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A 27-year Study of Eastern Bluebirds in Wisconsin: Productivity, Juvenile Return Rates and Dispersal Outside the Study Area

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The establishment of 'bluebird trails,' which are series of nest boxes designed and maintained for the production of bluebirds, has become increasingly popular since first advocated by Musselman (1934). As a result, many enthusiasts monitor nesting success and band nestling bluebirds, and they are encouraged to report their findings in local or national journals. However, there are few comparative studies of nesting success in bluebirds (e.g., Peakall 1970); and, in a review of recent literature, we noted that there was no consistent method of reporting these data. For example, authors often report only the total number of young fledged per 'successful' nesting attempt (i.e., those that produce at least one young) or the total number of fledged from all boxes monitored (e.g., Berner and Smith 1995). Both of these practices preclude accurate estimates of nesting success because cases of total and partial nest failure are ignored. Nest failure as a result of predation, competition for nest sites, or poor weather is often a key factor leading to differences in nesting success across areas or years in bluebirds and other passerines (Radunzel et al., in press., Arcese et al. 1992). Thus, standardization and complete reporting of results are desirable if we are to understand how bluebird populations are limited and what management tactics are most beneficial.

This article gives the results of 27 years of monitoring the nesting success of Eastern Bluebirds (*Sialia sialis*) in Wisconsin. We also present data on the return rate of banded nestlings to our study area and the regional dispersal of bluebirds. Finally, we compare our results on nesting success to those of others. Our main aim in this paper is to encourage amateur researchers to report their results in a way that makes them comparable to studies underway elsewhere, or that have occurred previously, so that we may gain a better regional picture of the ecology and conservation of this species.

METHODS

Study Area and Procedure — This study was conducted in Brown and Oconto counties near Green Bay, WI, from 1968 to 1994. Data on nesting success of bluebirds in ca. 500-700 nest boxes monitored annually were collected by VMB and several cooperating amateur ornithologists. Boxes were monitored weekly from mid-March each year until nesting began and more frequently thereafter. Data collected included date of clutch initiation, maximum number of eggs laid, and number of young hatched and banded. These data are presented here as annual means ± 1 SE.

All nestlings were banded with USF&WS metal bands at about 10 days of age. Adults were also trapped and banded at this time. We, therefore, also report number of nestlings banded in the study area that were recovered in following years. Finally, we mapped banding locations of birds recovered in the study area that had been banded elsewhere, and recovery locations of birds that we banded and that were recovered elsewhere.

These locations were supplied to us by the Bird Banding Laboratory in Laurel, Maryland.

All data reported in this paper were recorded from nesting attempts initiated in a single nest box type (Open Top Box, designed by VMB). We provide a more detailed statistical analysis of the nesting success in Open Top versus several other types of nest boxes in a separate paper (Radunzel et al., in press). The Open Top Box is modeled after fence post nest sites that bluebirds once used extensively (Zeleny 1976). The box is deep (29 cm minimum), has a predator guard on the front that extends the entrance hole (6 cm) and reduces raccoon and domestic cat predation (Radunzel et al., in press.), and it has a screened hole in the top of the box (8 cm) to discourage occupation by other species (Radunzel et al., in press).

A total of 1505 nesting attempts was recorded in Open Top nest boxes over 27 years. Nest boxes were placed in yards next to fields or along roadways and agricultural fields. All boxes were placed in what was considered prime bluebird habitat by Zeleny (1976), Munro and Rounds (1985) and Lumsden (1989).

To compare our results with those of others, we reviewed recent literature to compile summary data on mean initiation date, clutch size, number of young hatched, and number of young banded or fledged. In some cases we estimated these values. For example, many authors presented only number of nests monitored and total number of young fledged. In these cases, we calculated number of young fledged per nest by division. We note these cases where appropriate.

RESULTS AND DISCUSSION

Number of Birds Breeding — The number of females that bred at least once each year varied widely over the course of this study, from a low of 9 in 1979 to a high of 154 in 1991 (Table 1). Variation occurred although the number of boxes available remained about constant after 1970 and always exceeded the number of attempts by more than a factor of three. Sauer and Droege (1990) note that over the same period, Eastern Bluebirds showed a general decline and recovery in the Upper Midwest. We found that the number of females recorded breeding each year was closely correlated with the average number of birds observed per route in Breeding Bird Surveys conducted in Wisconsin ($r = 0.89$, $N = 21$, $P < 0.001$; Pearson correlation coefficient, data from 1968 to 1991 courtesy of D. Sample, Wisconsin Department of Natural Resources). This suggests that our observed changes in the number of females breeding were indicative of wider changes in regional population size.

Nesting Success — Bluebirds began nesting in our study area between 27 May and 14 June. However, mean date of laying was later because bluebirds did not lay synchronously, and because they often made second and third nesting attempts (Table 1). Nevertheless, when only first clutches were considered, average initiation date in our study area was still later than that reported in other studies (Table 2). This may indicate that clutch initiation occurs later at higher latitudes in bluebirds. In support of this idea, we note that Green Bay is located farther north than other study sites reporting earlier initiation dates (Table 2). Peakall (1970) reported similar relationships between latitude and clutch size in bluebirds (summarized in Table 2).

We found that clutch size averaged 4.39 eggs (N=27 yrs., SE=0.03) and varied little between years (Table 1). This value is comparable to those reported in other studies, where clutches were also found to average between four or five eggs (Table 2).

Mean number of young hatched was 3.66 (N=27 yrs., SE=0.08); but, unlike clutch size, it varied markedly across years (Table 1). This variation occurred in part because poor weather late in spring occasionally caused the failure of several nests. Although it was rare for other studies to report the number of young hatched (Table 2), we suggest that it is essential to do so if one wishes to detect at what stage nest failure most commonly occurs and hatching rate in the absence of total nest failure.

Of five studies reporting the number of young hatched, three found marginally higher values than our own long-term average of 3.66 per attempt (Table 2). However, these three

Table 1. Success of Open Top Boxes by Year. (See Methods for details.)							
Year	Number Nestings	Mean Initiation Date	Clutch Size	Number Hatched	Number Banded	Percent Young Returned	Percent Nests Successful
1968	23	31 May	4.35	4.05	3.27	1.49	83
1969	30	28 May	4.27	2.87	2.87	1.85	70
1970	20	07 Jun	4.40	4.29	3.10	3.68	75
1971	71	27 May	4.49	3.53	3.21	2.84	76
1972	64	02 Jun	4.11	3.75	3.55	2.45	89
1973	52	10 Jun	4.29	3.21	2.62	2.40	71
1974	61	10 Jun	4.21	3.39	2.85	1.91	77
1975	48	14 Jun	4.46	3.15	3.13	3.13	81
1976	28	06 Jun	4.46	3.71	3.71	0.70	86
1977	20	01 Jun	4.60	4.00	3.90	0.83	95
1978	15	13 Jun	4.13	3.07	2.53	4.88	87
1979	9	31 May	4.67	4.47	3.78	2.13	89
1980	14	03 Jun	4.00	3.64	3.64	4.62	86
1981	17	09 Jun	4.29	3.29	3.24	1.06	76
1982	20	04 Jun	4.40	3.60	3.50	3.77	84
1983	25	06 Jun	4.32	3.80	3.28	1.91	92
1984	29	04 Jun	4.45	3.66	3.31	1.40	90
1985	37	30 May	4.62	4.60	4.03	5.14	97
1986	54	27 May	4.30	3.44	3.30	2.20	83
1987	70	03 Jun	4.43	3.36	2.99	1.16	77
1988	52	30 May	4.42	3.90	3.65	2.11	92
1989	107	31 May	4.36	3.79	3.76	2.86	93
1990	136	09 Jun	4.56	3.34	2.63	2.13	73
1991	154	01 Jun	4.48	3.79	3.31	2.65	82
1992	124	03 Jun	4.40	3.79	3.55	1.14	88
1993	106	01 Jun	4.40	3.61	3.32	0.54	88
1994	116	30 May	4.47	3.71	3.56	—	89

Table 2. A Comparison of Eastern Bluebird Studies.							
Study	**Box Type**	**Boxes/Yr.**	**Date**	**Clutch**	**Hatch**	**Fledg**	**% Nests Successfu**
This Study, WI	OT	1505/27	24 May*	4.39	3.66	3.33	84
Pinkowski 1977, MI	C,NC	299/9	20 Apr.	4.48		3.94*	55
Pinkowski 1978,MI**	-	14/5	14 Apr.	4.33	3.83	3.5*	56
Pinkowski 1979,MI	C,NC	324/10	-	4.04		3.73*	57
Zuern 1994, WI	T	31/1	-	-		2.74	87
Zuern 1995,16 states + Ontario	T	118/1	-	-		3.76	-
Palahniuk & Bakko 1995, KS	C	9/1	-	4.22		2.00	-
Cousineau & Morse 1986, KS	C	20/1	-	4.59	3.79	3.54	83
Pitzrick 1986,NY		136pr/1	-	-		4.54	-
Parren 1988, VT		128/1	-	5.1		4.1	77
Thomas 1946, AR		67/9	7-10 Mar	4.06	3.18	2.69	70
Pitts 1988,TN	C	94/15	18 May	4.65	3.85	2.95	71
Laskey 1943,TN		3512 egg/5	27 Mar.	5.00		-	45
White & Woolfenden 1973, FL	C,NC	495/7	-	4.42		-	55
Musselman 1934	M	33/1	-	4.42		3.73	-
Dupree & Wright 1988, Ont.		12/1	-	-		3.50	-
Dupree & Wright 1988, Ont.		31/1	-	-		3.45	-
Rounds & Munro 1983, Man.		427/5	-	-		4.04	-
Asselin 1990, Quebec	C	20/1	-	4.15		3.45	83
Peakall 1970, WI		112/7	-	4.51		-	-
" Queb,Ont		51/7&	-	4.18		-	-
" New England		68/7	-	4.34		-	-
" NY		826/7&	-	4.58		-	-
" PA		1400/7&	-	4.57		-	-
" DE, MD, NJ		139/7&	-	4.35		-	78
" GA, NC, SC, VA		86/7	-	4.40		-	-
" FL		227/5	-	4.33		-	-
" OH		350/7&	-	4.55		-	-
" KY, WV, TN		346/6	-	4.48		-	-
" AL, LA, MS		118/5	-	4.36		-	-
" IL, IN		292/7	-	4.52		-	-
" IA, MN, NB, SD		276/7	-	4.54		-	52
" AR, KS, MO,TX,OK		151/7	-	4.52		-	-
" MI		342/7&	-	4.52		-	-

Box types are coded OT (Open Top), C (Conventional Box; closed-top, 18-20 cm deep, 10-13 cm square floor), NC (natural cavity), T (tree branch), P (Peterson Box), M (mailbox).

* = for successful nests only

** = on 3 birds

& = may be underestimate.

estimates were based on many fewer nesting attempts and years than was our long-term estimate (Table 2). Moreover, average number of young hatched in our study area surpassed that observed elsewhere in 5 of 27 years and was about equal to the values observed elsewhere in several other years (e.g., compare Table 1 and 2). We also note that number of young hatched will be influenced by clutch size, which is larger in the southern portion of the Eastern Bluebird's range (Peakall 1970, Table 2). Thus, for direct comparisons of hatching success between areas, one should divide number of young hatched by clutch size to obtain average number of young hatched per egg laid. Finally, because weather catastrophes that contribute to inter-annual variation in mortality are rare events (such as killing frosts or heavy snow; e.g., Arcese et al. 1992), short-term studies will tend to either miss such events by chance and overestimate hatching success, or experience such events and underestimate it. Because our study spanned 27 years, we suggest that it provides a good estimate of both average hatching success and typical level of variation in hatching success.

Mean number of young banded was 3.33 (N=27 yrs., SE=0.08), but it varied between 2.53 and 4.03 (Table 1). We did not find other reports of average number of young banded in studies that we reviewed. However, values that we report for banding-age young are comparable to those reported for number of young fledged in many studies elsewhere (Table 2). This suggests either that the typical mortality rate of nestlings from ca. 10 d of age to fledging is very low, or that number of young surviving to banding age in our study area is unusually high.

Many studies did report number of young fledged (Table 2), but very few of these indicated how this value was estimated. One might be tempted to think that if one or more young are observed alive as fledglings, that all young have fledged successfully. However, this method will over-estimate the number of young fledged if predators remove one or more young from the box prior to fledging, or if young in shallow boxes fledge prematurely and die as a result. One must therefore assume that unless all fledglings are counted simultaneously, or unless each is individually marked as a nestling and then subsequently counted, fledging success will be over-estimated.

The percentage of all nesting attempts that resulted in at least one young surviving to banding age ranged from 70% in 1969 to 97% in 1985. Overall, 84% of nesting attempts produced banding-age young (Table 1). This overall rate of success equaled or exceeded those reported elsewhere for survival to fledging (Table 2). This might be expected given that our estimate does not include incidents of total nest failure that may have occurred after the time of banding. However, average success reported in nine studies lasting more than one year was only 60% (Table 2), and the average of all 13 studies was only slightly higher (67%; Table 2). Because it is highly unlikely that 18% of nests failed during the period from the banding to fledging, these comparisons indicate that nesting success in Open Top boxes equaled or exceeded that observed elsewhere.

More importantly, however, we note that studies conducted over longer periods reported much lower rates of success than those reported in only one year (Table 2). This might result if amateur banders more often reported their results after particularly good seasons. Alternatively, it could also result by chance, given that bluebirds experienced large annual fluctuations in the rate of nest failure in our study (Table 1), and because longer term studies are more likely to experience such years. For example, we found that percent of successful nests exceeded 85% in 14 of 27 years, and exceeded 90% in 4 of 27 years (Table 1). Thus, studies conducted for only one year have a good probability of observing high rates of success by chance. For these reasons, we suggest that long-term studies will yield much more reliable estimates of success than those based on only a few years. Finally, most studies that we reviewed provided only total number of young fledged from successful nests, without providing information on total number of nesting attempts that were initiated. These studies were not included in Table 2 because, by ignoring incidents of total nest failure, they provided inflated estimates of fledging success.

Annual number of banded returns varied much more widely than did other measures of productivity, from a low of 0.54% in 1993 to a high of 5.14% in 1985 (Table 1). This variation may be due in part to the small average number of banded returns recorded each year and, as a result, large random errors in these annual estimates. However, more detailed analyses of these data indicate that statistically significant differences existed among years in the rate at which banded young returned to breed in the study area (Radunzel et al., in press). This suggests either that juvenile survival or natal site fidelity varied among years. We will explore the former possibility in the future by assessing the degree to which return rates were related to variation in winter weather. Unfortunately, no other studies that we reviewed presented data on the return rate of banded young. We suggest that future studies of bluebirds make every attempt to re-trap adults at nest boxes in order to gather these data, because doing so is crucial to gaining an understanding of what factors limit population size (Arcese et al. 1992).

Regional Dispersal — The majority of birds recovered were found during the breeding season, within 150 km of the center of study site (Fig. 1). Of 22 birds recovered in all, 14 were hatch-year birds of unreported sex, seven were adult females and one was an adult male. Six breeding birds were also recovered in the study area that had been banded elsewhere. One of these was a male from Michigan, one was a male from Illinois, and the remaining birds were females from elsewhere in Wisconsin. A map of the banding and recovery locations of these birds suggests that the Eastern Bluebird population in the Upper Midwest is probably more or less panmictic, with little local sub-structure (Fig. 1). This seems reasonable in light of the low annual return rate of banded nestlings that we observed (Table 1), because it is likely that many unrecovered birds survived and became breeders outside of the study area.

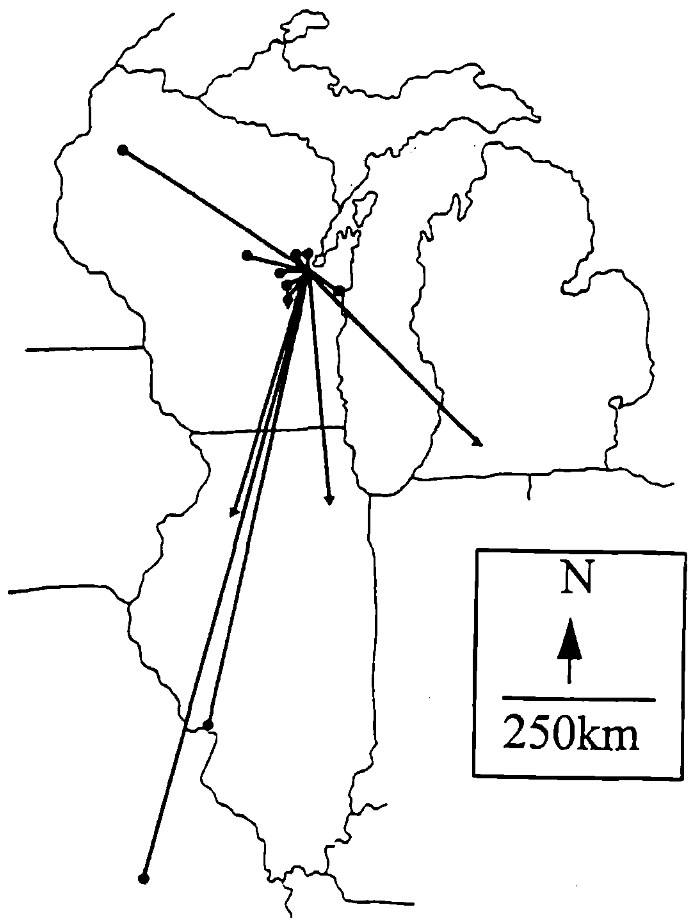
Three birds banded in the study area were recovered between November and February in Illinois, Missouri, and Arkansas, where they were apparently wintering. Two of these birds were banded as nestlings, one was banded as an adult, and all three were recovered in the first winter after being banded.

CONCLUSIONS

With careful organization and some determination, amateur banders can amass substantial amounts of information of interest to both scientific and lay audiences in ornithology. We anticipate that future analyses of our data will provide insights into the factors that affect population size in bluebirds and will thus point out which management tactics are likely to enhance their numbers. Our results suggest that Open Top nest boxes performed as well or better than the majority of other nest boxes used for the production of bluebirds (Table 2). Elsewhere, we provide a detailed statistical analysis of the aspects of various box types that enhance nesting success (Radunzel et al., in press). Overall, our results suggest that the major factor influencing variation in the production of bluebirds is the fraction of nests that are successful each year. There was relatively little difference in clutch size, or the number of young surviving to banding or fledging age if only successful nests were considered. We note that most other studies of bluebirds only present data on estimated number of young fledged. We suggest that this may not be the most accurate measure of nesting success with which to compare productivity across studies or areas because of the difficulties of observing and counting individual fledglings, and because of the tendency to over-estimate fledging success. A simple and unambiguous alternative is to report the total number of young banded per nest, including all nests where eggs were laid, even if no eggs hatch.

Recapture data for banded Eastern Bluebirds are rare, but it is invaluable if we are to understand how their populations are limited. We therefore suggest that banders re-trap adults whenever possible. At present, our results suggest that Eastern Bluebirds in the Upper Midwest probably constitute one relatively unstructured breeding population, and that variation in the local recruitment rate of juveniles may contribute to annual variation in population size.

Figure 1. Map of the upper Midwest United States showing where bluebirds from the study site originated and were recovered. Circles indicate where birds recovered on the study site were originally banded, and triangles indicate where birds banded on the study site were later recovered. The single diamond represents New London, Wisconsin, where both of the above cases apply.



SUMMARY

This article summarizes the results of 27 years of monitoring nesting success In Eastern Bluebirds in Wisconsin. A total of 1505 nesting attempts was recorded in Open Top nest boxes placed in private yards or along roads and agricultural fields. We also reviewed literature to summarize the results of others on the initiation of breeding, clutch size, and the number of young hatched, banded and fledged. Nesting began between 27 May and 14 June in each of 27 years. Clutch size averaged 4.39 eggs (N=27 yrs, SE=0.03) and varied little among years. The mean number of young hatched was 3.66 (N=27 yrs, SE=0.08), but it varied markedly across years in part because poor spring weather occasionally caused several nests to fail. The mean number of young banded was 3.33 (N=27 yrs, SE=0.08) and varied between 2.53 and 4.03 The annual percentage of all nesting attempts resulting in at least one young surviving to banding age ranged from 70% to 97% and averaged 84%. The annual percentage of banded young that returned to breed varied widely, from 0.54% to 5.14%. The distribution of recovery locations of birds banded in this study that were recovered elsewhere, and the banding locations of birds recovered in our study area, suggests that the Eastern Bluebird population in the Upper Midwest is more or less panmictic, with little local sub-structure. Our results suggest that Open Top nest boxes perform as well or better than most other nest boxes used by bluebirds, and that a key factor influencing variation in productivity is the fraction of nests that are successful each year. With careful organization

and some determination, amateur banders can amass substantial amounts of information of interest to both scientific and lay audiences in ornithology. The analysis of these data will help us to understand how bluebird populations are limited and what management tactics are most beneficial.

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LITERATURE CITED

Arcese, P., J.N.M. Smith, W.M. Hochachka, C.M. Rogers and D. Ludwig. 1992. Stability, regulation, and the determination of abundance in an insular Song Sparrow population. *Ecology* 73:805-822.

Asselin, D. 1990. Eastern Bluebird encouraged to return to southern Quebec. *Sialia* 12:93-94.

Berner, Kl.L. and B.S. Smith. 1995. 1994 nesting box report. *Sialia* 17:89-95.

Bittner, R. A. 1988. Bluebirds at Abernathy: History and 1988 results. *Blue Jay* 46: 215-217.

Cousineau, M. and W. Morse. 1986. Comparison of an established bluebird trail to new trails. *Sialia* 8:83-85.

Dupree, C., and M. Wright. 1988. Canadian nesting box report 1987. *Sialia* 19:95-96.

Laskey, A. R. 1943. The nesting of bluebirds banded as nestlings. *Bird-Banding* 14:39-43.

Lumsden, HG. 1989. Test of nest box preferences of Eastern Bluebirds, *Sialia sialis*, and Tree Swallows, *Tachycineta bicolor*. *Can. Field-Nat.* 103:595-597.

Mackintosh, D. J. 1984. Canadian nesting box report 1983. *Sialia* 6:91-93.

__________. 1986. Canadian nesting box report 1985. *Sialia* 8:93-94.

Munro, H.L. and Rounds, R.C. 1985. Selection of artificial nest sites by five sympatric passerines. *J. Wildl. Manage.* 149:264-276.

Musselman, T.E.. 1934. Help the bluebirds. *Bird-Lore* 36:9-13.

Palahniuk, D. P. and E. B. Bakko. 1995. Nesting activity on a box-paired trail. *Sialia* 17:3-6.

Parren, S. G. 1988. Bluebirds across Vermont: statewide bluebird network created. *Sialia* 10:143-144.

Peakall, D.P. 1970. The Eastern Bluebird: its breeding season, clutch size, and nesting success. *Living Bird* 9:239-256.

Pinkowski, B. C. 1977. Breeding adaptations in the Eastern Bluebird. *Condor* 79:289-302.

__________. 1978. Five years of observations of a male Eastern Bluebird. *Jack-Pine Warbler* 56:161-163.

__________. 1979. Effects of a severe winter on a breeding population of Eastern Bluebirds. *Jack-Pine Warbler* 57:8-12.

Pitts, T. D. 1988. Effects of nest box size on Eastern Bluebird nests. *J. Field Ornithol.* 59:309-313.

Pitzrick, V. M. 1986. The Amity Lake bluebird trail. *Sialia* 8:71-73.

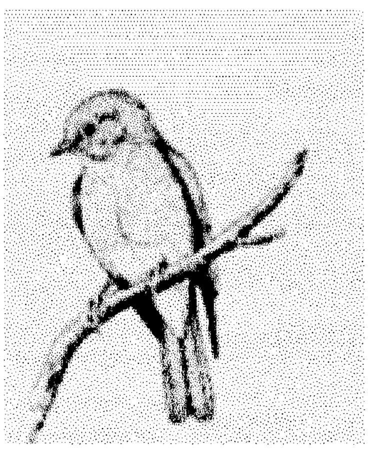
Radunzel, L. A., D. M. Muschitz, V. M. Bauldry, and P. Arcese. A long-term study of variation in the breeding success of Eastern Bluebirds by year and cavity type. *J. Field Ornithol.*, in press.

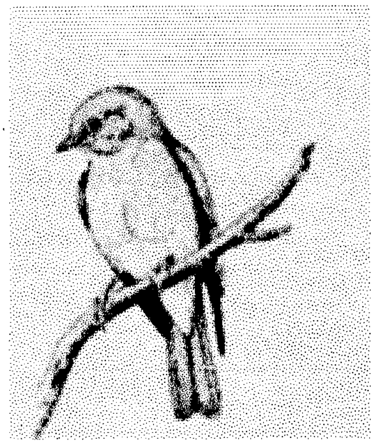
Rounds, R. C. and H. L. Munro. 1983. Brood size of the Eastern and Mountain Bluebirds in Manitoba. *J. Field Ornithol.* 54:304-311.

Sauer, J.R. and S. Droege. 1990. Recent population trends of the Eastern Bluebird. *Wilson Bull.* 102:239-252.

Shantz, B. R. 1986. A history of the Ellis bird farm. *Sialia* 8:143-146.

__________. 1984. Ellis Bird Farm Ltd. report, 1983. *Sialia* 6:93.





Thomas, R. H. 1946. A study of the Eastern Bluebird in Arkansas. *Wilson Bull.* 58:143-183.

White S. C., and G. E. Woolfenden. 1973. Breeding of the Eastern Bluebird in central Florida. *Bird-Banding* 44:110-123.

Zeleny, L. 1976. The bluebird. Indiana University Press, Bloomington.

Zuern, F. A. 1994. Tree branch bluebird house. *Sialia* 16:13-15.

__________. 1995. Tree branch bluebird box performance in 1994 field test. *Sialia* 17:23-26.