This is substantially lower than the 4.6% recovery rate reported for 643 nestlings banded in Kansas in 1961-1968 (Schroeder and Ely 1972). The direct recovery rate in that study was 2.6% (12 recoveries from 643 bandings).

Recoveries from nestling doves in Colorado were reported from consecutive years 1958-1961 and 1969-1970. These data were too sparse for derivation of accurate estimates of mortality rates but the estimated average survival rate was .344 with an average mortality rate of .656 (relative recovery rate method, Geis 1972).

Figure 6. Nestling mourning dove (Photograph by Ron Oakleaf).

Data were not sufficient to compare mortality rates of nestlings banded on either side of the Continental Divide. The estimated mortality rate of 65.6% is higher than the annual mortality estimates of 54.5 to 64.5% for nestlings banded in South Dakota in 1956-1961 (Rice and Lovrien 1974).

Immatures

There were 15,539 immature mourning doves banded in Colorado during 1913-1974. This total included 14,920 banded in the 1964-1974 period. There were 8 recoveries scattered over 7 years from the 619 immature doves banded prior to 1964 (apparent recovery rate = 1.3%). There were 312 recoveries reported through 22 November 1976 from the 1964-1974 bandings (apparent recovery rate = 2.1%). Apparent recovery rates for the 1964-1974 immature bandings were 1.2% for those banded west of the Continental Divide and 2.2% for those banded east of the Continental Divide. The apparent direct recovery rates were 0.06 and 1.2%, respectively, west and east of the Continental Divide. Only data from 1967-1974 were used for mortality and survival estimates due to small sample sizes (Table 13).

Estimates of annual survival rates for immature mourning doves were 52.8% for the entire state, 52.0% for immatures banded east of the Continental Divide, and 64.9% for immatures banded west of the Continental Divide (Table 13). The annual survival rate for immatures of 52.8% was higher than the 39.7% reported by Rice and Lovrien (1974) for immature doves banded in South Dakota and higher than reported for immature doves (37.8-39.1%) in the Eastern Management Unit (Hayne 1975).

Reward bands were placed on 122 immature doves in 1971 in Colorado as part of a Central Management Unit cooperative study; an additional 1,106 immatures were banded at the same time for use as controls. Through 22 November 1976, 4 (apparent recovery rate = .0328) reward bands were reported, while 20 (apparent recovery rate = .0181) control bands were reported. Direct and indirect recovery rates (2 and 2, 10 and 10 recoveries, respectively) were similar. Thus, while sample sizes are small, reward band data for Colorado suggest that about half (55.2%) of all bands recovered are reported. This is substantially higher than the estimated 32% reporting rate for mourning doves banded in 1965-1966 calculated by Tomlinson (1968).

Table 13. Apparent survival rates for mourning doves banded east and west of the Continental Divide and statewide in Colorado, 1964-1974.

	Statewide	East of Continental Divide	West of Continental Divide
HY	52.8	52.0	64.9
AHY	57.0	56.3	58.2
AHY Males	55.5	55.7	48.4
AHY Females	58.3	56.2	51.1

Adults

Prior to 1964, 389 adult (349 unknown sex, 27 males, 13 females) mourning doves were banded in Colorado. These bandings resulted in 9 recoveries (apparent recovery rate = 2.3%) spread over 7 years. There were 15,965 adult (423 unknown sex, 9,030 males, 6,901 females) banded in Colorado in the 1964-1974 interval. These bandings resulted in 318 recoveries (1 unknown sex, 189 males, 128 females). This is an apparent recovery rate of 2.0% with an apparent direct recovery rate of 1.0%. Only 3 recoveries (all direct) were received from 293 bandings accomplished prior to or after the 1 June-31 August period. Consequently, these bandings and recoveries were included in all calculations.

Estimated survival rates were 57.0% for all adults, 55.5% for males, and 58.3% for females (Table 13). These survival rates are higher than those (48.4, 47.6, and 51.5%, respectively) reported for mourning doves banded in South Dakota (Rice and Lovrien 1974). Estimates of survival rates of adult males and females in Colorado are substantially higher than those of adult males (39.1 to 41.8%) and adult females (34.3 to 37.6%) banded in the Eastern Management Unit (Hayne 1975).

Sample sizes of bandings and recoveries of mourning doves in West Slope areas were small (4,271 banded and 30 recovered). However, the apparent recovery rate (0.07%) in West Slope areas is substantially lower than for doves banded east of the Continental Divide (2.49%). While inadequate numbers of recoveries

have been received from West Slope bandings, indications are that doves banded in that geographic area of the state have lower harvest rates than those banded in East Slope areas.

Survival and Recovery Models

The data from 1964-1974 were examined by M. E. Seamans (USFWS, Denver) using current methodology. The top model suggested a log-linear trend in annual survival. The number of competing models ($\leq$2 AIC units from top model) and their structure (some with no temporal trend, some with a simple linear trend) suggested that any trends in survival over time were slight. Age effects were in some top models but not others, suggesting a slight or moderate relationship between survival and dove age (mean annual survival of HY = 0.48, SE = 0.06; AHY = 0.56, SE = 0.03). Area effects were also in a number of top models, however, sampling effort was much lower west of the Continental Divide which hindered comparisons (mean annual survival in the East = 0.54, SE = 0.03; West = 0.61, SE = 0.10) (compare with data in Table 13). The top model structure for recovery suggested recovery probability varied by: area (greater east than west of the Continental Divide); and age (greater for HY than AHY). Higher harvest rates for HY birds and birds east of the Divide are the likely cause behind these age and area differences. In addition, recovery probability east of the Continental Divide differed among years with no pattern, whereas west of the Divide recovery probability appeared constant over time.

CONCLUSIONS

Mourning doves are important migratory game birds in Colorado with annual estimates of number of hunters exceeding 30,000 and harvests exceeding 600,000 birds. Banding studies during 1964-1974 indicated survival rates were 48 to 56% and the annual rate of harvest was ~2.5%. The largest proportion of recoveries of doves banded in Colorado was from within the state followed by Mexico, Texas, New Mexico, Arizona, and California. Mourning Doves banded in Montana and Wyoming contributed significantly to the Colorado dove harvest. Many young (HY) doves were not available to hunters as they apparently migrated prior to the opening date of the hunting season. Survival and mortality estimates varied by age and sex class, and also by location (West Slope vs. East Slope).

MANAGEMENT RECOMMENDATIONS

Colorado is in the Central Management Unit for mourning doves. The present data are too sparse to suggest the area west of the Continental Divide in Colorado would best fit in the Western Management Unit although some doves have an affinity to migrate to the southwest. Management activities for mourning doves have changed in recent years with more emphasis on banding and analysis of wings of early September harvested birds. The emphasis on banding on an annual basis and not on a staggered schedule by groups of states should be considered in view of needs for management of this important migratory species.

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