

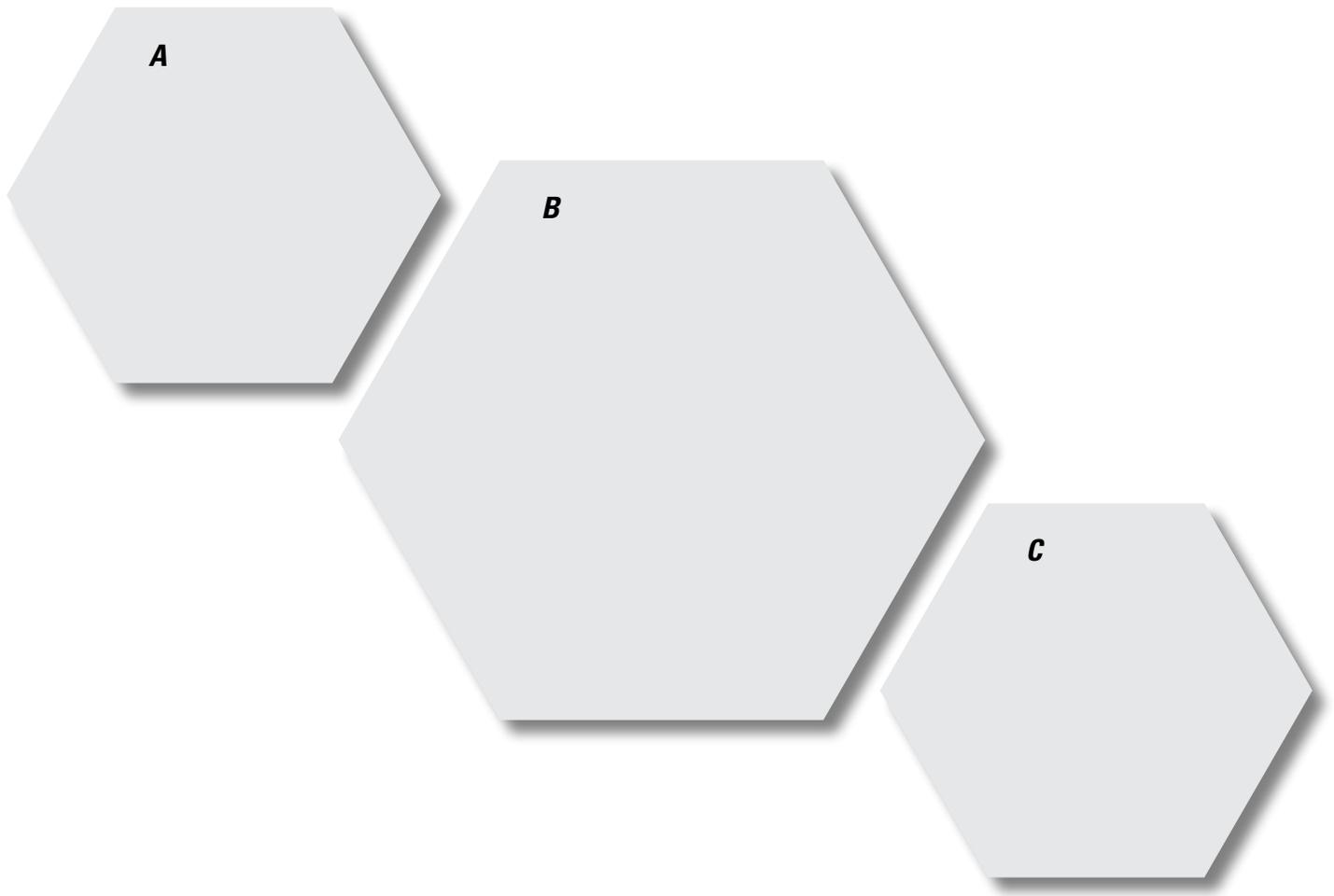
# The Effects of Management Practices on Grassland Birds— Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds

Chapter PP of

**The Effects of Management Practices on Grassland Birds**



Professional Paper 1842–PP



**Cover.** *A*, Female Brown-headed Cowbird. Photograph by David O. Lambeth, used with permission. *B*, Parasitized Clay-colored Sparrow nest with two Clay-colored Sparrow eggs and three Brown-headed Cowbird eggs. Photograph by Lawrence D. Igl, U.S. Geological Survey. *C*, Male Brown-headed Cowbird. Photograph by David O. Lambeth, used with permission. Background photograph: Northern mixed-grass prairie in North Dakota, by Rick Bohn, used with permission.

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By Jill A. Shaffer,<sup>1</sup> Lawrence D. Igl,<sup>1</sup> and Douglas H. Johnson<sup>1</sup>

Chapter PP of

## **The Effects of Management Practices on Grassland Birds**

Edited by Douglas H. Johnson,<sup>1</sup> Lawrence D. Igl,<sup>1</sup> Jill A. Shaffer,<sup>1</sup> and John P. DeLong<sup>1,2</sup>

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<sup>1</sup>U.S. Geological Survey.

<sup>2</sup>University of Nebraska-Lincoln (current).

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## Abbreviations

BBS	Breeding Bird Survey
spp.	species (applies to two or more species within the genus)

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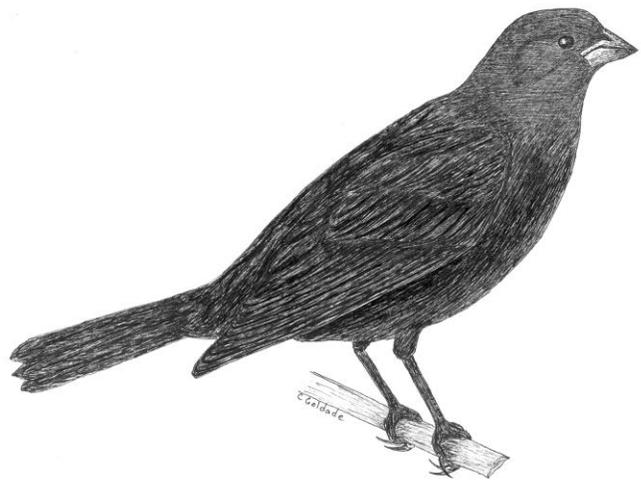
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## General Overview

The Brown-headed Cowbird (*Molothrus ater*) is an obligate brood parasite that relies entirely on host species to incubate its eggs and rear its young. The cowbird evolved on the open grasslands of the Great Plains, but its population expanded eastward and westward following European settlement (fig. PP1; Mayfield, 1965; Rothstein and others, 1980; Lowther, 1993). The species' current breeding distribution is widespread, covering much of the 48 conterminous United States, southern Canada, and northern Mexico. Note that northern Mexico is not shown in figure PP1 because the ability of the North American Breeding Bird Survey to document the status of the Brown-headed Cowbird and other North American bird species whose breeding ranges extend into northern Mexico has been limited by a lack of information from poorly surveyed regions in Mexico (Pardieck, 2008). At the continental level, the cowbird reaches its highest abundance in the center of its breeding range in the northern Great Plains, and cowbird abundance generally declines with increasing distance from the Great Plains (Thompson and others, 2000; Igl and Johnson, 2007; Sauer and others, 2013). Vernacular and scientific names of plants and animals follow the Integrated Taxonomic Information System (<https://www.itis.gov/>) and the 59th Supplement to the American Ornithological Society's Checklist of North American Birds (Chesser and others, 2018).

Although cowbirds are not considered a serious threat to their primary avian hosts (Ortega and others, 2005), cowbird brood parasitism has been recognized as a potential threat to the survival of threatened and endangered species (for example, Kirtland's Warbler [*Setophaga kirtlandii*]; Kelly and DeCapita, 1982) and has been implicated in the declines of other bird species through reduced reproductive output (Rothstein, 1975, 1990; Mayfield, 1977; Payne, 1977; Brittingham and Temple, 1983; Sealy, 1992; Robinson and others, 1995). As a result, efforts to control or limit cowbird populations in North America are common (Rothstein and Robinson, 1998; Ortega and others, 2005). Elsewhere, Shaffer and others (2003) summarized factors that affect cowbird distribution and parasitic activity and described how cowbirds respond to grassland management practices (for example,



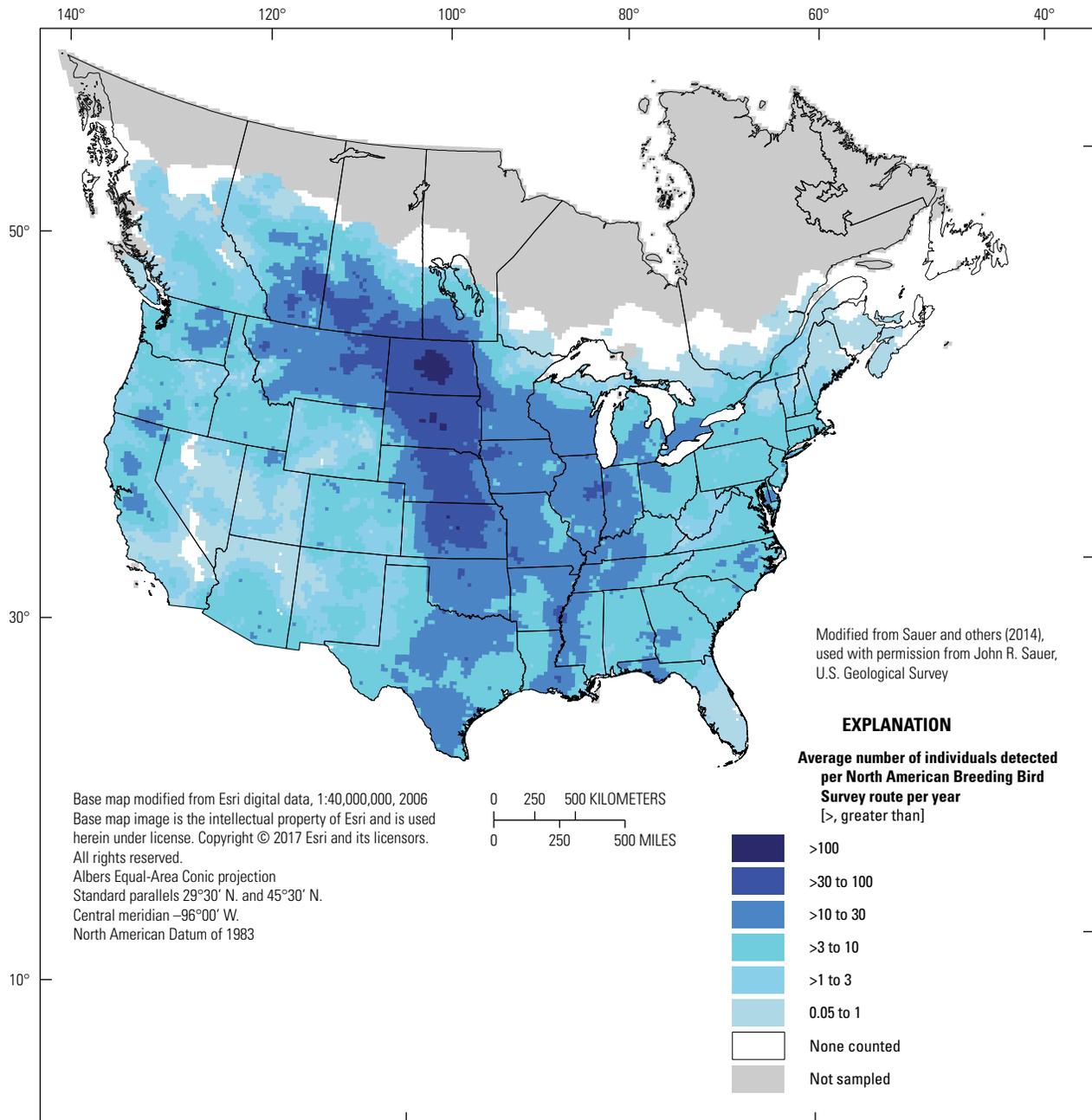
Brown-headed Cowbird. Illustration by Christopher M. Goldade, U.S. Geological Survey.

burning, haying, and grazing), including those practices aimed at controlling or limiting cowbird populations. Keys to discouraging Brown-headed Cowbird parasitism or controlling populations of Brown-headed Cowbirds in the Great Plains are maintaining large expanses of grassland, eliminating foraging areas (for example, feedlots) and perch sites, and reducing the extent of overgrazed pastures (Shaffer and others, 2003). Herein, cowbird parasitism rates are summarized for the 40 species of grassland birds included in “The Effects of Management Practices on Grassland Birds” (Johnson and others, 2019).

## Rates of Cowbird Parasitism

Rates of cowbird brood parasitism, obtained from the literature and from unpublished data provided by colleagues, are summarized for 40 grassland bird species in table PP1. The frequency of nests parasitized was used as an index to the rates of parasitism, and the rate (percent) of cowbird parasitism was defined as the total number of parasitized nests ( $\times 100$ ) divided

## 2 Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds



**Figure PP1.** Breeding distribution of the Brown-headed Cowbird (*Molothrus ater*) in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data, 2008–12. The BBS abundance map provides only an approximation of breeding range edges.

by the total number of nests reported for a given species in a study.

The Brown-headed Cowbird is a host generalist; eggs of the cowbird have been found in nests of more than 220 species of North American birds (Ortega, 1998; Lowther, 2016). Of the 40 focal grassland bird species, 25 are known victims of cowbird parasitism (table PP1), including four of the 18 nonpasserine species (Greater Prairie-Chicken [*Tympanuchus cupido*], Upland Sandpiper [*Bartramia longicauda*], Wilson's Phalarope [*Phalaropus tricolor*], and Ferruginous

Hawk [*Buteo regalis*]). Of the 22 grassland passerines, 21 were identified as hosts of the Brown-headed Cowbird (table PP1). There are no known records of cowbird brood parasitism for one passerine, the Sedge Wren (*Cistothorus platensis*), perhaps because the entrance to its globular-shaped nest is too small for female cowbirds to enter (Herkert and others, 2001). The McCown's Longspur (*Rhynchophanes mccownii*) is considered a host based on historical accounts consisting of one to two nests that were parasitized (Friedmann, 1963), but in records consisting of 10 or more nests,

parasitism was not reported (table PP1). Wilson's Phalarope and Loggerhead Shrike (*Lanius ludovicianus*) also exhibited very low parasitism; each species had at least one report of 1 percent (table PP1). The highest parasitism rate was for the Dickcissel (*Spiza americana*), at 95 percent. Fourteen species had one or more studies reporting heavy (greater than 30 percent) parasitism (as defined by Mayfield, 1965), whereas five species experienced low (less than 10 percent) parasitism rates (table PP1). Three species—Sprague's Pipit (*Anthus spragueii*), Chestnut-collared Longspur (*Calcarius ornatus*), and LeConte's Sparrow (*Ammospiza leconteii*)—experienced low-to-moderate (10–30 percent) parasitism rates. The remaining three parasitized species (Greater Prairie-Chicken, Ferruginous Hawk, and Nelson's Sparrow [*Ammospiza nelsoni*]), two of which are nonpasserines, had only one or two incidental records of cowbird parasitism, so a parasitism rate could not be calculated.

Nonpasserine species are generally considered to be unsuitable or inappropriate hosts of the Brown-headed Cowbird because the cowbird's diet or its developmental strategy (altricial) are incompatible with those of the hosts (Sealy, 2015), and thus, nonpasserine nests usually are avoided by Brown-headed Cowbirds (Rothstein and Robinson, 1998; Sealy, 2015). Sealy (2015) summarized Friedmann's (1929, 1963) proposed requirements for the suitability of hosts of parasitic cowbirds (*Molothrus* species [spp.]): (1) the hosts exhibit an altricial post-hatching pattern of development, (2) the hosts lay eggs not much bigger than the cowbird's eggs, (3) the hosts place food into the nestlings' gaping bills, and (4) the hosts feed the young an arthropod diet that will sustain the cowbird's development. None of the four parasitized species of nonpasserine grassland birds are known to have raised cowbird young (Ortega, 1998; Sealy, 2015). In contrast, most of the 21 passerine cowbird hosts are known to have fledged cowbird young from parasitized nests (Ortega, 1998; Shane, 2000; Green and others, 2002; Davis and Lanyon, 2008; Davis and others, 2014). Only three grassland passerine hosts are not known to have raised cowbird young: Loggerhead Shrike, McCown's Longspur, and Nelson's Sparrow (Ortega, 1998; Yosef, 1996; With, 2010; Shriver and others, 2011).

The reported rates of brood parasitism by Brown-headed Cowbirds vary considerably among and within grassland host species (table PP1), making it difficult to identify generalizable patterns across a species' breeding range. Jensen and Cully (2005a, 2005b) and Igl and Johnson (2007) found evidence of decreasing parasitism levels among grassland birds as distance increases from the center of the cowbird's breeding range in the Great Plains. A few species with widespread breeding distributions follow this pattern, although not consistently, with generally higher parasitism rates in the southern or northern Great Plains and lower parasitism rates east and west of this area. These species include the Savannah Sparrow (*Passerculus sandwichensis*), Grasshopper Sparrow (*Ammodramus savannarum*), Eastern Meadowlark (*Sturnella magna*), Bobolink (*Dolichonyx oryzivorus*),

and Dickcissel (table PP1). Species with breeding ranges restricted to the northern Great Plains that do not conform to this pattern include the Sprague's Pipit, Chestnut-collared Longspur, McCown's Longspur, and Baird's Sparrow (*Centronyx bairdii*). Of these species, the Baird's Sparrow was the only species to experience heavy parasitism (36 percent), and that only occurred in one study (Davis, 1994; Davis and Sealy, 1998). The data presented in table PP1 emphasize the complexity and variability of cowbird parasitism in North America and can serve as a reminder that cowbird parasitism rates are not constant across space or time. Brown-headed Cowbirds differentially parasitize hosts within the same habitats, even within the core of the cowbird's breeding range (Igl and Johnson, 2007). Many factors affect parasitism rates, including location, habitat, proximity of nests to woodland and other habitat edges, alternate hosts, and defensive host behaviors.

## Host Defenses against Parasitism

Mayfield (1965) indicated that grassland birds may have evolved behavioral defenses against Brown-headed Cowbird brood parasitism because of their long evolutionary history of co-occurrence in the Great Plains. Evolutionarily, however, cowbirds and their hosts have interacted for a relatively short period of time (2.8–3.8 million years) compared to other brood parasite-host systems on other continents (Rothstein and others, 2002; Peer and others, 2013). As such, cowbirds lack some of the more sophisticated adaptations (for example, egg mimicry) possessed by other brood parasites (for example, Common Cuckoo [*Cuculus canorus*]), and host defenses against cowbird brood parasitism are less complex than defenses exhibited by hosts of other brood parasites (Peer and others, 2013). Defenses possessed by cowbird hosts in grasslands include aggressively defending their nests against female cowbirds, egg rejection, desertion of parasitized nests, and burying cowbird eggs in the nest lining. Many cowbird hosts display aggressive behavior toward cowbirds (Ortega, 1998), including several grassland bird species: Loggerhead Shrike, Clay-colored Sparrow (*Spizella pallida*), Field Sparrow (*Spizella pusilla*), Bobolink, and Eastern Meadowlark (Robertson and Norman, 1976, 1977; Grieff, 1995; Ortega, 1998). The success of aggressive behaviors in preventing cowbird parasitism is considered limited (Sealy and others, 1998; Peer and others, 2013). About 13 percent of cowbird hosts are known to reject cowbird eggs (Peer and Sealy, 2004). Of the grassland birds that have been identified as cowbird hosts, the Loggerhead Shrike is considered an egg rejecter (Rothstein, 1982). Several other grassland birds have been recently identified as intermediate rejecters, including the Eastern Meadowlark, Western Meadowlark (*Sturnella neglecta*), and Dickcissel (Peer and others, 2000). Nest desertion is considered a more effective anti-parasitism strategy. Among smaller cowbird hosts, nest desertion is a

common response to cowbird parasitism (Ortega, 1998; Hosoi and Rothstein, 2000). Nest desertion with subsequent re-nesting has been reported in about 16 percent of known cowbird hosts (Hosoi and Rothstein, 2000), although the frequency of abandonment may be quite low (Sealy, 1999; Davis and Sealy, 2000). The frequency of desertion of parasitized nests appears to be more common in grasslands and other nonforest habitats than in forest habitats (Hosoi and Rothstein, 2000). Grassland birds known to abandon their nests as a result of parasitism or cowbird removal of host eggs include the Clay-colored Sparrow, Brewer's Sparrow (*Spizella breweri*), Field Sparrow, Lark Sparrow (*Chondestes grammacus*), Lark Bunting (*Calamospiza melanocorys*), Grasshopper Sparrow, Eastern Meadowlark, and Dickcissel (Baepler, 1968; Hill, 1976; Walley, 1985; Ortega, 1991; Hosoi and Rothstein, 2000). Burial of cowbird eggs by a host is a less common defense against cowbird brood parasitism and is sometimes considered a continuation of nest building (Rothstein, 1975; Sealy, 1995). The Clay-colored Sparrow occasionally buries cowbird eggs in its nest lining (Igl and Johnson, 2007).

## Summary

The Brown-headed Cowbird is an obligate brood parasite that relies entirely on host species to incubate its eggs and rear its young. The Brown-headed Cowbird is a host generalist; eggs of the cowbird have been found in nests of more than 220 species of North American birds. Although cowbirds are not considered a serious threat to their primary avian hosts, cowbird brood parasitism has been recognized as a potential threat to the survival of threatened and endangered species and has been implicated in the declines of other bird species through reduced reproductive output. In this chapter, we summarized the rates of cowbird brood parasitism for 40 grassland bird species. The reported rates of brood parasitism by Brown-headed Cowbirds varied considerably among and within grassland host species, and the factors that influence parasitism rates were described. Defenses possessed by cowbird hosts in grasslands include aggressively defending their nests against female cowbirds, egg rejection, desertion of parasitized nests, and burying cowbird eggs in the nest lining.

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**14 Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds**

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<i>Greater Prairie-Chicken (Typanuchus cupido)</i>			
1 record	--	Minnesota	Svedarsky, 1979.
<i>Upland Sandpiper (Bartramia longicauda)</i>			
1 record	--	Manitoba	Davis and others, 1999.
1 record	--	North Dakota	Higgins, 1971.
1 record	--	Minnesota	J.H. Bowles <i>in</i> Friedmann, 1963.
1 record	--	Montana	Igl and Johnson, 2007.
0	15	Nebraska	Kempema, 2007.
0	16	Oklahoma	Reinking and others, 2009.
0	21	Wisconsin	R.B. Renfrew, Vermont Center for Ecostudies, Norwich, Vermont, written commun. [n.d.].
0	28	Minnesota, North Dakota	M. Winter, WissenLeben e.V., Raisting, Germany, and D.H. Johnson, unpub. data.
<1	189	North Dakota	Higgins and Kirsch, 1975.
5	43	Nebraska	Faanes and Lingle, 1995.
8	13	South Dakota	Berman, 2007.
<i>Wilson's Phalarope (Phalaropus tricolor)</i>			
1 record	--	Manitoba	Hatch, 1971.
2 records	--	Utah	Williams and Trowbridge, 1938.
0	21	Minnesota, North Dakota	M. Winter and D.H. Johnson, unpub. data.
1	386	Saskatchewan	M.A. Colwell and D. Delehanty <i>in</i> Colwell and Jehl, 1994.
<i>Ferruginous Hawk (Buteo regalis)</i>			
1 record	--	North Dakota	A. Eastgate <i>in</i> Friedmann, 1929.
<i>Loggerhead Shrike<sup>b,c</sup> (Lanius ludovicianus)</i>			
0	10	Washington	Vander Haegen and Walker, 1999.
0	60	Missouri	Kridelbaugh, 1983.
0	61	Minnesota	Brooks and Temple, 1990.
0	77	Colorado	Porter and others, 1975.
0	131	Oklahoma	Tyler, 1992.
0	162	Idaho	Woods and Cade, 1996.
<1	1,661	Manitoba	K.D. De Smet, Manitoba Conservation Data Centre, Winnipeg, Manitoba, written commun. [n.d.].
1	261	Iowa	De Geus and Best, 1991.
<i>Horned Lark (Eremophila alpestris)</i>			
0	12	Washington	Vander Haegen and Walker, 1999.
0	23	Saskatchewan	Gaudet, 2013.
0	140	Wyoming	Mahoney and Chalfoun, 2016.
0	163	Saskatchewan	Maher, 1973.
2	201	Quebec	Terrill, 1961.
3	161	Ontario	Peck and James, 1987.
4	119	Ontario	Ontario nest records, <i>in</i> Friedmann and others, 1977.

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented; --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Horned Lark (<i>Eremophila alpestris</i>)—Continued</b>			
9	11	Illinois	Robinson and others, 2000.
16	32	Minnesota, Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
19	16	Kansas, Missouri, Nebraska	Lowther, 1977.
19	26	North Dakota	R.E. Stewart <i>in</i> Friedmann and others, 1977.
45	31	Kansas	Hill, 1976.
53	15	Saskatchewan	S.K. Davis, Canadian Wildlife Service, Regina, Saskatchewan, written commun. [n.d.].
60	84	North Dakota	Koford and others, 2000.
<b>Sprague's Pipit (<i>Anthus spragueii</i>)</b>			
0	11	Saskatchewan	Lusk, 2009.
0	11	Alberta	Yoo and Koper, 2017.
0	21	Alberta	Ludlow and others, 2014.
0	24	Saskatchewan	B. Dale, unpub. data, <i>in</i> Robbins and Dale, 1999.
0	33	Saskatchewan	Maher, 1973.
0	33	Saskatchewan	Gaudet, 2013.
0	50	Saskatchewan	G.C. Sutter, Royal Saskatchewan Museum, Regina, Saskatchewan written commun. [n.d.].
0	61	Saskatchewan	Pipher, 2011.
2	58	Alberta, Saskatchewan	Sutter and others, 2016.
2	128	Montana	Jones and others, 2010.
15	20	Manitoba	De Smet, 1992.
15	65	Saskatchewan	Davis, 2003.
16	19	Saskatchewan	Klippenstine and Sealy, 2008.
18	17	Manitoba	Davis, 1994, Davis and Sealy, 2000.
<b>Chestnut-collared Longspur (<i>Calcarius ornatus</i>)</b>			
0	36	Saskatchewan	Fairfield, 1968.
0	38	Saskatchewan	Regina Museum of Natural History Nest Record Cards, <i>in</i> Fairfield, 1968.
0	54	Saskatchewan	Lusk, 2009.
0	111	Saskatchewan	Maher, 1973.
0	115	Saskatchewan	Pipher, 2011.
0	254	Alberta	Hill and Gould, 1997.
<1	212	Saskatchewan	Gaudet, 2013.
1	137	Alberta	Yoo and Koper, 2017.
2	770	Montana	Jones and others, 2010.
4	23	Manitoba	Harris, 1944.
4	27	Saskatchewan	Smith and Smith, 1966.
4	71	North Dakota	Granfors and others, 2001.
5	96	Saskatchewan	Klippenstine and Sealy, 2008.
7	42	South Dakota	Berman, 2007.

**16 Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds**

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Chestnut-collared Longspur (<i>Calcarius ornatus</i>)—Continued</b>			
8	26	Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
12	26	Manitoba	De Smet, 1992.
14	57	Manitoba	Davis, 1994; Davis and Sealy, 2000.
14	352	Montana	Lloyd, 2003.
16	490	Saskatchewan	Davis, 2003.
18	22	Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Maher, 1973.
22	37	North Dakota	R.E. Stewart <i>in</i> Friedmann and others, 1977.
23	62	North Dakota	Stewart, 1975.
<b>McCown's Longspur (<i>Rhynchophanes mccownii</i>)</b>			
1 record	--	Saskatchewan	Macoun and Macoun, 1909.
1 record	--	Saskatchewan	S.J. Darcus <i>in</i> Friedmann, 1963.
1 record	--	North Dakota	A. Eastgate <i>in</i> Friedmann, 1963.
2 records	--	North Dakota	L.B. Bishop <i>in</i> Friedmann, 1963.
0	45	Wyoming	Mickey, 1943.
0	60	Montana	DuBois, 1935.
0	71	Wyoming	Mahoney and Chalfoun, 2016.
0	74	Saskatchewan	Maher, 1973.
<b>Clay-colored Sparrow<sup>b,d,e</sup> (<i>Spizella pallida</i>)</b>			
0	13	Wisconsin	Vos and Ribic, 2013.
2	250	North Dakota	Grant and others, 2006.
5	781	Minnesota, North Dakota	Winter and others, 2004.
9	434	North Dakota	Murphy and others, 2017.
10	135	Minnesota	Johnson and Temple, 1990.
11	204	Manitoba	Hill and Sealy, 1994.
11	246	North Dakota	Pietz and others, 2009.
12	196	Minnesota, Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
14	492	North Dakota	Granfors and others, 2001.
17	496	North Dakota	Kerns and others, 2010.
20	20	Alberta	Salt, 1966.
23	13	Ontario	Ontario nest records, <i>in</i> Friedmann and others, 1977.
24	49	North Dakota	Koford and others, 2000.
24	275	Alberta, Manitoba, Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Friedmann and others, 1977.
27	82	Saskatchewan	Davis, 2003.
33	40	Minnesota	Buech, 1982.
36	232	Manitoba	Knapton, 1978.
38	29	Ontario	Peck and James, 1987.
38	42	North Dakota	Romig and Crawford, 1995.
39	33	North Dakota	Stewart, 1975.

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Brewer's Sparrow<sup>d</sup> (<i>Spizella breweri</i>)</b>			
0	12	Nevada	Rotenberry and Wiens, 1989.
0	17	Wyoming	A. Chalfoun, U.S. Geological Survey, Laramie, Wyoming, written commun. [n.d.].
0	18	Montana	L.D. Igl and D.H. Johnson, unpub. data.
0	44	Montana	Logan, 2001.
0	79	Montana	B. Walker, Colorado Parks and Wildlife, Grand Junction, Colorado, written commun. [n.d.].
0	110	Oregon	Rotenberry and Wiens, 1989.
0	133	Montana	A. Chalfoun, written commun. [n.d.].
0	153	Wyoming	A. Holmes, Northwest Wildlife Science, LLC, written commun. [n.d.].
1	428	Montana	Abe, 2007.
3	32	British Columbia	Cannings and others, 1987.
4	657	British Colombia	Mahony and others, 2006.
5	281	Washington	Vander Haegen and Walker, 1999.
6	363	Washington	Vander Haegen, 2007.
13	16	Idaho	Rich, 1978.
52	25	Alberta	Biermann and others, 1987.
58	19	Washington	N. Mahony, Environment and Climate Change Canada, Edmonton, Alberta, written commun. [n.d.].
<b>Field Sparrow<sup>b,d</sup> (<i>Spizella pusilla</i>)</b>			
<1	681	Pennsylvania	Burhans and others, 2001.
1	276	Kentucky, Tennessee	Giocomo and others, 2008.
3	32	Michigan	Evans, 1976.
3	36	Minnesota, North Dakota	M. Winter and D.H. Johnson, unpub. data.
3	66	Indiana	Nolan, 1963.
6	93	Indiana	Galligan and others, 2006.
7	122	California, Oklahoma, Texas	Western Foundation Collection, <i>in</i> Friedmann and others, 1977.
11	36	Michigan	Batts, 1958.
11	147	Illinois	Best, 1978.
11	443	Missouri	Burhans and others, 2000.
13	122	Kentucky, Tennessee	Hinnebusch, 2008.
14	22	Wisconsin	Vos and Ribic, 2013.
14	86	Illinois	Robinson and others, 2000.
16	57	Pennsylvania	Norris, 1947.
18	33	Michigan	Berger, 1951.
19	334	Ontario	Peck and James, 1987.
20	25	Illinois	Best, 1979.
20	179	Ontario	Ontario nest records, <i>in</i> Friedmann and others, 1977.
21	52	Michigan	Sutton, 1960.
27	667	Michigan	Walkinshaw, 1978.
30	10	Minnesota	Buech, 1982.
32	72	Michigan	Evans, 1978.

**18 Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds**

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Field Sparrow<sup>b,d</sup> (<i>Spizella pusilla</i>)—Continued</b>			
32	159	Ohio	Hicks, 1934.
36	14	Kansas, Missouri, Nebraska	Lowther, 1977.
49	141	Kansas	Rivers and others, 2010.
52	71	Illinois	Strausberger and Burhans, 2001.
53	19	Illinois	Strausberger and Ashley, 1997.
59	29	Illinois	Strausberger, 1998.
80	20	Iowa	Crooks, 1948; Crooks and Hendrickson, 1953.
<b>Vesper Sparrow (<i>Poocetes gramineus</i>)</b>			
0	10	Iowa	Frawley, 1989.
0	12	Saskatchewan	Maher, 1973.
0	18	Michigan, Pennsylvania, Wisconsin	Harrison, 1975.
0	19	Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Maher, 1973.
0	22	Alberta	Yoo and Koper, 2017.
0	28	Minnesota, North Dakota	M. Winter and D.H. Johnson, unpub. data.
0	53	North Dakota	Granfors and others, 2001.
0	56	Saskatchewan	Gaudet, 2013.
<1	246	North Dakota	Grant and others, 2006.
1	37	Saskatchewan	Pipher, 2011.
1	85	Michigan	F.C. Evans <i>in</i> Berger, 1968.
2	53	Alberta	Ludlow and others, 2014.
2	119	Wisconsin	Vos and Ribic, 2013.
3	77	Washington	Vander Haegen and Walker, 1999.
3	107	California, Oklahoma, Texas	Western Foundation Collection, <i>in</i> Friedmann and others, 1977.
4	74	Quebec	Terrill, 1961.
4	84	Washington	Vander Haegen, 2007.
5	42	Alberta, Saskatchewan	Sutter and others, 2016.
8	112	Quebec	Hicks, 1934.
10	89	Michigan	Southern and Southern, 1980.
11	45	Iowa	Rodenhouse and Best, 1983.
11	442	Ontario	Peck and James, 1987.
12	195	Alberta, Manitoba, Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Friedmann and others, 1977.
15	20	Minnesota, Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
15	110	Saskatchewan	McMaster and others, 1999.
15	242	Ontario	Ontario nest records, <i>in</i> Friedmann and others, 1977.
16	25	Michigan	J.F. Ponshair <i>in</i> Berger, 1968.
18	44	Saskatchewan	Lusk, 2009.
20	40	Saskatchewan	Klippenstine and Sealy, 2008.
26	94	North Dakota	Koford and others, 2000.
61	41	Iowa	Stallman and Best, 1996.

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Lark Sparrow<sup>d</sup> (<i>Chondestes grammacus</i>)</b>			
0	18	Kansas	Erickson, 2017.
0	24	Washington	Vander Haegen and Walker, 1999.
5	20	Texas	Bennett and others, 2014.
6	17	Oklahoma	Ely, 1957.
7	228	California, Oklahoma, Texas	Western Foundation Collection, <i>in</i> Friedmann and others, 1977.
8	25	Minnesota, North Dakota	M. Winter and D.H. Johnson, unpub. data.
10	318	Texas	Long and others, 2012.
13	15	Manitoba	Walley, 1985.
13	23	Oklahoma	Patten and others, 2011.
18	11	Illinois	Robinson and others, 2000.
20	15	Alberta, Manitoba, Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Friedmann and others, 1977.
23	22	Oklahoma	Reinking and others, 2009.
27	22	Kansas	R.F. Johnston <i>in</i> Friedmann, 1963.
41	42	Nebraska	Kempema, 2007.
45	33	Oklahoma	Newman, 1970.
71	17	Kansas	Rivers and others, 2010.
82	11	Kansas	Hill, 1976.
<b>Lark Bunting<sup>d</sup> (<i>Calamospiza melanocorys</i>)</b>			
0	30	Kansas	Shane, 2000.
8	12	Nebraska	Kempema, 2007.
10	51	Saskatchewan	Lusk, 2009.
15	142	Kansas	Hill, 1976.
19	93	Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
21	77	Kansas	Wilson, 1976.
28	18	Montana, North Dakota, South Dakota	Allen, 1874.
55	22	Saskatchewan	Sealy, 1999.
61	23	North Dakota	Koford and others, 2000.
<b>Savannah Sparrow (<i>Passerculus sandwichensis</i>)</b>			
0	26	Michigan	Southern and Southern, 1980.
0	30	Saskatchewan	Pipher, 2011.
0	120	Alberta	Yoo and Koper, 2017.
1	405	Wisconsin	Renfrew and others, 2005.
2	54	Michigan	Potter, 1974.
4	27	Saskatchewan	Gaudet, 2013.
4	140	Quebec	Terrill, 1961.
7	14	Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Maher, 1973.
7	531	Ontario	Peck and James, 1987.
7	675	Minnesota, North Dakota	Winter and others, 2004.

20 Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Savannah Sparrow (<i>Passerculus sandwichensis</i>)—Continued</b>			
10	82	Minnesota, Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
11	190	Alberta	Ludlow and others, 2014.
11	542	Wisconsin	R.B. Renfrew, written commun. [n.d.].
13	240	Ontario	Ontario nest records, <i>in</i> Friedmann and others, 1977.
13	260	Montana	Jones and others, 2010.
16	83	North Dakota	Pietz and others, 2009.
16	111	Alberta, Manitoba, Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Friedmann and others, 1977.
20	236	North Dakota	Kerns and others, 2010.
21	24	Manitoba	De Smet, 1992.
21	150	North Dakota	Granfors and others, 2001.
22	27	Saskatchewan	Lein, 1968.
26	141	North Dakota	Murphy and others, 2017.
28	47	Saskatchewan	Klippenstine and Sealy, 2008.
29	83	Saskatchewan	Davis, 2003.
30	100	Montana	Fondell and Ball, 2004.
32	31	Manitoba	Davis, 1994; Davis and Sealy, 2000.
37	46	Minnesota	Johnson and Temple, 1990.
<b>Grasshopper Sparrow<sup>d</sup> (<i>Ammodramus savannarum</i>)</b>			
0	23	Missouri	Winter, 1998.
0	78	Wisconsin	Renfrew and others, 2005.
0	85	Wisconsin	Vos and Ribic, 2013.
0	131	Kentucky, Tennessee	Giocomo and others, 2008.
2	41	Indiana	Galligan and others, 2006.
2	100	Ohio	Price, 1934, <i>in</i> Friedmann, 1963.
3	32	Wisconsin	Byers and others, 2017.
4	102	Wisconsin	R.B. Renfrew, written commun. [n.d.].
4	123	Montana	Jones and others, 2010.
6	273	Oklahoma	Reinking and others, 2009.
7	46	Minnesota	Johnson and Temple, 1990.
7	274	Oklahoma	Patten and others, 2011.
8	13	Illinois	Robinson and others, 2000.
8	39	Minnesota, North Dakota	M. Winter and D.H. Johnson, unpub. data.
8	74	Ontario	Peck and James, 1987.
9	62	Iowa	Patterson, 1994; Patterson and Best, 1996.
10	21	North Dakota	Granfors and others, 2001.
20	61	Minnesota, Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
21	85	Nebraska	Kempema, 2007.
22	18	Kansas	Hill, 1976.
26	58	North Dakota	Koford and others, 2000.

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Grasshopper Sparrow<sup>d</sup> (<i>Ammodramus savannarum</i>)—Continued</b>			
27	48	Manitoba	Davis, 1994; Davis and Sealy, 2000.
27	327	Iowa	Hovick and others, 2012.
30	40	Manitoba	De Smet, 1992.
33	18	South Dakota	Berman, 2007.
34	61	Kansas	Jensen, 1999.
40	81	Kansas	Erickson, 2017.
44	339	Kansas, Oklahoma	Rahmig and others, 2009.
48	46	Kansas	Rivers and others, 2010.
50	18	Kansas	Elliott, 1978.
58	12	Kansas	Klute, 1994; Klute and others, 1997.
<b>Baird's Sparrow (<i>Centronyx bairdii</i>)</b>			
0	11	Saskatchewan	Maher, 1973.
0	23	Saskatchewan	Gaudet, 2013.
0	24	Alberta	Yoo and Koper, 2017.
0	31	Saskatchewan	Pipher, 2011.
4	89	Montana	Jones and others, 2010.
5	39	Saskatchewan	Lusk, 2009.
6	35	Alberta	Ludlow and others, 2014.
15	13	Manitoba	De Smet and Conrad, 1991.
16	68	Manitoba	De Smet, 1992.
16	70	Saskatchewan	Klippenstine and Sealy, 2008.
21	182	Saskatchewan	Davis, 2003.
27	11	North Dakota	Granfors and others, 2001.
36	76	Manitoba	Davis, 1994; Davis and Sealy, 1998.
<b>Henslow's Sparrow (<i>Centronyx henslowii</i>)</b>			
0	20	Wisconsin	Byers and others, 2017.
0	21	Indiana	Galligan and others, 2006.
0	35	Missouri	Jaster and others, 2014.
0	39	Kentucky, Tennessee	Hinnebusch, 2008.
1	113	Kentucky, Tennessee	Giocomo and others, 2008.
1	135	Indiana	Crimmins and others, 2016.
1	136	Indiana	J. Robb and others <i>in</i> Herkert and others, 2002.
5	59	Missouri	Winter, 1999.
8	12	Ontario	Peck and James, 1987.
8	24	Oklahoma	Patten and others, 2011.
8	24	Oklahoma	Reinking and others, 2009.
9	22	Oklahoma	D. Reinking <i>in</i> Winter, 1999.

**22 Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds**

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

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Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>LeConte's Sparrow (<i>Ammospiza leconteii</i>)</b>			
0	36	Wisconsin	T.C. Erdman <i>in</i> Lowther, 2005; Richter, 1969.
2	50	Minnesota, North Dakota	Winter and others, 2005.
25	12	Minnesota, North Dakota, South Dakota	Igl and Johnson, 2007.
29	14	Minnesota	Peabody, 1901.
<b>Nelson's Sparrow (<i>Ammospiza nelsoni</i>)</b>			
1 record	--	Manitoba	J. Lane <i>in</i> Hill, 1968.
1 record	--	Montana	Nordhagen and others, 2005.
<b>Bobolink<sup>b</sup> (<i>Dolichonyx oryzivorus</i>)</b>			
0	12	Illinois	Buxton and Benson, 2015.
0	19	Michigan	Southern and Southern, 1980.
0	20	Wisconsin	Martin, 1967.
5	184	Ohio	Hicks, 1934.
6	52	Wisconsin	Byers and others, 2017.
6	136	Ontario	Peck and James, 1987.
11	314	Minnesota, North Dakota	Winter and others, 2004.
12	104	Wisconsin	R.B. Renfrew, written commun. [n.d.].
18	237	Iowa	Fletcher and others, 2006.
19	78	Minnesota, Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
25	12	North Dakota	Koford and others, 2000.
25	68	North Dakota	Pietz and others, 2009.
31	36	North Dakota	Granfors and others, 2001.
34	47	Minnesota	Johnson and Temple, 1990.
40	108	North Dakota	Kerns and others, 2010.
51	839	Nebraska	D. Kim <i>in</i> Renfrew and others, 2015.
<b>Eastern Meadowlark<sup>b,c,d</sup> (<i>Sturnella magna</i>)</b>			
0	11	Wisconsin	Vos and Ribic, 2013.
0	27	Ohio	S.D. Hull, Wisconsin Department of Natural Resources, Madison, Wisconsin, written commun. [n.d.].
0	20	Missouri	Jaster and others, 2014.
0	87	Kentucky, Tennessee	Giocomo and others, 2008.
0	131	Indiana	Galligan and others, 2006.
0	311	Illinois	Walk and others, 2010.
2	52	Quebec	Terrill, 1961.
2	57	Illinois	Robinson and others, 2000.
2	370	Ontario	Peck and James, 1987.
4	26	Ontario	Ontario nest records, <i>in</i> Friedmann and others, 1977.
5	582	Oklahoma	Reinking and others, 2009.
6	36	Wisconsin	Byers and others, 2017.
6	244	unspecified region	Cornell nest records, <i>in</i> Friedmann and others, 1977.
6	631	Oklahoma	Patten and others, 2011.

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

[For each species, entries are ordered by increasing parasitism rate. For commonly parasitized species, only reports of 10 or more nests are included. For rarely parasitized species, reports are included regardless of the number of nests to indicate that parasitism has been documented. --, no data; n.d., no date; <, less than]

Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
<b>Eastern Meadowlark<sup>b,c,d</sup> (<i>Sturnella magna</i>)—Continued</b>			
10	47	Missouri	Winter, 1998.
16	38	Wisconsin	Lanyon, 1957.
22	49	Kansas	Erickson, 2017.
22	110	Wisconsin	R.B. Renfrew, written commun. [n.d.].
25	269	Kansas, Oklahoma	Rahmig and others, 2009.
27	67	Kansas	Rivers and others, 2010.
31	69	Kansas	Jensen, 1999.
49	71	Kansas	Granfors, 1992.
50	10	Kansas	Fleischer, 1986.
50	14	Kansas	Franco, 1972.
70	40	Kansas	Elliott, 1978.
<b>Western Meadowlark<sup>c</sup> (<i>Sturnella neglecta</i>)</b>			
0	17	Alberta	Yoo and Koper, 2017.
0	19	Saskatchewan	Gaudet, 2013.
0	36	Washington	Vander Haegen and Walker, 1999.
4	26	Alberta	Ludlow and others, 2014.
7	29	Kansas	Hill, 1976.
7	42	Montana	Fondell and Ball, 2004.
9	54	Nebraska	Kempema, 2007.
11	71	Minnesota, North Dakota	M. Winter and D.H. Johnson, unpub. data.
15	34	Saskatchewan	Klippenstine and Sealy, 2008.
16	56	Minnesota, Montana, North Dakota, South Dakota	Igl and Johnson, 2007.
18	76	Minnesota	Johnson and Temple, 1990.
20	20	Saskatchewan	Prairie Nest Records Scheme, <i>in</i> Maher, 1973.
22	41	Wisconsin	Lanyon, 1957.
25	103	Saskatchewan	Davis, 2003.
26	119	Montana	Jones and others, 2010.
44	36	South Dakota	Berman, 2007.
44	65	Manitoba	Davis, 1994; Davis and Sealy, 2000.
45	320	North Dakota	Koford and others, 2000.
46	24	Manitoba	De Smet, 1992.
<b>Dickcissel<sup>c,d</sup> (<i>Spiza americana</i>)</b>			
0	21	Wisconsin	Vos and Ribic, 2013.
0	29	Illinois	Robinson and others, 2000.
0	204	Kentucky, Tennessee	Giocomo and others, 2008.
1	505	Illinois	Walk and others, 2010.
2	733	Mississippi	Conover and others, 2011.
3	86	Texas	Lituma and others, 2012.
3	143	Texas	Steigman, 1993.
4	47	Indiana	Galligan and others, 2006.

24 Rates of Brown-Headed Cowbird (*Molothrus ater*) Parasitism in Nests of North American Grassland Birds

**Table PP1.** Rates of brood parasitism in nests of grassland bird species that are known victims of Brown-headed Cowbirds (*Molothrus ater*).—Continued

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Parasitism rate (percent) <sup>a</sup>	Number of nests	Location	Source
Dickcissel <sup>c,d</sup> ( <i>Spiza americana</i> )—Continued			
5	22	Texas	Fretwell and others, 1974.
7	269	Oklahoma	Churchwell and others, 2008.
8	12	Oklahoma	Ely, 1957.
8	24	Kansas, Missouri, Nebraska	Lowther, 1977.
9	241	Missouri	Winter, 1999.
16	86	Illinois	Buxton and Benson, 2015.
17	1,208	Oklahoma	Patten and others, 2011.
18	40	Missouri	Jaster and others, 2014.
18	1,107	Oklahoma	Reinking and others, 2009.
19	200	Iowa	Fletcher and others, 2006.
21	34	Iowa	Frawley, 1989.
26	23	Kansas	R.F. Johnston <i>in</i> Friedmann, 1963.
31	61	Oklahoma	Overmire, 1962.
33	15	Oklahoma	Wiens, 1963.
33	39	Iowa	Patterson, 1994; Patterson and Best, 1996.
45	957	Kansas, Oklahoma	Rahmig and others, 2009.
50	28	Kansas	Hill, 1976.
50	477	Kansas, Oklahoma	Jensen and Cully, 2005b.
53	17	Nebraska	Hergenrader, 1962.
56	124	Kansas	Jensen, 1999; Jensen and Finck, 2004.
58	184	Kansas	Erickson, 2017.
60	186	Kansas	Hughes, 1996.
65	23	Kansas	Fleischer, 1986.
68	57	Iowa	L.D. Igl, unpub. data.
69	620	Kansas	Zimmerman, 1983.
70	890	Kansas	Rivers and others, 2010.
78	55	Kansas	Zimmerman, 1966.
82	34	Kansas	Klute, 1994; Klute and others, 1997.
83	71	Kansas	Sandercock and others, 2008.
91	65	Kansas	Hatch, 1983.
95	19	Kansas	Elliott, 1978.

<sup>a</sup>The following grassland bird species are not known victims of Brown-headed Cowbird brood parasitism: Greater Sage-Grouse (*Centrocercus urophasianus*), Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*), Mountain Plover (*Charadrius montanus*), Long-billed Curlew (*Numenius americanus*), Marbled Godwit (*Limosa fedoa*), Willet (*Tringa semipalmata*), American Bittern (*Botaurus lentiginosus*), Northern Harrier (*Circus hudsonius*), Swainson's Hawk (*Buteo swainsoni*), Golden Eagle (*Aquila chrysaetos*), Burrowing Owl (*Athene cunicularia*), Short-eared Owl (*Asio flammeus*), Merlin (*Falco columbarius*), Prairie Falcon (*Falco mexicanus*), and Sedge Wren (*Cistothorus platensis*).

<sup>b</sup>Occasionally displays aggressive behavior toward cowbirds.

<sup>c</sup>Ejects cowbird eggs from parasitized nests in some populations.

<sup>d</sup>Occasionally abandons nests due to cowbird brood parasitism.

<sup>e</sup>Occasionally buries cowbird eggs in nest lining.

For more information about this publication, contact:  
Director, USGS Northern Prairie Wildlife Research Center  
8711 37th Street Southeast  
Jamestown, ND 58401  
701-253-5500

For additional information, visit: <https://www.usgs.gov/centers/npwrc>

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