

Assessing differences in mourning dove *Zenaida macroura marginella* nesting activity after 40 years

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In 1992-1993 we replicated a mourning dove *Zenaida macroura marginella* study conducted in 1951-1952 near Fillmore, Utah, to document differences in nesting activity between time periods. Nests along irrigation canals averaged 6.8 nests/km in 1993 vs 36.9 nests/km in 1952. Dove production was 2.4 offspring per pair in 1993 vs 3.9 offspring per pair in 1952, and nest abandonment was higher: 12.9 vs 6.2%, respectively. No differences occurred in nest success (57.1 vs 57.4%) or nest predation (35.7 vs 29.6%). The breeding season was 80 days in 1952, 75 days in 1992, and 70 days in 1993. Nest height was lower in 1992-1993 than in 1951-1952, and nest frequency by vegetation type changed from predominately willow *Salix* spp. to a broader distribution of nests among available vegetation types. Two distinct riparian habitats existed in both time periods: a natural creek and man-made irrigation canals. The highest nest density occurred in riparian areas during both time periods, but the relative number of nests within these riparian habitats differed, with the highest number of nests occurring along the creek in 1992-1993 and along the irrigation canals in 1951-1952. The highest predation rates occurred in creek habitat during 1992-1993.

Key words: mourning dove, nesting, nest predation, nest success, population, reproduction, Utah, *Zenaida macroura marginella*

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Mourning doves *Zenaida macroura marginella* are among the most abundant birds in the USA (Peterjohn et al. 1994), but their numbers show differing trends across their distribution. Three largely independent populations (Kiel 1959) exist, and three management units have been defined based on these populations. Among these three, the western population (occurring in the states of Arizona, Utah, Idaho, Nevada, California, Oregon, Washington, USA, and British Columbia, Canada) has shown the most consistent downward trend for the past 10 and 37-year periods (Dolton & Holmes 2002). Slow persistent changes are often difficult to assess because no single event can be temporally related to a decline. In these instances, a data set collected before the onset of a decline can prove valuable in assessing differences over time.

In 1951-1952, R. Dahlgren (1955) conducted a mourning dove study near Fillmore, Utah, in which he recorded nesting data, call-count statistics, food habits and incidence of trichomoniasis. In 1992-1993 we returned to the same study site and compared nesting data to those collected in 1951-1952. Our intent was to document similarities and differences and to use the data to formulate hypotheses about the broader population decline.

Material and methods

The study site was 2 km northwest of Fillmore, Utah, in an area called the Old Fields (39°00'N, 112°20'W). Chalk Creek, which ran through the area, was diverted into irrigation canals that branched through approximately 570 ha of farmland. Mean annual rainfall was 37.9 cm. Research was conducted in 12.6 km of riparian vegetation (8.1 km irrigation canal and 4.5 km creek). Riparian vegetation consisted of a generally continuous layer of shrubs interspersed with trees. Canal vegetation consisted mainly of willow *Salix* sp., squawbush *Rhus tilobata*, wild rose *Rosa* sp., and golden currant *Ribes aureum*. Creek vegetation consisted mainly of willow, squawbush, cottonwood *Populus* sp., locust *Robinia* sp., and box elder *Acer negundo*.

We replicated Dahlgren's (1955) nesting study. In 1951 he surveyed the study area from early July through mid-September in various habitat types. In 1952 he surveyed from mid-April through mid-September and concentrated all efforts on the most productive nesting habitat: 5.3 km of irrigation canal, which he completely censused once per week. In both years, he rechecked all nests once per week.

We replicated Dahlgren's methods for study site selection, nest searching and data collection. Unless noted, methods were the same between the two studies.

Beginning 1 May 1992, we conducted nest searches in all major vegetation types: sagebrush *Artemisia tridentata*, juniper *Juniperus utahensis*-sagebrush, alfalfa *Medicago* sp., common rye *Secale* sp., barley *Hordeum* sp., corn *Zea* sp., fallow fields, creek banks and irrigation canals. To select the most productive 5.3 km of riparian habitat, we began with a complete census of 5.9 km of riparian vegetation that contained the highest dove activity. On 19 July, due to low incidence of nests and differing nest predation between the creek and irrigation canals, we expanded the weekly census to include all irrigation canals (8.1 km) plus 4.5 km of Chalk Creek. In 1993, all studies were conducted in the riparian areas. Thus, our data included all of Dahlgren's study areas plus an additional 2.8 km of irrigation canal and 4.5 km of creek. We separated the data by habitat and used the results from irrigation canals to compare with Dahlgren's study.

Beginning 15 April 1992 and 1 May 1993 and continuing through 5 September, we searched for dove nests once per week by walking the riparian areas and flushing nesting birds. We estimated age of eggs and nestlings (Hanson & Kossack 1957) and checked all previously discovered nests once per week. Inaccessible nests were checked with a mirror pole and were aged by hatch dates. We checked all nests on day 10 of the nestling period to determine fledging (Coon et al. 1981, Nichols et al. 1984).

We classified nest failure as predation or abandonment. We flushed the parent only on first encounters to minimize investigator disturbance (Westmoreland & Best 1985, Major 1990). Subsequent checks were from a distance (Morrow & Silvy 1983). Dahlgren flushed birds on first encounters and most subsequent checks.

We estimated the number of nesting pairs on the same dates as Dahlgren by counting the number of nests in the study area and adding nests initiated the following week that we could not attribute to renesting (Dahlgren 1955). We adjusted the estimate for sampling area to match Dahlgren's 5.3 km of vegetation. To calculate average fledglings per pair, we divided the number of fledglings by the number of nesting pairs. We also divided number of fledglings by the total number of successful nests to compare number of fledglings per successful nest.

We used only nests in which eggs were laid to calculate rates of predation, abandonment and success. Predation rate was the proportion of nests depredated, and abandonment rate was the proportion abandoned. Apparent nest success was the proportion that produced fledglings. We also calculated Mayfield survival estimates (Mayfield 1975, Hensler & Nichols 1981), with sepa-

rate estimates for egg and nestling stages. The probability of survival often differs for these two stages in mourning doves (Best & Stauffer 1982, Morrow & Silvy 1982).

We measured nest height and recorded plant species providing support and cover. Mean height between successful and unsuccessful nests was compared with a two-tailed Student's *t*-test. We determined predator type by photographing predation events during the latter half of 1993. We baited empty dove nests with Hungarian partridge eggs and placed camera traps similar to those developed by Major (1991), but modified for use in dove nests.

We compared proportions (e.g. nest success and predation rates) with two-tailed normal approximations to contingency table analysis (Zar 1996). We directly compared nest census data (e.g. number of nests and nests/km). Dahlgren provided specific data on nests initiated during each week of the season in 1952. We grouped our data into the same time blocks and compared initiation dates. To avoid the possibility of a single unexpected nest occurring very early or very late in the season and disproportionately skewing season length, we excluded the first and last 5% of the nests in all data sets. In effect, season length for both studies was the time in which 90% of the nests were initiated.

Because doves are indeterminate nesters (i.e. they produce many nests in sequence throughout the season), season length can affect overall productivity. We modeled potential effects of nesting season length by constructing a chart of all possible combinations of successes and failures for a given rate of nest success. We assumed that renesting occurred six days after failure or fledging (P. Meyers, unpubl. data and consistent with Dahlgren's upper observation) and that all pairs continued to nest throughout the season. Fledging was assumed to occur on day 24 (Coon et al. 1981, Nichols et al. 1984). Chance of success, offspring per pair, and average length of survival for failed nests were calculated from 1993 canal data. We assumed that neither success nor failure affected the probability of future success. Finally, if a nest was initiated within the specified season length, we assumed that there was enough time left in the season to complete the nesting attempt.

The entire study area was surveyed in both 1952 and 1993. Because of their comprehensiveness and similarity in study sites, we used 1952 and 1993 for most comparisons. Unless stated, all comparisons between time periods are between 1993 irrigation canals and 1952 irrigation canals. We did, however, consider the general scale of the 1951 data to reference the population during that time period.

We also compared data between subsequent years.

Because the study site was expanded in 1992, we used the subset of the area surveyed the entire season to compare 1992 to 1993. Search areas and timing differed between 1951 and 1952, so we limited comparison to nest success data for those two years.

For most data (e.g. nest success, predation, nests/km, productivity and breeding pairs) Dahlgren gave numbers specific to irrigation canals. For two data sets (abandonment and nest height) he pooled data between years. For these combined data sets, we tested for differences between 1992 and 1993, and if none were found, we pooled those years to compare to Dahlgren's data.

Results

We found 82 dove nests (41 in irrigation canals) in 1992 and 112 nests (54 in irrigation canals) in 1993. Dahlgren found 145 nests in various habitat types during July-September 1951. In 1952, he found 196 nests in irrigation canals and 56 nests in three tree stands. In 1992-1993, the highest nest densities occurred in the riparian areas. Within the riparian areas, nest numbers were higher in Chalk Creek than in irrigation canals.

Results between consecutive years were similar (Table 1). Comparable areas produced the same number of nests (37) in both 1992 and 1993, and similar nest success ($Z = 0.23$, $P = 0.82$), predation rate ($Z = 0.71$, $P = 0.48$), and abandonment rate (Fisher's Exact test: $P = 0.48$). In 1992 and 1993, 18 and 16 nesting pairs were present, respectively, and the first eggs of the season were laid on the same date (16 May) in both years. Nest success was similar between 1951 and 1952 ($Z = 0.10$, $P = 0.92$), as was predation rate ($Z = 0.86$, $P = 0.39$). Nest success in 1952 did not differ between irrigation canals and tree stands ($Z = 0.24$, $P = 0.81$). More nests were found in 1952 ($N = 252$) than in 1951 ($N = 145$) due to the shorter sampling period in 1951 and more time spent in lower density areas.

Differences between 1951-1952 and 1992-1993 were greater than between consecutive years (see Table 1). Number of nests/km of irrigation canal was similar between 1992 and 1993 but much lower than the number found in 1952. When adjusted for sampling area, the peak number of nesting pairs in 1993 was 29% of that in 1952. Also, dove production (offspring per pair per season) was lower in 1993. Mated pairs fledged an average of 2.4 offspring in irrigation canals and 1.6 in Chalk Creek. These figures are 62 and 41%, respectively, of the 3.9 offspring per pair reported by Dahlgren for 1952.

Neither apparent nest success ($Z = 0.03$, $P = 0.98$) nor predation rate ($Z = 0.85$, $P = 0.40$) were different between

Table 1. Mourning dove nesting data for 1951-1952 according to Dahlgren (1955) and for 1992-1993, Fillmore, Utah.

	Year						
	1951	1952 Canals ^a	1992 Canals	1993 Canals	1992 Subset ^b	1993 Subset ^b	1993 Creek
Total nests	145	196	41	54	37	37	36
Apparent nest success	57.7%	57.1%		57.4%	45.9%	43.2%	27.8%
Nest predation	34.1%	35.7%		29.6%	37.8%	45.9%	50.0%
Nest abandonment		6.2%	18.8%	11.1%	16.2%	8.1%	22.2%
Unknown fate				1.9%		2.7%	
Nesting pairs		53		24	18	16	12
Nests/pair		3.65		2.3			
Fledglings/successful nest	1.78	1.85		1.83			1.9
Fledglings				57			19
Fledglings/pair		3.9		2.4			1.6
Nests/km riparian habitat		36.9	9.0	6.8			8.7
Season length		80	75	70			

^a Dahlgren reported separate nest success for canals and groves but pooled both habitat types for predation rate and fledgling per successful nest. In addition, he pooled 1951 and 1952 abandonment data. For this reason, the column does not add up to 100%.

^b The study area was expanded during the 1991 season. This subset includes only areas surveyed the entire nesting season in both years.

1993 and 1952. Abandonment rate for 1992-1993 was 12.9%, which was higher than the 6.2% seen in 1951-1952 ($Z = 1.99, P = 0.046$). Nest height in 1993 ($1.8 \text{ m} \pm 1.2$) was lower ($T = 4.1, df = 79, P < 0.001$) than in 1952 (2.47 m). For successful nests, average height was $1.7 \text{ m} \pm 1.2$ in 1992-1993, and did not differ ($T = 1.4, df = 47, P > 0.10$) from height of depredated nests ($1.4 \text{ m} \pm 1.0$), though predation rate on ground nests (60.0%) was higher than on elevated nests (31.5%), $Z = 2.19, P = 0.026$.

Nest frequency by vegetation type changed slightly from 1952 (Table 2). In 1952 willow and wild rose contained the majority of nests, while nest frequency in 1992-1993 was more evenly distributed across the range of available plant types. In addition to irrigation canals, Dahlgren censused three tree stands that produced 56 nests in 1952. Of these stands, a grove remained that produced three nests in 1993, remnants of an orchard produced nine nests in 1993, and the third tree stand no longer existed.

Table 2. Mourning dove nests (in %) by plant species during 1951-1952 according to Dahlgren (1955) and during 1992-1993. The P-value denotes difference between 1952 and 1993 canals.

Plant species ^a	Year					P-value
	1951 Total N = 139	1952 Canals N = 196	1992 Canals N = 37	1993 Canals N = 45	1993 Creek N = 37	
Willow	59.7	53.1	32.4	20.0	2.7	< 0.001
Wild rose	13.6	21.9	21.6	8.8	0	0.047
Currant	1.4	8.1	10.8	6.6	0	-
Cottonwood	2.9	5.1	2.7	11.1	0	-
Locust	2.2	7.1	13.5	17.7	0	-
Hawthorn <i>Crataegus</i> spp.	6.5	6.1	2.7	11.1	0	-
Poplar	4.3	4.1	0	0	0	-
Elm <i>Ulmus</i> sp.	2.9	4.1	5.4	2.2	2.7	-
Ash <i>Fraxinus</i> sp.	2.2	0.5	8.1	6.7	0	-
Squawbush	0	2.6	0	13.3	86.5	-
Apple	5.8	3.1	5.4	2.2	0	-
Plum	3.6	0	10.8	2.2	0	-
Virgins bower	53.2	0	16.2	0	0	< 0.001 ^b
Bedstraw <i>Galium triflorum</i>	0	0	43.2	0	0	-
Rye Grass	0	0	0	0	2.7	-
Sagebrush	0	0	0	0	5.4	-

^a Nests were often associated with multiple species so columns do not add up to 100%.

^b 1951 vs 1992

Predator composition in the study area in 1992-1993 was similar to the qualitative description provided by Dahlgren. We photographed four instances of nest predation. Ground squirrels, probably rock squirrels *Otospermophilus grammurus*, destroyed two of these nests. Unidentified mammalian predators destroyed the other two. Rock squirrels were the most abundant predator in the study area.

The nesting season was 5-10 days shorter in 1992 and 1993 than in 1952 (see Table 1). Season termination was similar, but the start of the breeding season was later. The parameters we used to estimate productivity for these season lengths were 57.4% chance of success, 1.9 offspring per successful nest, and average nest failure occurring on day 10 of the nest cycle. Under optimum conditions, we calculated that each pair could produce 4.3 fledglings over 80 days available for nest initiations, and 3.7 fledglings for 70 and 75 days (a 14% reduction).

Mayfield estimates for survival in the irrigation canals were: 57.4% (95% confidence interval (CI) = 44.1-74.4%) for the egg stage and 87.0% (CI = 76.7-98.5%) for the nestling stage. Mayfield survival estimates in Chalk Creek were: 55.9% (CI = 36.8-83.8%) for the egg stage and 41.4% (CI = 24.0-69.6%) for the nestling stage.

The highest number of nests/km of riparian habitat occurred along Chalk Creek (15.1 nests/km in 1992 and 8.7 nests/km in 1993). Nest success along Chalk Creek was lower ($Z = 2.60$, $P = 0.009$) than along irrigation canals for 1993, while predation rate was higher (50.0 vs 29.6%; $Z = 1.95$, $P = 0.03$). The difference in survival between the creek and canals was due entirely to high losses during the nestling stage in Chalk Creek. Mayfield survival estimates in the egg stage were nearly the same for both habitats ($Z = 0.22$, $P = 0.83$), but were lower along the creek for the nestling stage ($Z = 3.51$, $P < 0.0004$). Abandonment rate did not differ ($Z = 1.42$, $P = 0.16$) between creek (22.2%) and canals (11.1%). Nest height along the creek ($1.4 \text{ m} \pm 0.8$) was lower ($T = 2.7$, $df = 58$, $P < 0.01$) than along the irrigation canals ($1.8 \text{ m} \pm 1.2$).

Discussion

Difficulties arise in reaching conclusions about the Fillmore population because the studies are separated by 40 years, and many of the comparisons involve only two years of data. However, data from consecutive years and from broader regions suggest that the observed differences may be indicative of events occurring over the larger time period rather than yearly variation. The difference in dove numbers we observed is consistent with

historical changes noted by Dolton & Holmes (2002) for the western population. Given the larger scale trends, we would expect to see a lower population at the Fillmore site. Also, the differences we observed between time periods were large relative to the differences we observed between consecutive years. Data from 1992 and 1993 were very similar, and given the difference in sampling effort, data from 1951 and 1952 were also very similar.

Dove populations can show major fluctuations between consecutive years. Miller et al. (2001) observed much higher dove production during years with warm dry springs as opposed to cold wet springs. We analyzed daily mean temperature and rainfall (Utah Climate Center, Utah State University, Logan) for the years of both studies and could not explain the differences in dove nesting based on these two variables. Spring 1952 was dry, and as expected, had high nesting effort. However, spring 1951 was wet, yet Dahlgren found 145 nests in the last two months of the season. Also, 1992 was relatively dry and warm, while 1993 was wet and cool, but the number of nests per kilometer in the irrigation canals did not differ between these two years. A comparison of our results with Dahlgren's indicated that 5.3 km of canal in 1952 contained nearly five times as many doves as 8.1 km of the same canals in 1993. These differences probably cannot be accounted for by the relatively small differences we saw in weather patterns. Although an accurate measure of change between 1952 and 1993 is not attainable because only 1952's data are complete, the supporting evidence from 1951 suggests a notable difference in the number of nesting doves and their productivity between time periods.

Productivity depends on the number of fledglings per successful nest and the number of nests per pair. Although the number of fledglings per successful nest was the same as in 1952, the number of nests per pair was lower. In 1992-1993 we had fewer birds producing fewer nests, which lead to a nest density that was 18.2% of that in 1952. Tomlinson et al. (1988) estimated that each breeding pair in the western management unit (WMU) must average 2.8 fledglings per year to maintain a stable population. In Utah, where adult mortality is lower, the required average is 1.6 fledglings per pair (Tomlinson et al. 1988). Our estimate of 2.4 fledglings per pair along irrigation canals is below the reproductive benchmark for the WMU, but above that for Utah. These estimates come from banding studies over a large area and may not be realistic for such a small site. If we use these estimates as guidelines, however, they suggest that even though doves in Chalk Creek may just be maintaining population levels (1.6 fledglings per pair), the overall population should be increasing.

Our method of estimating productivity, however, is appropriate as an index, but may not be an accurate estimate of numbers. The method was developed by McClure (1943) and has been used in many dove studies (Cowan 1952, Dahlgren 1955, Randall 1955, Fichter 1959, Schroeder 1970), but it relies on two untested assumptions. First, it assumes equal ingress and egress of mated pairs in the area. Second, it assumes that all pairs nest throughout the breeding season or that no previously unproductive pairs replace birds that terminate nesting early. Given the uncertainty of these assumptions, we cannot clearly say whether low productivity is contributing to the lower population levels in Fillmore. However, considering the magnitude of difference, lowered productivity may be a contributing factor.

Nest success did not differ between time periods, so two proximate causes remain for lowered production: 1) the doves abandoned the study area or terminated reproductive efforts early (probably after unsuccessful attempts), or 2) the doves took longer to reneest. We are uncertain about both of these factors and we suggest additional investigation.

The results suggest that the breeding season in 1952 was 5-10 days longer (mainly at the beginning of the season) than the breeding time frame in 1992-1993. The absence of early-season data in 1951 makes it impossible to compare data for more than one year, however, and general conclusions on season length cannot be made outside of the years in question. Nesting season is a variable that depends on many factors and probably changes from year to year. Season length differed by five days between 1992 and 1993. The possibility exists that in 1952 the nesting season was unusually long. In any event, the estimate of a 14% decrease in fledglings produced for a 10-day difference was a maximum value. The realized value may be less if doves compensate through behavioural changes, such as nesting later into the season or decreasing time between reneesting.

Ostrand (1995) stated that the linear amount of shrubby vegetation along the riparian corridors changed little between 1952 and 1993 for this same study area. He was unable to measure structure or species, however. Qualitative comparison of Dahlgren's general descriptions and examination of his photographs suggest that the riparian areas were generally similar. Management of the canal vegetation is much the same as in the 1950s, with landowners occasionally cutting the vegetation and allowing it to regrow.

As noted, two tree stands present in 1952 were either gone or considerably reduced. The fact that nest height was significantly lower in 1992 and 1993 suggests that some changes in vegetation structure may have occurred.

We noted that a large portion of riparian habitat went unused for nesting. This habitat may have been unsuitable for reasons we could not see, or the general population may have been too low to occupy all suitable habitats. Nest-site availability appeared to be sufficient to support more doves in the Fillmore study site. Some areas not used in 1992 were used in 1993, and vice versa. The character of these nesting areas appeared similar. This may suggest that nesting substrate is not limiting, and the low number of nests may be due to other factors.

Predation was the largest cause of nest failure in all years. This is true for most bird species (Lack 1954, Ricklefs 1969). Overall predation rate, however, was remarkably similar during the two time periods, and we do not consider a change in predation to be a likely cause of the differences we noted in Fillmore.

Although abandonment was only a small part of overall nest failure, we did note a difference in abandonment rate between 1952 and 1993. In both studies nests were flushed on initial encounter. Nests were rechecked with the same frequency in both studies, but we avoided flushing birds a second time while Dahlgren flushed on each visit. We would expect that the initial flush would cause the bulk of investigator disturbance. However, since we flushed birds fewer times overall, our disturbance and its effect on abandonment should have been the same or less than Dahlgren's.

It is important to note that our study only describes differences between time periods. The actual changes that may have occurred throughout this time period are still unclear. Some of the differences we have observed may be due to a continued long-term decline that was initiated prior to 1951. These differences, while falling short of explaining population declines in the study area, much less the WMU, do suggest areas of future research. Many possible explanations exist for these differences, including habitat changes that may have affected food supply, nesting availability or nesting behaviour. Overall, our area shows lower reproductive output and nest density. In addition evidence exists for a higher abandonment rate and a possible delayed season. Although many explanations exist, a preponderance of literature shows that this suite of symptoms can be indicative of stress related to diet (Anderson & Stewart 1973, Jones & Ward 1976, Aboul-Ela et al. 1992) or toxicants (McArthur et al. 1983, Tori & Peterle 1983, Koval et al. 1987); see Meyers (1994) for additional references.

Although these hypotheses are speculative, some evidence does exist for lowered food and nutrient availability in our study area. Ostrand (1995) reported the absence of bee weed *Cleome serrulata*, an important early-season food source in 1951-1952, in dove diets at the Fill-

more site. Nutrient analysis (Utah State University Analytical Laboratories, Logan) shows that bee weed contains higher protein and mineral levels than local wheat. He also found a reduction in wheat production in the surrounding area and a significant correlation between the dove population and a combination of decreased wheat production and a decreased number of beef farms (doves in the area forage heavily at feed lots). Further investigation into the relationship between nesting dynamics and food stress in wild dove populations may elucidate the patterns we have observed. Also, screening for toxicants in early spring would be a simple and inexpensive way to rule out this possibility.

Because the scale of our study was small compared to the scale of the overall population decline, we suggest additional studies concentrating on season length, nest density and production. Such studies over a larger portion of the WMU may lead to broader-scale patterns. If similar patterns are not found in other declining local populations, it would suggest that the decline is occurring at a larger scale than we measured. In this case, symptoms such as low nest density may be explained by low overall dove numbers (in combination with low productivity).

A study at the Fillmore site to investigate spatial distribution of nests over several years might clarify whether a shortage of nesting habitat exists. If the birds use areas vacant in previous years, the habitat can be considered useable, and one should conclude that there simply are not enough doves to utilize available nesting habitat. In addition, an intensive telemetry study of time between re-nesting and an assessment of whether doves abandon the study area after unsuccessful nesting attempts may reveal the proximate cause of lowered reproductive output.

The effect of dove hunting in both the USA and Mexico should also be investigated. Although probably not a single cause of population declines, hunting may interact with other factors. Data from mourning dove call-count surveys (Dolton & Holmes 2002) show differing populations between hunted and non-hunted states in the Eastern Management Unit (EMU). States without hunting show stable trends for 10 and 37-year periods, whereas states with hunting show declining trends for the same time period. These areas differ spatially as well, so the ultimate cause for the differing trends is unclear. Several studies focused on survival in hunted areas have been initiated in the EMU (McGowan & Otis 1998, Otis 2002, Berdeen & Otis 2002), and banding studies have been initiated in 28 states. Because overall survival is lower in the WMU, similar studies should be conducted there.

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