

Study



TASHIRO-VIERLING KERRI

HUMAN-COMMENSAL PREDATORS AND THEIR IMPACT IN RED-WINGED BLACKBIRD (*AGELAIUS PHOENICEUS*) BREEDING HABITAT.

Research Report

Boulder Mountain Parks

by Kerri T. Vierling, EPO Biology, CB 334

University of Colorado, Boulder, CO 80309-0334

W: 492-5842

Abstract - The objective of this study was to identify the major predators in Red-winged blackbird (*Agelaius phoeniceus*) breeding habitats in Boulder County and examine their relationship to habitat type. Using artificial nests with modeling clay eggs and a quail egg, I identified predators by marks left on the clay egg during a predation event. I examined predation in natural habitats (wetlands, tallgrass prairie) and anthropogenic habitats (hayfields, roadside ditches). During a single nine day trial, I placed twenty-five artificial nests in 4 different habitats: wetlands, tallgrass prairie, hayfields, and roadside ditches. I conducted six trials during late May and early June in 1996 and 1997. Nests in tallgrass prairie suffered the greatest amount of predation (58%) and 65% of the nests were depredated by corvids. In contrast, predation rates in all other habitats were low. Fewer than 7% of the nests in wetlands and hayfields were depredated, and 22% of the nests in roadside ditches were depredated. Corvids were major predators in all habitats except wetlands. The results of this study suggest that human-commensal predators (corvids and raccoons) are prevalent predators in Red-winged blackbird breeding habitats.

Objectives and hypothesis

Predation is a major factor affecting species population dynamics. Although predation is recognized as one of the prime causes of nest failure in avian species (Martin 1995), the identity of the predators is often unknown. The objective of this study is to identify the major predators in Red-winged blackbird (*Agelaius phoeniceus*) breeding habitats in Boulder County and examine their relationship to habitat type.

Habitat type may influence the presence of predators, especially in reference to human activity. It is generally recognized that human-commensal predators such as corvids, raccoons (*Procyon lotor*), and domestic cats (*Felis catus*) may be important predators in areas of human activity (e.g. suburbs; Wilcove 1985). While other studies have addressed predator identity as it differs among habitat

V
-
E
-
T
-
Z
9

type (Angelstam 1986, Picman 1988, Laurence et al. 1993), none do so when examining different habitat types in a suburban landscape.

I tested the hypothesis that habitat type (natural versus anthropogenic) is a prime determinant of predator identity. If habitat is a prime determinant of predator identity, then predation by human-commensal predators (corvids and raccoons) should be high in anthropogenic habitats and low in natural habitats. The alternative prediction was that habitat type does not affect the frequency of depredation by human-commensal predators, and that predation by human-commensal predators occurs equally as frequently in all habitats. This may be particularly true if suburban context is more important than habitat type.

Methodology

I purchased 100 grass bird nests which were similar in size to Red-winged blackbird nests. In each nest, I placed one Chinese quail egg (*Excalfactoria chinensis*) and one modeling clay egg. The clay egg was anchored to the nest with small drapery hooks in the bottom of the nest. I wore rubber gloves when handling nest materials and eggs in order to minimize human scent which might be used by mammals to locate the nests. In addition, I incubated both the modeling clay eggs and the nests in paper bags with vegetation and detritus for two weeks prior to the beginning of the experiment so as to mask any unnatural odors.

I ran a linear transect through the following Red-winged breeding habitats: wetlands, hayfields, tallgrass prairie, and roadside ditches. Again, I wore rubber gloves and boots in order to mask human scent (Nol and Brooks 1982, Yahner and Delong 1991). The nests were placed 5 meters away from the transect every 10 meters in an alternate fashion (one on the left, one on the right, etc.). I placed nests at variable heights to mimic Red-winged blackbird nest placement.

Twenty five nests were set out in each habitat type during a single trial and two separate trials were conducted. Red-winged blackbird incubation typically lasts 9-10 days, so artificial nests remained in the field for 9 days. Since extended periods of exposure may result in egg putrefaction (Leimgruber et al. 1994), new eggs were used in each trial. Artificial nests were monitored every 2-3 days, at which time nest contents were examined. If nests were depredated, I removed the clay egg and stored it for later identification, I identified the beak/teeth marks on the clay eggs with impressions made from museum specimens on a modeling clay template. I compared the frequency of depredation between

habitats using a chi-square contingency test. However, I was unable to compare the frequency of depredation by different species due to small sample sizes.

Results

The frequency of predation differed significantly between habitats ($\chi^2=87.2$, $p<.001$). Nests in tallgrass prairie suffered the greatest amount of predation (58%) during the study. In contrast, 9/150 of the nests in wetlands were depredated (6%), 9/150 of the artificial nests in hayfields (6%) were depredated, and 32/150 roadside ditches were depredated (22%).

Avian predators, primarily corvids, constituted major predators in all habitats (Table 1). Black-billed magpies (*Pica pica*) beak marks were found in 42% of the depredated nests, Blue jays (*Cyanocitta cristata*) depredated 10% of the nests, and American crows (*Corvus brachyrhynchos*) were responsible for only 1% of all predation events. A small percentage of the marks were made by avian predators but were unidentifiable (5%).

Very few mammalian species depredated nests in this study. Raccoons (*Procyon lotor*) were only responsible for 8 predation events in wetlands, tallgrass prairie, and roadside ditches. Fourteen depredation events by *Rattus* spp. were distributed about equally among all habitats, and 2 nests were depredated by a large mammalian predator (either *Vulpes* spp. or *Canis latrans*)

Table 1. Predation frequency on artificial nests in four different habitats. Black-billed magpies (BBMA), Blue jays (BLJA), and American crows (AMCR) were identified as avian predators.

	wetlands	tallgrass	hayfields	ditches
BBMA	1	42	3	12
BLJA	0	14	0	1
AMCR	0	1	0	0
unidentified avian predator	1	3	0	4
<i>Vulpes/Canis</i> raccoon	3	2	0	3
<i>Rattus</i>	4	4	2	4
no mark	0	10	0	6
Removed from nest	0	10	3	3
Total	9	87	9	33

Approximately 10% of the clay eggs had no marks on them.. Snakes are noted to be "clean" predators (i.e. leaving no signs at the nest) (Major 1991); they may be responsible for depredating nests and leaving no marks on the clay eggs. However, the lack of marks may also be due to the clay egg appearance/smell; if the predators did not like either the appearance or smell of the clay egg, they may not have attempted to take the clay egg.

Boulder Mountain Park study sites

Three of the wetland study sites occurred on Boulder Mountain Park land around Boulder Reservoir. The frequency of predation was <3% on these sites and the predators recorded included rats and Black-billed magpies.

Discussion and Conclusions

The frequency of predation differed significantly between habitats with tallgrass prairie experiencing the highest level of predation. One reason why tallgrass prairie nests experienced high levels of nest predation may be due to nest placement. The placement of the nests did not always coincide with suitable vegetation cover. This lack of concealment may have made it easier for visual predators such as birds to locate nests. In contrast, the nests in the other habitats were always placed in somewhat concealing microsites because those were uniformly available in those habitat types.

Depredation by human-commensal mammalian predators such as raccoons and corvids was proportionally high in all habitats. The prevalence of human-commensal predators (especially corvids) may have occurred because of the landscape context in which the study sites occur. All of the study sites occurred relatively close to suburban edges and areas of human activity. Thus, landscape context may prove to a greater determinant of predator identity than habitat type in Boulder.

Very few predation events were recorded by raccoons, which are major predators on natural nests (pers. obs.). This suggests that parental activity and presence may act as important cues for mammalian predators; since mammals hunt primarily through olfactory cues, there may be a scent associated with active nests which was absent in the artificial nest experiments (but see Gottfried and Thompson 1978).

There are two major conclusions from this study. First, the results of this study failed to support the hypothesis that predator

identity differed between habitat types. Human-commensal predators (raccoons and corvids) were associated with predation events in almost all the habitats. This suggests that in addition to habitat type, landscape context may also be important in determining the predator community.

Second, the frequency of predation on artificial nests did not reflect predation on active nests. In a study which was concurrent with this artificial nest study, Red-winged blackbird nests in wetlands, tallgrass prairie, hayfields, and roadside ditches were monitored over the summer. Active nests in roadside ditches experienced almost 80% predation rates, yet artificial nests suffered only 6% predation. The disparity in artificial versus active nest predation suggests that interpreting data concerning predation rates based solely on artificial nests must be done with caution.

LITERATURE CITED

Angelstam, P. 1986. Predation on ground-nesting birds' nests in relation to predator densities and habitat edge. *Oikos* 47: 365-373.

Gottfried, B.M. and C.F. Thompson. 1978. Experimental analysis of nest predation in an old-field habitat. *Auk* 95: 304-312.

Laurence, W.F., J. Garesche, and C.W. Payne, 1993. Avian nest predation in modified and natural habitats in tropical Queensland: an experimental study. *Wildl. Res.* 20: 711-723.

Leimgruber, P., W.J. McShea, J.H. Rappole. 1994. Predation on artificial nests in large forest blocks. *J. Wildl. Manage.* 58(2): 254-260.

Major, R.E. 1991. Identification of nest predators by photography, dummy eggs, and adhesive tape. *Auk* 108: 190-195.

Martin, T.E. 1995. Avian life history evolution in relation to nest sites, nest predation, and food. *Ecol. Monogr.* 65: 101-127.

Nol, E. and R.J. Brooks. 1982. Effects of predator exclosures on nesting success of Killdeer. *J. Field Ornithol.* 53: 263-268.

Picman, J. 1988. Experimental study of predation on eggs of ground-nesting birds: effects of habitat and nest distribution. *Condor* 90:124-131.

Yahner, R.H. and C.A. Delong. 1992. Avian predation and parasitism on artificial nests and eggs in two fragmented landscapes. *Wilson Bull.* 104: 162-168.

Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. *Ecology* 66: 1211-1214.

Source and sink habitats of Red-winged blackbirds

Kerri T. Vierling, University of Colorado

Dept. of Environmental, Population, and Organismic Biology

492-5842

e-mail: kerri@ucsuc.colorado.edu

Abstract

The objective of this study was to determine the source and sink habitats of Red-winged blackbirds (*Agelaius phoeniceus*). Between 1995-1997, I monitored 591 Red-winged blackbird nests in natural (wetland, tallgrass prairie) and anthropogenic (hayfields, roadside ditches) habitats. On average, Red-winged blackbirds experienced higher reproductive success in natural habitats (42%) than in anthropogenic habitats (16%). Predation was the major cause of nest failures, and differed significantly between natural and anthropogenic habitats. While anthropogenic always functioned as demographic sinks, the prediction that natural habitats functioned as sources was not supported. Source status of natural habitats varied with year and type of habitat. Tallgrass prairie was a strong source in 1996 and a strong sink in 1995 and 1997. Alternatively, Red-winged blackbirds nesting in wetlands in the absence of Yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) functioned as a possible source in 1995, but not in 1996 or 1997. All natural habitats functioned as demographic sinks in 1997. These data suggest that predation is the major determinant of habitat quality and that it strongly influences source-sink status. In addition, these data indicate that Boulder may function as a regional sink, possibly because human commensal predators may thrive in the suburban-rural landscape.

Objectives and hypotheses

A continuum of habitat quality exists for species concerning reproduction and mortality. The concept of source and sink population dynamics relates specifically to this variability of habitat quality. Source habitats are those in which reproduction exceeds mortality whereas mortality exceeds reproduction in sink habitats (Pulliam 1988). While many models exist which detail source and sink population dynamics, few field studies have adequately tested these models. My overall objective is to determine the source and sink habitats of the Red-winged blackbird (*Agelaius phoeniceus*). This study examines the sink/source population dynamics of this generalist species at a landscape level in a mosaic of habitats that are

natural (wetland, tallgrass prairie) and anthropogenic (roadside ditches, hayfields).

I tested two hypotheses in relation to this study:

Hypothesis 1: Predation is a prime determinant of breeding habitat quality.

Prediction: Predation is higher in anthropogenic habitats than in natural habitats.

Hypothesis 2: Habitat-specific predation rates determine which habitats function as sources or sinks.

Prediction 1: Source habitats will have lower predation rates than sink habitats.

Prediction 2: Natural habitats will function as sources whereas anthropogenic habitats will function as sinks.

Study sites

The 36 study sites were located throughout Boulder and were primarily properties owned by Open Space and Boulder Mountain Parks. Anthropogenic habitats were classified as either those in which cultivation, mowing, and/or spraying of insecticides/pesticides occurred whereas habitats in which those activities did not occur were classified as natural. I studied Red-winged blackbird population dynamics in the following habitat types: 6 wetlands with both Yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) and Red-winged blackbirds, 9 wetlands with Red-winged blackbirds breeding in the absence of Yellow-headed blackbirds, 5 tallgrass prairie sites, 5 hayfields, and 11 roadside ditches.

Methodology

Predation rates

I monitored as many nests as possible every 2-3 days in the above habitats. If the nest contents disappeared prior to the fledging of young, a predation event occurred. I quantified the frequency of predation rates on nests in the different habitats and statistically analyzed the data using a contingency table (Zar 1984). Although I present the data as percentages, I used the frequency of predation compared to the total sample size for the statistical analysis.

Source and sink determination

Determination of source and sink habitats requires both reproductive and mortality data. Using the method outlined by Donovan et al. (1995), I can estimate the minimum number of fledglings required to offset adult mortality. A population will replace itself if:

Equation 1:

1- adult survivorship = mean # of female offspring/female/year x juvenile survivorship

(Ricklefs 1973); rearranging equation 1 yields equation 2, which can be used to determine source and sink habitats.

Equation 2:

1- adult survivorship/juvenile survivorship = mean # of female offspring/female/year

If the observed productivity (mean number of female offspring/female/year) is less than (1-adult survivorship)/juvenile survivorship, I will conclude that the population is a sink (Donovan et al. 1995). Conversely, if the observed productivity exceeds (1-adult survivorship)/juvenile survivorship, I will conclude that the population is a source.

The calculation of the mean number of female offspring per female requires the use of four different parameters: the mean number of female offspring produced per successful nest, habitat-specific reproductive success, the number of renests, and the number of broods per year (Donovan et al. 1995). I calculated reproductive success using the Mayfield method (1975) and all other values were gathered through observation.

The calculation of source and sink habitats also requires the use of mortality data. While habitat-specific mortality may occur, I will assume similar mortality rates among habitats for the following reasons. First, mortality rates among breeding habitats may be relatively insignificant compared to overwinter mortality. The highest rates of mortality for most birds occur during the winter and since Red-winged blackbirds from all breeding habitats form winter flocks, these birds are subject to the same winter mortality pressures regardless of their breeding habitats. In addition, acquisition of habitat-specific mortality data require a long term study and this is not feasible within the time framework of this project. For these reasons, I will use published estimates of Red-winged blackbird for

the above calculations. Annual adult survival estimates range from 52-62% while the survival of juveniles in the first year ranges from 49-65% (Fankhauser 1961, Stewart 1978, Beletsky 1996). Using an average of mortality estimates from the literature, these calculations indicate that those populations producing fewer than 0.86 fledglings/female/year may be considered sinks while those producing more than 0.86 fledglings/female/year may be considered sources.

Results

Predation rates among habitats

Predation was the main cause of nest failures in the different habitats (Table 1). Predation differed significantly between habitats ($\chi^2=13.4$, $df=1,4$, $p<.001$); birds nesting in roadside ditches experienced the greatest amount of predation while birds breeding in wetland areas experienced the lowest predation rates. On average, 45% of all nests in natural habitats were depredated whereas 70% of all nests in anthropogenic habitats were depredated.

In order to determine source and sink habitats, data on reproductive success and productivity were gathered (Table 2). Reproductive success differed significantly between habitats ($\chi^2=29.7$, $p<.001$) with natural habitats experiencing the highest success and anthropogenic habitats experiencing the lowest success. Productivity, the average number of fledglings/nest, also differed significantly between habitats ($F=8.9$, $p<.0001$). Nests in natural habitats fledged more young on average (1.3 fledglings/nest) than did anthropogenic habitats (0.56 fledglings/nest).

Source-sink determination

Source-sink status varied with the mortality estimates and survivorship estimates used, so a table was constructed to illustrate the range of productivity values necessary to offset adult mortality (Table 3).

Source-sink status varied between habitats. In general anthropogenic habitats functioned as strong sinks throughout the three year study (Table 4). Regardless of the mortality and survivorship estimates used, both hayfields and roadside ditches produced significantly fewer offspring than would be needed to offset adult mortality. This trend was true in 1995, 1996, and 1997.

While natural habitats tended to experience higher levels of reproductive success and productivity, they did not consistently

function as source habitats. Using the average for mortality estimates, the only natural habitat which possibly functioned as a source over the three year study was tallgrass prairie (Table 4). Wetlands with Red-winged Blackbirds nesting in the absence of Yellow-headed Blackbirds most likely functioned as a weak sink while Red-winged Blackbirds nesting in wetlands with both species of blackbirds produced a similar number of female offspring as Red-winged Blackbirds nesting in anthropogenic habitats.

Source-sink status of natural habitats also varied between years (Table 4). In 1995, most natural habitats functioned as sinks, unless juvenile survivorship values were extremely high (see Table 3). In 1996, tallgrass probably functioned as a source, with both wetlands functioning as weak sinks. In 1997, all natural habitats were demographic sinks.

In general, there was a strong relationship between predation and source-sink status. Habitats with high predation rates (roadside ditches, wetlands with both Yellow-headed Blackbirds and Red-winged Blackbirds) tended to function as strong sinks while those with lower predation rates either functioned as sources or as weak sinks. Predation rates and the mean number of female fledglings/female were negatively correlated (-0.87). This suggests that higher values of predation led to lower productivity values; hayfields did not quite match the predicted productivity because many of the nests failed due to mowing.

Boulder Mountain Parks properties

Boulder Reservoir was the only Mountain Park property used in this study, and reproduction at the reservoir for 1997 was slightly better than those recorded elsewhere for this year (Table 5). However, the wetlands at Boulder Reservoir apparently functioned as demographic sinks this year, as did all wetlands. While 0.86 female fledglings/female/year would need to be produced to maintain a population, neither wetland type produced enough young to maintain the population. Wetlands with both species of blackbird produced 0.20 female fledglings/female/year while wetlands with Red-winged blackbirds only produced 0.42 female fledglings/female/year.

Discussion and Conclusions

For Red-winged blackbirds, predation was the prime determinant of habitat quality. Birds breeding in anthropogenic habitats suffered higher predation rates than those which nested in natural habitats. Hayfields often have artificially high densities of predators (Andren et al. 1985, Angelstam 1986) while roadside

ditches often function as travel corridors for predators (Fritzell 1978).

The level of predation in a habitat was a good predictor of whether that habitat functioned as a source or sink. In general, habitats with high predation rates functioned as sinks whereas habitats with low predation rates functioned as sources. A similar relationship between predation and source/sink habitats was found for migratory birds nesting in fragmented versus unfragmented forests in North America. Birds nesting in fragmented forests suffered higher rates of predation and parasitism by Brown-headed Cowbirds (*Molothrus ater*); in general, the fragmented forests acted as sinks whereas unfragmented forests appeared to be population sources (Donovan et al. 1995). Rogers et al. (1997) also found predation to be a major factor on source-sink status for Song Sparrows nesting in British Columbia.

Interspecific competition for nest sites apparently contributed to the sink status wetlands with both Red-winged Blackbirds and Yellow-headed Blackbirds. The displacement of Red-winged Blackbirds to the periphery of the marsh may have increased the risk of nest predation. High rates of predation have been noted for Red-winged Blackbirds nesting in similar situations at other sites (Young 1963). Presumably, nests at the periphery of the marsh are more accessible to some mammalian predators than nests that occur in the deeper water at the interior of the marsh (Leonard and Picman 1987).

Weather influenced laying dates and affected predation rates. Birds nesting later in the season experienced higher levels of nest predation than birds nesting early. These data suggest that the wetter springs of 1995 and 1997 delayed nest initiation such that the nests were more likely to be depredated. Similar trends have been found for other avian species (e.g. Wood ducks *Aix sponsa*; Hepp and Kennamer 1993). Nests initiated later in the season may have a higher probability of predation because many predators such as Black-billed magpies (*Pica pica*) and raccoons may be foraging with their young when Red-winged blackbirds are beginning to breed (Bailey and Niedrach 1965, Cushman et al. 1993, Fitzgerald et al. 1995).

Factors other than predation contributed to sink status. Hayfields were mowed during the height of the Red-winged Blackbird breeding season and caused approximately 21% of all nest losses. In 1995, mowing contributed strongly to the sink status of hayfields. In 1996 and 1997, the impacts of mowing were not as strong. However, mowing coupled with predation caused hayfields to

function as strong sinks, which has been noted elsewhere (Frawley 1989).

The results of this study suggest that the area of Boulder functioned as regional sink for Red-winged blackbirds over a three year period. Landscape context may be an important factor influencing source-sink status, because the majority of study sites occurred in a matrix of suburban/rural settings. Human-commensal predators such as raccoons and corvids may be much more abundant in such a matrix (Hoffman and Gottschang 1977, Wilcove 1985) and may have serious impacts on nesting birds. Further studies addressing landscape context should elucidate the relationship between landscape context and source-sink status.

Literature Cited

- Andren, J., P. Angelstam, E. Lindstrom, and P. Widen. 1985. Differences in predation pressure in relation to habitat fragmentation. *Oikos* 45: 273-277.
- Angelstam, P. 1986. Predation on ground-nesting birds' nests in relation to predator densities and habitat edge. *Oikos* 47: 365-373.
- Bailey, A.M. and R.J. Niedrach. 1965. *Birds of Colorado*. Denver Museum of Natural History, Denver, Colorado.
- Beletsky, L. 1996. *The Red-winged Blackbird: the biology of a strongly polygynous songbird*. Academic Press, San Diego, California.
- Cushman, R.C., S.R. Jones, and J. Knopf. 1993. *Boulder County Nature Almanac*, Pruett Publishing Company, Boulder, Colorado.
- Donovan, T.M., F.R. Thompson III, J. Faaborg, and J.R. Probst. Reproductive success of migratory birds in habitat sources and sinks. *Cons. Biol* 9: 1380-1395.
- Fankhauser, D.P. 1967. Survival rates in Red-winged blackbirds. *Bird-Banding* 38: 139-142.
- Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. *Mammals of Colorado*. Denver Museum of Natural History and University Press of Colorado, Niwot, Colorado.
- Frawley, B.J. 1989. The dynamics of nongame bird breeding ecology in Iowa alfalfa fields. M.S. Thesis. Iowa State Univ., Ames, Iowa.
- Fritzell, E.K. 1978. Habitat use by prairie raccoons during the waterfowl breeding season. *J. Wildl. Manage.* 42: 118-127.
- Hepp, G.R. and R.A. Kennamer. 1993. Effects of age and experience on reproductive performance of Wood Ducks. *Ecology* 74: 2027-2036.
- Hoffman, C.O. and J.L. Gottschang. 1977. Numbers, distribution, and movements of a raccoon population in a suburban residential community. *J. of Mammal.* 58: 623-636.

Leonard, M.L. and J. Picman. 1987. Nestling mortality and habitat selection by marsh wrens. *Auk* 104: 491-495.

Mayfield, H. 1975. Suggestions for calculating nest success. *Wilson Bull.* 87: 456-466.

Pulliam, H.R. 1988. Sources, sinks, and population regulation. *Amer. Nat.* 132: 652-661.

Ricklefs, R. 1973. Fecundity, mortality, and avian demography. pages 366-435 in D.S. Farner ed. *Breeding biology of birds*. Nation Academy of Science.

Rogers, C.M., M.J. Taitt, J.N.M. Smith, and G. Jongejan. 1997. Nest predation and cowbird parasitism create a demographic sink in wetland-breeding Song Sparrows. *Condor* 99: 622-633.

Stewart, P. 1978. Survival tables for starlings, Red-winged blackbirds, and common grackles. *North Amer. Bird Bander* 3: 93-94.

Wilcove, D. 1985. Nest predation in forest tracts and the decline of migratory songbirds. *Ecology* 66: 1211-1214.

Young, H. 1963. Age-specific mortality in the eggs and nestlings of blackbirds. *Auk* 80: 145-55.

Zar, J. 1984. *Biostatistical Analysis*. Prentice Hall, New Jersey.

Table 1. Predation rates on Red-winged blackbird nests in Boulder County between 1995-1997. YEBL refers to yellow-headed blackbirds and REBL refers to Red-winged blackbirds. * Mowing accounted for 21% of failed nests in hayfields.

Habitat types	%Failure	% Predation	% Other
Natural habitats			
Wetlands w/ YEBL+REBL	83	71	12
Wetlands w/REBL only	55	45	10
Tallgrass prairie	54	51	3
Anthropogenic habitats			
Cultivated hayfields	77	54	23
Roadside ditches	89	86	3

Table 2. Reproductive success (calculated as the number of nests successful in fledging at least one young/all nests) and productivity (average number of fledglings/all nests \pm s.e.) of Red-winged blackbirds nesting in different habitats from 1995-1997. YEBL refers to Yellow-headed blackbird and REBL refers to Red-winged blackbirds.

Habitat types	Reproductive success (%)	Productivity
Natural habitats		
Wetlands w/YEBL+REBL	17	0.64 (\pm 0.20)
Wetlands w/ REBL only	45	1.4 (\pm 0.09)
Tallgrass prairie	46	1.4 (\pm 0.29)
Anthropogenic habitats		
Cultivated hayfields	23	0.69 (\pm 0.16)
Roadside ditches	11	0.73 (\pm 0.11)

Table 3. Number of female fledglings/female/year necessary to offset adult mortality/juvenile survival based on different survival and mortality estimates.

	Highest adult mortality (0.55)	Average adult mortality (0.44)	Lowest adult mortality (0.35)
Lowest juvenile survival (0.30)	1.8	1.5	1.2
Average juvenile survival (0.51)	1.1	0.86	0.69
Highest juvenile survival (0.65)	0.85	0.68	0.46

Table 5. Comparison of reproductive parameters between Boulder Reservoir and other study sites in Boulder in 1997. Productivity is measured as the number of fledglings/all nests. Sample sizes (the number of nests) are in parentheses. N/A means that no other study sites were used. YEBL refers to Yellow-headed blackbirds and REBL refers to Red-winged blackbirds

	Boulder Reservoir		Other sites	
	% Reproductive success	Productivity	% Reproductive success	Productivity
Wetlands w/ YEBL+REBL	9.5 (31)	0.38	n/a	n/a
Wetlands w/ REBL only	33.9 (55)	.63	14.2 (8)	1.02