

**LONG-TERM MONITORING OF PARASITISM AND PREDATION IMPACTS ON  
SENSITIVE NEOTROPICAL MIGRATORY SONGBIRDS IN BOULDER,  
COLORADO.**

**Year-end Report**

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## LONG-TERM MONITORING OF PARASITISM AND PREDATION IMPACTS ON SENSITIVE NEOTROPICAL MIGRATORY SONGBIRDS IN BOULDER, COLORADO.

### Abstract

The foothill ponderosa pine forests along the Colorado Front Range are an important, unique and understudied habitat. Ponderosa pine forests are important to a variety of wildlife species, including breeding Neotropical migrant songbirds. Among the number of songbirds breeding in this habitat are a number of species considered sensitive to landscape changes that increase nest predation and Brown-headed Cowbird parasitism. From 1997-1999 we found and monitored 385 nests; of those 33.5% (n = 349) were known to have been preyed upon, and 28.4% of 155 Brown-headed Cowbird host species' nests were parasitized. Nesting success (i.e., fledging at least 1 young) was significantly lower ( $P < 0.05$ ) for parasitized species (53.1%, n=143) than nonparasitized species (64.6%, n=206), implicating the strong negative effect of cowbird parasitism on host populations. There were no strongly significant trends in parasitism, predation or nest success between migrants nesting in ponderosa pine forests close to the city of Boulder and those nesting in similar forests at an equal elevation and slope farther away from the potential urban effects at Heil Ranch.

In 1998-1999 the avian community was surveyed at 219 50-m radius point count stations across 11 major habitat types, during three early morning 10 minute counts at the height of the breeding season. Avian richness was highest in foothill riparian habitats, while richness in grassland habitat was significantly lower than in all other habitat classes sampled. Using a Partner's-in-Flight (PIF) weighted conservation ranking scheme for evaluating Neotropical migrant habitat, we strongly suggest that the most important habitats for migrants in Boulder County are grasslands and foothill riparian. PIF rankings of all 219 points are provided. 160 of the 219 points were also surveyed for Brown-headed Cowbirds, 1998-1999, in the morning (sunrise  $\pm$  30 minutes until three hours past sunrise) when cowbirds are searching for nests to parasitize, in the afternoon (1200 - 1500 h), when they are generally feeding and in the evening (1700-2000 h) when they are feeding or going to roost. Brown-headed Cowbirds were found to be most abundant in foothill and lowland riparian habitats and ponderosa pine forests close to Boulder in the morning, foothill riparian in the afternoon, and in foothill riparian and urban in the evening.

Brown-headed Cowbird parasitism and nest predation have strong impacts on the nesting success of Neotropical migrants in Boulder County. There is no strong evidence at this time of urban effects on the nesting success, even though there is an urban effect on cowbird abundance and distribution. PIF values from the 219 morning census locations suggest that habitats of with the greatest abundance, and thus of great concern for breeding migrants are grassland and foothill riparian habitats. Coniferous foothill habitats also provide important breeding sites for priority species such as the Virginia's Warbler, MacGillivray's Warbler, Green-tailed Towhee, and the *Empidonax* flycatchers. Further analysis with Geographical Information System (GIS) software will allow us to build predictive models for all the open space properties from these 219 points. Additionally, logistic regression analysis of specific nest-site parameters (e.g., distance to urban edge) will allow us to determine if there are any strong patterns of parasitism and predation associated with Neotropical migrant nest failure in Boulder County.

## Introduction

Foothill ponderosa pine (*Pinus ponderosa*) is fairly common along the east slope of the Colorado Front Range, extending north and south along the entire length of the state (Little 1971). It can be characterized by a park-like appearance of open canopy ponderosa pine, scattered Douglas fir (*Psuedotsuga menziesii*), and an understory composed of five major plant associations including shrubs and a ground covering of mixed grass and rock outcrops (Forest Ecosystem Management Plan 1999). A number of Neotropical migrants breed in ponderosa pine and adjacent montane riparian and shrubland habitats of Boulder County, many of which are considered sensitive across their southwestern range (Winternitz and Crumpacker 1985, Hall et al. 1997, Rich and Breadmore 1997).

Our objective was to determine the effects of urbanization on the distribution, abundance, and reproductive success of Neotropical migrant songbirds breeding in the foothill ponderosa pine forests and adjacent riparian and shrub habitats west of Boulder, Colorado.

This report is compilation of three years of field study, 1997-1999, across several jurisdictions. In addition to data collected on City of Boulder Open Space we also provide information on data collected on Boulder Mountain Parks and Boulder County Open Space. This provides a more comprehensive examination of cowbird and nest predation impacts on sensitive Neotropical migrants breeding in Boulder County.

## Methods and Materials

**Study Sites** - All research was conducted on Boulder County Open Space (BCOS), City of Boulder Open Space (CBOS) and Mountain Parks (BMP). Nest searching and monitoring was conducted on Shannahan Ridge (CBOS), Enchanted Mesa (BMP), Flagstaff Mountain (BMP), Gregory, Bear, Long, Skunk, and Bluebell Canyons (BMP), Walker Ranch (BCOS), Betasso Preserve (BCOS), and Heil Ranch (BCOS). Please refer to our 1998 year-end report (Cruz et al. 1999) for maps of many of these study site locations. In 1999 we added Heil Ranch (BCOS) and the Lindsay Property (CBOS) as new locations for nest searches. We also expanded our point count surveys to more thoroughly cover BMP and we put three new transects in at Heil Ranch in 1999.

**Nests** - Nests were found through observations of nesting behavior (Ralph et al. 1993). Once found, nests were marked with a small blue flag > 10 m from the nest. The nests were monitored at least once every three days from the day it was found until the nest became inactive. Nest contents were observed directly or with a 6 m mirror pole. Efforts were made to not attract nest predators to the nest site (Picozzi 1975, Westmoreland and Best 1985, Major 1989). Following nest inactivity, vegetative parameters were measured following James and Shugart (1970), and as modified for the standardized protocol developed by Martin and Ropper (1988). In addition, we measured distances from the nest to human impacts: trails, roads, homes, canopy openings, power line right-of-ways, and livestock.

**Point Counts** - We established 160 50m point count stations in 1998 to census nesting songbirds and cowbirds across the foothills and valley of Boulder County. We censused these points in 1999. We censused each of these points a total of nine times during the breeding season, three times during each of three time periods: morning (sunrise  $\pm$  30 minutes until three hours past sunrise), afternoon (1200-1500 h), and evening (1700-2000 h). These times correspond with known cowbird activities: breeding during the morning and early afternoon, foraging in the afternoon and early evening prior to going to the roost at dusk (Rothstein et al. 1984, Gougen and Matthews 1997).

The points are distributed as follows: Eighty-four point count stations are established in the foothills; 58 in ponderosa pine (20 > 6500 m, 38 < 6500 m elevation) and 26 in mountain riparian habitats; Eighty-six points in suburban (30 points); rural and agricultural areas (31 points); and lowland riparian habitat (25 points). In addition, we established 40 new points in BMP and 20 points in Heil Ranch for morning censusing only.

All birds detected within a 50 m of each point were recorded during 10 minute censusing. For each point a Relative Abundance Index (RAI) is reported:

### Total Number of Birds Observed/Total Number of Census Periods

Total species richness and a Partner's in Flight value were applied to each point as well. The Partner's in Flight value is the sum of the abundance of each Neotropical migrant species at a given point multiplied by a conservation weight (Carter and Barker 1993). This allows for a quick assessment of high priority conservation sites.

For example;

$$\frac{4 \text{ American Robin (1.29)} + 6 \text{ Western Wood-peewee (2.29)} + 4 \text{ Plumbeous Vireo (2.86)} + 2 \text{ Virginia's Warbler (3.43)} + 3 \text{ Northern Flicker (1.14)} + 7 \text{ Cliff Swallows (2.00)} + 2 \text{ Dusky Flycatcher (3.00)}}{6 \text{ Census Periods}}$$

gives a Partner's-in-Flight conservation weight of 10.10.

Analysis – Cowbird parasitism, nest predation, and nest success are compared between sites close to Boulder and one farther away (Heil Ranch, BCOS) with nonparametric contingency analysis,  $\alpha = 0.05$ . Relative abundance and Partner's-in-Flight scores are compared between major habitat groups with Analysis of Variance. Variation of relative abundance, richness and PIF values were compared across broadly generalized habitat types in an ANOVA using Tukey-Kramer HSD. Habitats include: foothill residential, urban, ponderosa pine, Heil Ranch ponderosa pine, lowland riparian, foothill riparian, Douglas' fir, mixed conifer, and grassland. Abundance and richness values are reported for counts in lodgepole and mountain mahogany habitats, but because counts in these habitats are only represented by one location they were excluded from further analysis.

### Results

Year Effects – There are strongly significant year effects of nest predation ( $G_{ADJ} = 5.5963$ ,  $df = 2$ ,  $P < 0.05$ ) and nest success ( $G_{ADJ} = 8.1584$ ,  $df = 2$ ,  $P < 0.05$ ) between 1997 and 1999. Therefore statistical analyses are only used to compare parasitism, predation and success frequencies in 1999.

Nesting Success - 385 nests of 28 species have been monitored since 1997. Brown-headed cowbirds parasitized 11.7% of all available nests and 28.4% of parasitized species ( $n=155$ ) (Table 1). Cowbird parasitism is higher in the ponderosa pine forests closer to the City of Boulder (32.3%,  $n=127$ ) than farther away at Heil Ranch (13.0%,  $n=23$ ) (Table 1). However, there was no significant difference between these sites when examining the most commonly parasitized species (Table 2).

Nest predation accounts for 33.5% ( $n=349$ ) of all nest failures (Table 3). Predation is higher at Heil Ranch (45.5%,  $n=44$ ) than within the ponderosa pine forests closer to Boulder (32.2%,  $n=300$ ) (Table 3). Closer examination of nest predation on the most commonly found species reveals significantly higher predation on Mourning Doves nesting in ponderosa pine closer to Boulder, while Plumbeous Vireos have significantly higher predation rates in Heil Ranch (Table 4). Differences between the two sites for six species were not significant (Table 4).

Nesting success is lower for parasitized species (53.1%,  $n=143$ ) than nonparasitized species (64.6%,  $n=206$ ), and lower at Heil Ranch (42.9%,  $n=42$ ) than in ponderosa pine forests closer to Boulder (64.8%,  $n=183$ ) (Table 5). Differences between sites is most attributable to the lower success of parasitized species at Heil Ranch (21.2%,  $n=21$ ) than near Boulder (57.1%,  $n=119$ ) (Table 5). Nesting success was significantly greater for Plumbeous Vireos and Western Wood-pewees nesting near Boulder than those at Heil Ranch (Table 6). Overall, nesting success is significantly higher in ponderosa pine forests near Boulder (64.3%,  $n=56$ ), than in forests farther away at Heil Ranch (29.0%,  $n=31$ ) (Table 6).

Avian Richness – In general avian richness was greatest in foothill riparian habitats, but also high in the single mountain mahogany stand in Boulder Mountain Parks (Table 7). The highest richness recorded was at foothill riparian points GRCA-2 and MESA-4, both in Boulder Mountain Parks

and both with 24 species (Appendix 1). Avian richness among the lowland riparian sites was significantly greater ( $P < 0.05$ ) than richness among sites in foothill residential and urban habitats. Avian richness in grassland sites was significantly lower ( $P < 0.05$ ) than all other habitat types.

Avian Abundance – In general avian abundance was highest in urban, foothill residential and lowland riparian sites (Table 7). Although abundance of birds at CASO-4, a grassland site, ranked 2<sup>nd</sup> overall (Appendix 1), largely due to a breeding flock of Cliff Swallows and relatively high numbers of Vesper Sparrows and Western Meadowlarks. The relative abundance of birds in the urban sites was significantly ( $P < 0.05$ ) greater than the abundance of birds in all other habitats. The relative abundance of birds in foothill residential sites was significantly greater ( $P < 0.05$ ) than the abundance of birds in mixed conifer, grassland, Douglas fir, foothill riparian, ponderosa pine and Heil Ranch ponderosa pine habitats. The relative abundance of birds in lowland riparian sites was significantly greater ( $P < 0.05$ ) than the abundance of birds in grassland, foothill riparian, ponderosa pine and Heil Ranch ponderosa pine habitats.

Partner's-in-Flight weighted Avian Abundance and the Identification of Important Habitat for Breeding Migratory Songbirds - Because of the high abundance of Neotropical migrants, Partner's-in-Flight (PIF) rankings were generally highest on points located in foothill riparian and grassland habitats, and in the single mountain mahogany stand (Table 7). Because of a bridge-nesting colony of Cliff Swallows the lowland riparian site BCP-9, along the Boulder Creek Path, had the highest PIF ranking of 41.55 (Appendix 1). PIF rankings were significantly ( $P < 0.05$ ) higher among points in foothill riparian habitat than points in urban or residential habitats. Likewise, urban habitats scored significantly ( $P < 0.05$ ) lower PIF rankings than among points in grassland, lowland riparian, and ponderosa pine habitats.

Brown-headed Cowbird Abundance and Distribution – Generally, Brown-headed Cowbirds were found to be most abundant in foothill and lowland riparian habitats and ponderosa pine forests close to Boulder in the morning, foothill riparian in the afternoon, and in foothill riparian and urban in the evening (Figure 1). In the morning Brown-headed Cowbirds were significantly ( $P < 0.05$ ) more abundant in foothill riparian, lowland riparian and ponderosa pine forests close to Boulder than they were in urban, grassland, or foothill residential habitats. Additionally, cowbirds were significantly more abundant in foothill and lowland riparian habitats than they were in ponderosa pine forests at a large distance from Boulder (i.e., Betasso Preserve and Walker Ranch) (Figure 1). Distance of ponderosa pine forests from the City of Boulder did not have a significant effect on cowbird abundance in the morning when the females search for nests to parasitize.

In the afternoon, Brown-headed Cowbird abundance was significantly greater ( $P < 0.05$ ) in foothill riparian and urban habitat than in all other habitats; there was no significant difference in cowbird abundance in urban and foothill riparian habitats in the afternoon (Figure 1). In the evenings, cowbird abundance was significantly greater in foothill riparian habitats than all other habitats except urban (Figure 1).

Within habitat analysis revealed some significant temporal shifts in cowbird abundance. In urban habitats cowbirds were significantly ( $P < 0.05$ ) more abundant in the evening ( $50.00 \pm 14.11$ ) than in the morning (0.00). In ponderosa pine forests close to Boulder cowbirds were significantly ( $P < 0.05$ ) more abundant in the morning ( $29.86 \pm 4.30$ ) than in the afternoon ( $6.25 \pm 3.98$ ) and evening ( $4.76 \pm 3.98$ ). Cowbirds showed a significant trend ( $P = 0.04$ ) towards higher abundance in the morning ( $36.00 \pm 7.71$ ) than in the afternoon ( $10.93 \pm 7.1$ ) and evening ( $12.80 \pm 7.71$ ) in lowland riparian habitat; but because there was high within-period variation no significant abundance changes were detected between specific periods. There were no significant temporal changes in cowbird abundance in foothill residential, urban, and grassland habitats, and in the ponderosa pine forests far from Boulder (i.e., Betasso Preserve and Walker Ranch).

Coniferous Forests – 87 points were surveyed in the coniferous forests of Boulder County (Tables 8 and 9). The five most abundant migratory species in this habitat type are, in decreasing order, the

Chipping Sparrow, Western Tanager, Western Wood-pewee, Spotted Towhee, and Cordilleran Flycatcher (Table 9). The migratory species with PIF conservation ranks greater than 3.00 breeding in these coniferous habitats are the Virginia's Warbler, Dusky Flycatcher, MacGillivray's Warbler, Hammond's Flycatcher, Cordilleran Flycatcher, Green-tailed Towhee (Table 8). With the exception of the uncommon Dusky Flycatcher, mixed conifer and Douglas' fir habitats are of greatest importance to all of these species. Interestingly, the Cordilleran Flycatcher, Hammond's Flycatcher, and Green-tailed Towhee were abundant in the single mountain mahogany stand (Table 8). Not surprisingly, most of these species were most abundant at points located in Boulder Mountain Parks which had the greatest number of Douglas' fir and mixed conifer points (Table 9). However, Cordilleran Flycatchers were most abundant at Heil Ranch, Boulder County Open Space.

A second tier of highly ranked migratory species include the Broad-tailed Hummingbird, Plumbeous Vireo, Lazuli Bunting and Western Tanager. These species are either more common in ponderosa pine forests or nearly equally common across the conifer habitats (Table 8). The exception is the Lazuli Bunting which is more commonly found in foothill riparian habitat (Table 10). The Broad-tailed Hummingbird was more commonly found at points located in Boulder Mountain Parks and Heil Ranch, while the Plumbeous Vireo was found most common on City of Boulder Open Space points (Table 9). The Western Tanager was common across all properties, but least so at Betasso Preserve and Walker Ranch (Table 9).

Foothill Riparian – All but two of 39 foothill riparian census points were located in Boulder Mountain Parks (Table 10). The five most abundant migratory species in this habitat are, in decreasing order, the Spotted Towhee, Broad-tailed Hummingbird, Lazuli Bunting, Warbling Vireo, and Western Tanager (Table 10). Migratory species with PIF ranks greater than 3.00 breeding in this habitat include the Cordilleran Flycatcher, Dusky Flycatcher, Green-tailed Towhee, Green-tailed Towhee, and Virginia's Warbler (Table 10). Skunk Canyon is of particular interest because several species exhibit a significant preference for this shrubby riparian habitat; including the Lazuli Bunting, Spotted Towhee, and Yellow-breasted Chat (Table 10).

The foothill riparian zone is important for many migrants as indicated by the significantly high overall PIF value for this habitat and the high species richness. A second tier of migrants with high conservation values (> 2.50) includes the Broad-tailed Hummingbird, Lazuli Bunting, Western Tanager, Plumbeous Vireo, Black-headed Grosbeak and Yellow-breasted Chat (Table 10).

Grasslands – All of the grassland habitat census points were located on City of Boulder Open Space, two north of Boulder (Hidden Valley and Hogback Ridge) and two south of Boulder (Coalton Trail and Marshall Mesa). We initiated these sites with the intention of comparing host community composition and cowbird abundance between grazed (Coalton Trail and Hidden Valley) and ungrazed (Marshall Mesa and Hogback Ridge) sites. However, due to constraints beyond our control cattle did not get moved onto the grazed sites during the peak of breeding activity, and accordingly there were no significant trends in community composition or cowbird abundance found (Table 11).

What the grassland habitats around Boulder lack in species richness they more than make up for in total abundance of priority species. Most birds detected in the grasslands are migrants. The five most common migrants we detected are, in decreasing order, the Western Meadowlark, Grasshopper Sparrow, Vesper Sparrow, Cliff Swallow, and Lark Sparrow (Table 11). The Grasshopper Sparrow, Lark Sparrow and Western Kingbird have the highest PIF rankings (Table 11).

Hogback Ridge north of Boulder appears to be most different of the four sites. Significantly fewer migrants were detected per count at this site than the others. Where significant species-specific trends occur revolve around the avian community of Hogback Ridge. Grasshopper Sparrows and Vesper Sparrows were significantly less common at this site than the others, and Barn Swallows and Lark Sparrows were more common. Overall, highest bird abundance was highest at Coalton Trail.

### **Preliminary Conclusions and Further Analysis**

Brown-headed Cowbird parasitism and nest predation have strong negative impacts on the nesting success of Neotropical migrants in Boulder County. There is no strong evidence at this time of urban effects on the nesting success, even though there is a strong urban effect on cowbird abundance and distribution. Based on PIF conservation values, habitats of greatest concern for migrants are grasslands and foothill riparian. Greatest numbers of breeding migrants in both abundance and diversity occur in the conifer forests and foothill riparian zones. Further analysis with Geographical Information System software will allow us to build predictive models for all the open space properties from these 219 points. Additionally, logistic regression analysis of specific nest-site parameters (e.g., distance to urban edge) will allow us to determine if there are any strong patterns of parasitism and predation associated with Neotropical migrant nest failure in Boulder County.

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Latin Names used in Text

Blue Grouse  
Mourning Dove  
Common Nighthawk  
Common Poorwill  
Broad-tailed Hummingbird  
Western Kingbird  
Western Wood-pewee  
Dusky Flycatcher  
Hammond's Flycatcher  
Cordilleran Flycatcher  
Horned Lark  
Cliff Swallow  
Barn Swallow  
Steller's Jay  
Plumbeous Vireo  
Warbling Vireo  
Blue-gray Gnatcatcher  
Townsend's Solitaire  
Gray Catbird  
Cedar Waxwing  
Virginia's Warbler  
Yellow-rumped "Audubon's" Warbler  
MacGillivray's Warbler  
Yellow-breasted Chat  
Black-headed Grosbeak  
Lazuli Bunting  
Green-trailed Towhee  
Spotted Towhee  
Grasshopper Sparrow  
Vesper Sparrow  
Lark Sparrow  
Chipping Sparrow  
Dark-eyed Junco  
Western Meadowlark  
Brown-headed Cowbird  
Western Tanager  
Lesser Goldfinch  
Pine Siskin  
House Finch

*Dendragapus obscurus*  
*Zenaida macroura*  
*Chordeiles minor*  
*Phalaenoptilus nuttallii*  
*Selasphorus platycercus*  
*Tyrannus verticalis*  
*Contopus sordidulus*  
*Empidonax oberholseri*  
*Empidonax hammondii*  
*Empidonax occidentalis*  
*Eremophila alpestris*  
*Hirundo pyrrhonota*  
*Hirundo rustica*  
*Cyanocitta stelleri*  
*Vireo plumbeus*  
*Vireo gilvus*  
*Polioptila caerulea*  
*Myadestes townsendi*  
*Dumetella carolinensis*  
*Bombycilla cedrorum*  
*Vermivora virginiae*  
*Dendroica coronata*  
*Oporornis tolmiei*  
*Icteria virens*  
*Pheucticus melanocephalus*  
*Passerina amoena*  
*Pipilo chlorurus*  
*Pipilo maculatus*  
*Ammodramus savannarum*  
*Poocetes gramineus*  
*Chondestes grammacus*  
*Spizella passerina*  
*Junco hyemalis*  
*Sturnella neglecta*  
*Molothrus ater*  
*Piranga ludoviciana*  
*Carduelis psaltria*  
*Carduelis pinus*  
*Carpodacus mexicanus*

Figure Legend

Figure 1. The abundance and distribution of Brown-headed Cowbirds across seven major habitat types in Boulder County, Colorado, 1998-1999, during three time intervals: morning (dawn  $\pm$  30 minutes to 0800), afternoon (1200-1500) and evening (1700-2000).

## Cowbird Abundance

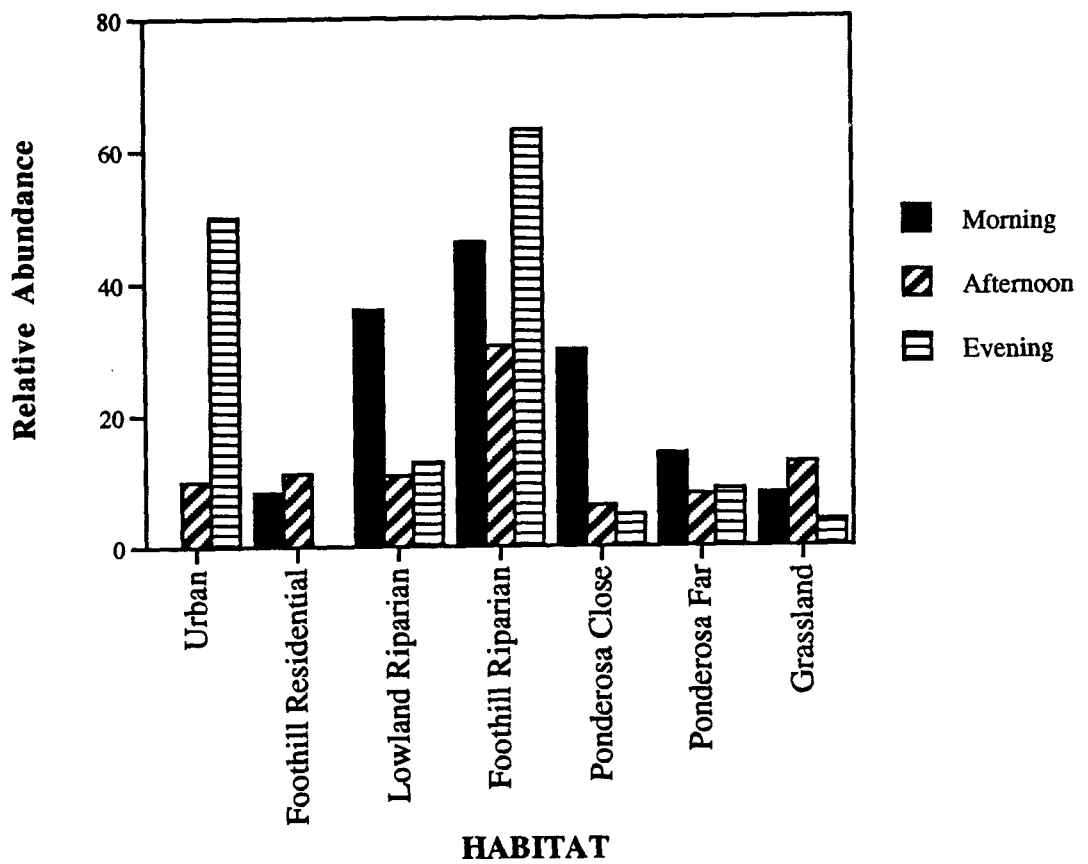


Table 1. Frequency of Brown-headed Cowbird parasitism in ponderosa pine forests in Boulder County, Colorado, 1997-1999.

Species	Boulder		High Elevation		Heil Ranch		Total Parasitism	
	%	n	%	n	%	n	%	N
American Robin	0	24			0	4	0	28
Blue-Gray Gnatcatcher	9.1%	11					9.1%	11
Black-headed Grosbeak	0	27			0	4	0	31
Broad-tailed Humming	0	11			0	3	0	14
Cedar Waxwing	20.0%	5					20.0%	5
Chipping Sparrow	3.7%	27			0	9	2.7%	36
Common Nighthawk	0	1			0	1	0	2
Common Poorwill					0	1	0	1
Cordilleran Flycatcher	0	2					0	2
Dark-eyed Junco	0	5					0	5
Gray Catbird	0	2					0	2
Hammond's Flycatcher	0	5					0	5
House Finch	0	2					0	2
Lazuli Bunting	0	2			0	2	0	4
Lesser Goldfinch	0	5			0	1	0	6
Mourning Dove	0	8			0	8	0	16
Plumbeous Vireo	56.9%	51			33.3%	9	53.3%	60
Pine Siskin					0	1	0	1
Spotted Towhee	12.5%	8			0	1	11.1%	9
Virginia's Warbler	100.0%	2					100.0%	2
Warbling Vireo	38.5%	13	0	5			27.8%	18
Western Tanager	10.0%	10			0	4	7.1%	14
Western Wood-pewee	0	99	0	3	12.5%	8	0.9%	110
Yellow-rumped Warbler	0	1					0	1
Subtotal								
Nonparasitized Species*	0%	194	0%	3	3.0%	33	0.4%	230
Subtotal								
Parasitized Species	32.3%	127	0%	5	13.0%	23	28.4%	155
Grand TOTAL	12.8%	321	0%	8	7.1%	56	11.7%	385

Boulder = Flagstaff Mountain, Gregory Canyon, Enchanted Mesa, Bluebell Canyon, and Shannahan Ridge; surveyed 1997-1999.

High Elevation = Walker Ranch; surveyed 1999.

Heil Ranch = surveyed 1999.

\* includes Western Wood-pewee, a rarely parasitized species.

Table 2. Comparison of Brown-headed Cowbird parasitism frequencies in relation to urbanization. Frequencies examined in two ponderosa pine forests, one close (Boulder) to an urban center the other (Heil Ranch) remote, 1999.

Species	<u>Boulder</u>		<u>Heil Ranch</u>		<u>Total Parasitism</u>		<i>P</i>
	%	N	%	N	%	N	
Plumbeous Vireo	40.0%	15	33.3%	9	37.5%	24	ns
Spotted Towhee	33.3%	3	0	1	25.0%	4	ns
Western Tanager	20.0%	5	0	4	11.1%	9	ns
TOTAL	34.8%	23	21.4%	14	29.7%	37	ns

*P* = Comparison of parasitism frequencies between sites using G-Test with Williams' correction.

Table 3. Frequency of nest predation in ponderosa pine forests in Boulder County, Colorado, 1997-1999.

Species	Boulder		High Elevation		Heil Ranch		Total Predation	
	%	n	%	n	%	n	%	N
American Robin	45.5%	22			0.0%	1	43.5%	23
Blue-Gray Gnatcatcher	45.4%	11					45.4%	11
Black-headed Grosbeak	33.3%	27			50.0%	2	34.5%	29
Broad-tailed Hummingbird	33.3%	9			33.3%	3	33.3%	12
Cedar Waxwing	50%	2					50%	2
Chipping Sparrow	42.3%	26			50.0%	8	44.1%	34
Common Nighthawk	100%	1					100%	1
Common Poorwill					100%	1	100%	1
Cordilleran Flycatcher	50.0%	2					50.0%	2
Dark-eyed Junco	20.0%	5					20.0%	5
Gray Catbird	0.0%	3					0.0%	3
Hammond's Flycatcher	50%	4					50%	4
House Finch	0.0%	2					0.0%	2
Hummingbird species	0.0%	1					0.0%	1
Lark Sparrow					100%	1	100%	1
Lazuli Bunting	50.0%	2			100%	2	75.0%	4
Lesser Goldfinch	20.0%	5			0.0%	1	16.7%	6
Mourning Dove	57.1%	7			16.7%	6	38.5%	13
Pine Siskin					0.0%	1	0.0%	1
Plumbeous Vireo	32.0%	50			75.0%	8	37.9%	58
Spotted Towhee	0.0%	6			0.0%	1	0.0%	7
Townsend's Solitaire					100%	1	100%	1
Virginia's Warbler	100%	2					100%	2
Warbling Vireo	45.4%	11	0.0%	3			35.7%	14
Western Tanager	0.0%	6			0.0%	1	0.0%	7
Western Wood-pewee	24.2%	95	0.0%	2	28.6%	7	24.0%	104
Yellow-rumped Warbler	100%	1					100%	1
TOTAL	32.3%	300	0.0%	5	45.4%	44	33.5%	349

Boulder = Flagstaff Mountain, Gregory Canyon, Enchanted Mesa, Bluebell Canyon, and Shannahan Ridge; surveyed 1997-1999.

High Elevation = Walker Ranch; surveyed 1999.

Heil Ranch = surveyed 1999.

Table 4. Comparison of nest predation frequencies in relation to urbanization. Frequencies examined in two ponderosa pine forests, one close (Boulder) to an urban center the other (Heil Ranch) remote, 1999.

Species	<u>Boulder</u>		<u>Heil Ranch</u>		<u>Total Predation</u>		<i>P</i>
	%	N	%	N	%	N	
Chipping Sparrow	50.0%	12	50.0%	8	50.0%	20	ns
Mourning Dove	100%	2	16.7%	6	37.5%	8	0.05
Plumbeous Vireo	28.6%	14	75.0%	8	45.4%	22	0.05
Spotted Towhee	0.0%	2	0.0%	1	0.0%	3	ns
Western Tanager	0.0%	2	0.0%	1	0.0%	3	ns
Western Wood-pewee	26.1%	23	28.6%	7	26.7%	30	ns
TOTAL	32.7%	55	41.9%	31	29.7%	86	ns

*P* = Comparison of parasitism frequencies between sites using G-Test with Williams' correction.

Table 5. Frequency of nest success for parasitized and non-parasitized species in ponderosa pine forests in Boulder County, Colorado, 1997-1999.

Species	Low Elevation		High Elevation		Heil Ranch		Total Success	
	%	n	%	n	%	n	%	N
<b>Parasitized Species</b>								
Blue-Gray Gnatcatcher	54.5%	11			0.0%	2	46.1%	13
Cedar Waxwing	50.0%	2					50.0%	2
Chipping Sparrow	53.8%	26			25.0%	8	47.1%	34
Lazuli Bunting	50.0%	2			0.0%	1	66.7%	3
Plumbeous Vireo	58.0%	50			25.0%	8	53.4%	58
Spotted Towhee	100%	6			100%	1	100%	7
Virginia's Warbler	0.0%	2					0.0%	2
Warbling Vireo	41.7%	12	100%	3			75.0%	8
Western Tanager	85.7%	7			0.0%	1		
Yellow-rumped Warbler	0.0%	1					0.0%	1
SUBTOTAL	57.1%	119	100%	3	21.2%	21	53.1%	143
<b>Parasitized Species</b>								
<b>Non-parasitized Species</b>								
American Robin	50.0%	22			100%	1	52.2%	23
Black-headed Grosbeak	64.3%	28					64.3%	28
Broad-tailed Hummingbird	55.5%	9			66.7%	3	58.3%	12
Common Nighthawk	0.0%	1					0.0%	1
Common Poorwill					0.0%	1	0.0%	1
Cordilleran Flycatcher	50.0%	2					50.0%	2
Dark-eyed Junco	80.0%	5					80.0%	5
Gray Catbird	100%	3					100%	3
Hammond's Flycatcher	50.0%	4					50.0%	4
House Finch	100%	2					100%	2
Hummingbird sp	0.0%	1					0.0%	1
Lark Sparrow					0.0%	1	0.0%	1
Lesser Goldfinch	80.0%	5			100%	1	83.3%	6
Mourning Dove	42.9%	7			66.7%	6	53.9%	13
Pine Siskin					100%	1	100%	1
Townsend's Solitaire					0.0%	1	0.0%	1
Western Wood-pewee*	69.2%	94	100%	2	66.7%	6	69.6%	102
SUBTOTAL	64.5%	183	100%	2	61.9%	21	64.6%	206
<b>Non-parasitized Species</b>								
GRAND TOTAL	61.6%	302	100%	5	42.9%	42	59.9%	349

Boulder = Flagstaff Mountain, Gregory Canyon, Enchanted Mesa, Bluebell Canyon, and Shannahan Ridge; surveyed 1997-1999.

High Elevation = Walker Ranch; surveyed 1999.

Heil Ranch = surveyed 1999.

\* includes Western Wood-pewee, a rarely parasitized species.



Table 6. Comparison of nest success frequencies in relation to urbanization. Frequencies examined in two ponderosa pine forests, one close (Boulder) to an urban center and the other (Heil Ranch) remote, 1999.

Species	<u>Boulder</u>		<u>Heil Ranch</u>		<u>Total Predation</u>		<i>P</i>
	%	N	%	N	%	N	
Chipping Sparrow	41.7%	12	25.0%	8	35.0%	20	ns
Mourning Dove	0.0%	2	66.7%	6	50.0%	8	ns
Plumbeous Vireo	71.4%	14	25.0%	8	54.5%	22	0.05
Spotted Towhee	100%	2	100%	1	100%	3	ns
Western Tanager	66.7%	3	0.0%	1	50.0%	4	ns
Western Wood-pewee	73.9%	23	28.6%	7	63.3%	30	0.05
TOTAL	64.3%	56	29.0%	31	51.7%	87	0.01

*P* = Comparison of parasitism frequencies between sites using G-Test with Williams' correction.

Table 7. Avian abundance, richness and Partner's-in-Flight ranking (mean  $\pm$  SE) by habitat type across Boulder County, Colorado, 1998-1999.

Habitat	N	Richness	Relative Abundance	PIF-value
Foothill Residential	20	11.80 $\pm$ 0.78	12.63 $\pm$ 0.85	5.69 $\pm$ 1.21
Urban	10	11.20 $\pm$ 1.11	17.73 $\pm$ 1.21	6.08 $\pm$ 1.72
Ponderosa Pine	47	14.79 $\pm$ 0.51	6.68 $\pm$ 0.56	10.96 $\pm$ 0.80
Heil Ranch Ponderosa	16	12.50 $\pm$ 0.87	6.60 $\pm$ 0.95	11.58 $\pm$ 1.36
Lowland Riparian	25	15.56 $\pm$ 0.70	11.03 $\pm$ 0.76	11.64 $\pm$ 1.09
Foothill Riparian	46	14.26 $\pm$ 0.52	6.83 $\pm$ 0.56	13.69 $\pm$ 0.80
Douglas' Fir	13	13.31 $\pm$ 0.97	6.87 $\pm$ 1.06	11.16 $\pm$ 1.51
Mixed Conifer	9	14.33 $\pm$ 1.16	7.54 $\pm$ 1.27	11.20 $\pm$ 1.82
Grassland	31	6.13 $\pm$ 0.63	7.18 $\pm$ 0.68	12.21 $\pm$ 0.98
Lodgepole	1	10.0	5.0	4.47
Mountain Mahogany	1	17.0	7.67	13.85

Table 8. Relative abundance (mean  $\pm$  SE) and Partner's-in-Flight (PIF) Colorado rank of common conifer forest nesting Neotropical migrants on City of Boulder Open Space (CBOS), Boulder Mountain Parks (BMP), Walker Ranch and Betasso Preserve, Boulder County Open Space (BCOS), and Heil Ranch, Boulder County Open Space (Heil), 1998-1999.

Species	PIF Rank*	Ponderosa Pine (61)	Mixed Conifer (10)	Douglas' Fir (14)	Mahogany (1)	Lodgepole (1)
Audubon's Warbler	1.71	0.12 $\pm$ 0.03	0.22 $\pm$ 0.07	0.22 $\pm$ 0.06	0.00	0.67
Blue-gray Gnatcatcher	2.29	0.07 $\pm$ 0.03	0.00 $\pm$ 0.06	0.00 $\pm$ 0.05	0.00 $\pm$ 0.20	0.00 $\pm$ 0.20
Black-headed Grosbeak	2.57	0.03 $\pm$ 0.02	0.00	0.09 $\pm$ 0.04	0.00	0.00
Broad-tailed Hummingb	2.71	0.23 $\pm$ 0.03	0.30 $\pm$ 0.08	0.27 $\pm$ 0.07	0.33 $\pm$ 0.26	0.00 $\pm$ 0.26
Chipping Sparrow	2.14	0.62 $\pm$ 0.07	0.30 $\pm$ 0.16	0.29 $\pm$ 0.14	0.33 $\pm$ 0.52	0.00
Cordilleran Flycatcher	3.00	0.14 $\pm$ 0.04	0.30 $\pm$ 0.09	0.37 $\pm$ 0.08	0.33 $\pm$ 0.29	0.00
Dusky Flycatcher	3.14	0.01 $\pm$ 0.00	0.00	0.00	0.00	0.00
Green-tailed Towhee	3.00	0.04 $\pm$ 0.03	0.38 $\pm$ 0.08	0.21 $\pm$ 0.07	0.33 $\pm$ 0.27	0.00
Hammond's Flycatcher	3.00	0.12 $\pm$ 0.03	0.15 $\pm$ 0.07	0.15 $\pm$ 0.06	0.33 $\pm$ 0.23	0.00
Lazuli Bunting	2.71	0.04 $\pm$ 0.02	0.05 $\pm$ 0.04	0.02 $\pm$ 0.04	0.00	0.00
MacGillivray's Warbler	3.14	0.00 $\pm$ 0.02	0.05 $\pm$ 0.04	0.33 $\pm$ 0.04	0.00	0.00
Plumbeous Vireo	2.86	0.19 $\pm$ 0.03	0.10 $\pm$ 0.07	0.05 $\pm$ 0.06	0.00	0.00
Spotted Towhee	2.29	0.32 $\pm$ 0.05	0.03 $\pm$ 0.13	0.00	0.00	0.00
Virginia's Warbler	3.43	0.09 $\pm$ 0.03	0.25 $\pm$ 0.08	0.27 $\pm$ 0.07	1.00 $\pm$ 0.08	0.00
Warbling Vireo	2.43	0.02 $\pm$ 0.02	0.08 $\pm$ 0.06	0.30 $\pm$ 0.05	0.00	0.00
Western Tanager	2.71	0.43 $\pm$ 0.05	0.40 $\pm$ 0.11	0.29 $\pm$ 0.10	1.00 $\pm$ 0.36	0.33 $\pm$ 0.36
Western Wood-pewee	2.29	0.47 $\pm$ 0.06	0.17 $\pm$ 0.14	0.01 $\pm$ 0.12	0.00	0.00

\*see Carter and Barker 1993

Table 9. Relative abundance (mean  $\pm$  SE) and Partner's-in-Flight (PIF) Colorado rank of common conifer forest nesting Neotropical migrants on City of Boulder Open Space (CBOS), Boulder Mountain Parks (BMP), Walker Ranch and Betasso Preserve, Boulder County Open Space (County), and Heil Ranch, Boulder County Open Space (Heil), 1998-1999.

Species	PIF Rank*	CBOS (18)	BMP (31)	County (20)	Heil (18)	Total (87)
Audubon's Warbler	1.71	0.10 $\pm$ 0.05	0.22 $\pm$ 0.04	0.08 $\pm$ 0.05	0.18 $\pm$ 0.05	0.16 $\pm$ 0.02
Blue-gray Gnatcatcher	2.29	0.06 $\pm$ 0.04	0.00 $\pm$ 0.03	0.00 $\pm$ 0.04	0.17 $\pm$ 0.04	0.05 $\pm$ 0.02
Black-headed Grosbeak	2.57	0.00 $\pm$ 0.03	0.04 $\pm$ 0.02	0.00 $\pm$ 0.02	0.10 $\pm$ 0.03	0.04 $\pm$ 0.01
Broad-tailed Hummingbird	2.71	0.14 $\pm$ 0.06	0.29 $\pm$ 0.04	0.20 $\pm$ 0.06	0.33 $\pm$ 0.06	0.24 $\pm$ 0.03
Chipping Sparrow	2.14	0.75 $\pm$ 0.11	0.47 $\pm$ 0.08	0.79 $\pm$ 0.10	0.07 $\pm$ 0.11	0.52 $\pm$ 0.06
Cordilleran Flycatcher	3.00	0.03 $\pm$ 0.07	0.28 $\pm$ 0.05	0.11 $\pm$ 0.06	0.31 $\pm$ 0.07	0.20 $\pm$ 0.03
Dusky Flycatcher	3.14	0.01 $\pm$ 0.01	0.01 $\pm$ 0.01	0.03 $\pm$ 0.01	0.00 $\pm$ 0.01	0.00 $\pm$ 0.00
Green-tailed Towhee	3.00	0.01 $\pm$ 0.06	0.13 $\pm$ 0.05	0.27 $\pm$ 0.06	0.00 $\pm$ 0.06	0.11 $\pm$ 0.03
Hammond's Flycatcher	3.00	0.11 $\pm$ 0.05	0.21 $\pm$ 0.04	0.09 $\pm$ 0.05	0.04 $\pm$ 0.05	0.13 $\pm$ 0.02
Lazuli Bunting	2.71	0.06 $\pm$ 0.03	0.05 $\pm$ 0.02	0.03 $\pm$ 0.03	0.02 $\pm$ 0.03	0.04 $\pm$ 0.01
MacGillivray's Warbler	3.14	0.00 $\pm$ 0.04	0.11 $\pm$ 0.03	0.05 $\pm$ 0.04	0.06 $\pm$ 0.04	0.06 $\pm$ 0.02
Plumbeous Vireo	2.86	0.22 $\pm$ 0.05	0.18 $\pm$ 0.04	0.14 $\pm$ 0.05	0.04 $\pm$ 0.05	0.15 $\pm$ 0.02
Spotted Towhee	2.29	0.70 $\pm$ 0.09	0.16 $\pm$ 0.07	0.03 $\pm$ 0.08	0.07 $\pm$ 0.09	0.23 $\pm$ 0.05
Virginia's Warbler	3.43	0.02 $\pm$ 0.06	0.30 $\pm$ 0.05	0.07 $\pm$ 0.06	0.08 $\pm$ 0.06	0.15 $\pm$ 0.03
Warbling Vireo	2.43	0.03 $\pm$ 0.05	0.12 $\pm$ 0.04	0.10 $\pm$ 0.04	0.02 $\pm$ 0.05	0.07 $\pm$ 0.02
Western Tanager	2.71	0.36 $\pm$ 0.08	0.49 $\pm$ 0.06	0.21 $\pm$ 0.08	0.53 $\pm$ 0.08	0.41 $\pm$ 0.04
Western Wood-pewee	2.29	0.69 $\pm$ 0.11	0.23 $\pm$ 0.08	0.32 $\pm$ 0.10	0.26 $\pm$ 0.11	0.35 $\pm$ 0.05

\*see Carter and Barker 1993

Table 10. Relative abundance (mean  $\pm$  SE) and PIF ranking of common Neotropical migrants breeding in foothill riparian (Bear Canyon, Gregory Canyon, Long Canyon, Skunk Canyon, and at ten scattered locations in Boulder Mountain Parks (BMP), and at Heil Ranch, Boulder County Open Space), 1998-1999.

Species	PIF rank**	Bear (11)	Gregory/Long (10)	Skunk (6)	BMP (10)	Heil (2)*	Total (39)	P
Audubon's Warbler	1.71	0.19 $\pm$ 0.05	0.18 $\pm$ 0.05	0.07 $\pm$ 0.07	1.00 $\pm$ 0.07	1.00 $\pm$ 0.12	0.17 $\pm$ 0.04	0.05
Blue-gray Gnatcatcher	2.29	0.00	0.00	0.20 $\pm$ 0.09	0.15 $\pm$ 0.06	0.50 $\pm$ 0.15	0.10 $\pm$ 0.04	NS
Black-headed Grosbeak	2.57	0.08 $\pm$ 0.11	0.18 $\pm$ 0.11	0.53 $\pm$ 0.16	0.30 $\pm$ 0.11	0.17 $\pm$ 0.25	0.23 $\pm$ 0.06	NS
Broad-tailed Hummingbird	2.71	0.32 $\pm$ 0.15	0.45 $\pm$ 0.16	0.80 $\pm$ 0.22	0.45 $\pm$ 0.15	0.33 $\pm$ 0.34	0.44 $\pm$ 0.08	NS
Chipping Sparrow	2.14	0.05 $\pm$ 0.05	0.17 $\pm$ 0.05	0.00	0.12 $\pm$ 0.05	0.17 $\pm$ 0.12	0.12 $\pm$ 0.04	NS
Cordilleran Flycatcher	3.00	0.35 $\pm$ 0.09	0.48 $\pm$ 0.09	0.07 $\pm$ 0.13	0.22 $\pm$ 0.09	0.00	0.29 $\pm$ 0.05	NS
Dusky Flycatcher	3.00	0.00	0.07 $\pm$ 0.02	0.00	0.00	0.00	0.02 $\pm$ 0.01	---
Green-tailed Towhee	3.00	0.01 $\pm$ 0.06	0.08 $\pm$ 0.06	0.00	0.20 $\pm$ 0.06	0.00	0.08 $\pm$ 0.03	NS
Hammond's Flycatcher	3.14	0.02 $\pm$ 0.03	0.13 $\pm$ 0.04	0.00	0.02 $\pm$ 0.04	0.00	0.04 $\pm$ 0.02	NS
Lazuli Bunting <sup>1</sup>	2.71	0.12 $\pm$ 0.10	0.05 $\pm$ 0.11	0.67 $\pm$ 0.15	0.58 $\pm$ 0.11	0.67 $\pm$ 0.24	0.32 $\pm$ 0.04	0.01
MacGillivray's Warbler	3.14	0.21 $\pm$ 0.08	0.35 $\pm$ 0.09	0.13 $\pm$ 0.12	0.20 $\pm$ 0.09	0.00	0.22 $\pm$ 0.04	NS
Plumbeous Vireo	2.86	0.01 $\pm$ 0.05	0.10 $\pm$ 0.05	0.07 $\pm$ 0.07	0.12 $\pm$ 0.05	1.00 $\pm$ 0.05	0.14 $\pm$ 0.04	NS
Spotted Towhee <sup>2</sup>	2.29	0.41 $\pm$ 0.17	0.43 $\pm$ 0.18	3.00 $\pm$ 0.25	1.47 $\pm$ 0.18	0.00 $\pm$ 0.25	1.02 $\pm$ 0.17	0.0001
Virginia's Warbler	3.43	0.17 $\pm$ 0.06	0.17 $\pm$ 0.06	0.07 $\pm$ 0.08	0.12 $\pm$ 0.06	0.67 $\pm$ 0.13	0.19 $\pm$ 0.04	NS
Warbling Vireo <sup>3</sup>	2.43	0.18 $\pm$ 0.09	0.57 $\pm$ 0.09	0.13 $\pm$ 0.13	0.27 $\pm$ 0.09	0.67 $\pm$ 0.21	0.32 $\pm$ 0.05	0.05
Western Tanager	2.71	0.12 $\pm$ 0.09	0.48 $\pm$ 0.10	0.13 $\pm$ 0.14	0.38 $\pm$ 0.10	0.50 $\pm$ 0.22	0.32 $\pm$ 0.05	0.05
Western Wood-pewee	2.29	0.02 $\pm$ 0.07	0.10 $\pm$ 0.08	0.00	0.27 $\pm$ 0.08	0.50 $\pm$ 0.17	0.15 $\pm$ 0.05	0.05
Yellow-breasted Chat <sup>4</sup>	2.57	0.18 $\pm$ 0.13	0.00	1.13 $\pm$ 0.19	0.27 $\pm$ 0.13	0.00	0.27 $\pm$ 0.08	0.001
Total	---	2.44 $\pm$ 0.42	4.00 $\pm$ 0.44	7.00 $\pm$ 0.62	5.13 $\pm$ 0.44	6.17 $\pm$ 0.98	---	0.0001
Total of all species	---	4.67 $\pm$ 0.51	7.20 $\pm$ 0.53	5.64 $\pm$ 0.69	8.45 $\pm$ 0.54	12.12 $\pm$ 1.20	---	0.0001

\* Heil sites excluded from model analysis due to sample size constraints.

1. Relative abundance in Skunk Canyon and BMP is significantly greater ( $P < 0.05$ ) than Bear Canyon and Gregory/Long Canyon.
2. Relative abundance in Skunk Canyon and BMP is significantly greater ( $P < 0.05$ ) than Bear Canyon and Gregory/Long Canyon; Skunk Canyon is significantly greater ( $P < 0.05$ ) than BMP.
3. Relative abundance in Gregory/Long Canyon is significantly greater ( $P < 0.05$ ) than in Bear Canyon.
4. Relative abundance in Skunk Canyon and BMP is significantly greater ( $P < 0.05$ ) than all other sites.
5. Relative abundance in Skunk Canyon is significantly greater ( $P < 0.05$ ) than Bear and Gregory/Long Canyons; BMP is significantly greater ( $P < 0.05$ ) than Bear Canyon.
6. Relative abundance in Bear Canyon is significantly lower ( $P < 0.05$ ) than BMP and Gregory/Long Canyon; Skunk significantly lower ( $P < 0.05$ ) than BMP.

\*\*see Carter and Barker 1993

Table 11. Relative abundance (mean  $\pm$  SE) and PIF ranking of common Neotropical migrants breeding in grazed (Coalton Trail area and Hidden Valley trail area) and ungrazed (Marshall Mesa and Hogback Ridge) grasslands on City of Boulder Open Space, 1998-1999.

Species	PIF rank*	Coalton (7)	Marshall (7)	Hidden Valley (10)	Hogback Ridge (7)	Total (31)	P
Barn Swallow <sup>1</sup>	1.29	0.00	0.05 $\pm$ 0.05	0.03 $\pm$ 0.04	0.21 $\pm$ 0.05	0.07 $\pm$ 0.03	0.05
Cliff Swallow	2.00	0.62 $\pm$ 0.31	0.36 $\pm$ 0.31	0.20 $\pm$ 0.26	0.00	0.28 $\pm$ 0.14	NS
Grasshopper Sparrow <sup>2</sup>	3.00	1.64 $\pm$ 0.23	1.62 $\pm$ 0.23	1.55 $\pm$ 0.19	0.14 $\pm$ 0.23	1.27 $\pm$ 0.15	0.0001
Horned Lark	1.43	0.23 $\pm$ 0.05	0.00	0.00	0.00	0.05 $\pm$ 0.03	---
Lark Sparrow <sup>3</sup>	2.57	0.00	0.00	0.18 $\pm$ 0.05	0.31 $\pm$ 0.06	0.13 $\pm$ 0.04	0.05
Vesper Sparrow <sup>4</sup>	2.29	2.43 $\pm$ 0.18	0.55 $\pm$ 0.18	0.22 $\pm$ 0.15	0.00	0.74 $\pm$ 0.19	0.001
Western Kingbird	2.57	0.00	0.02 $\pm$ 0.04	0.05 $\pm$ 0.03	0.10 $\pm$ 0.04	0.04 $\pm$ 0.02	NS
Western Meadowlark	2.14	1.64 $\pm$ 0.31	2.31 $\pm$ 0.31	2.02 $\pm$ 0.26	1.38 $\pm$ 0.31	1.85 $\pm$ 0.15	NS
Total <sup>5</sup>	---	6.57 $\pm$ 0.67	4.91 $\pm$ 0.67	4.25 $\pm$ 0.56	2.14 $\pm$ 0.67	---	0.001
Total of all Species <sup>6</sup>	---	14.76 $\pm$ 1.24	6.10 $\pm$ 1.24	4.97 $\pm$ 1.04	3.83 $\pm$ 1.24	---	0.0001

1. Relative abundance at Hogback Ridge is significantly greater (  $P < 0.05$  ) than Coalton.
2. Relative abundance at Hogback Ridge is significantly lower (  $P < 0.05$  ) than all other sites.
3. Relative abundance at Hogback Ridge is significantly greater (  $P < 0.05$  ) than Coalton and Marshall.
4. Relative abundance at Coalton is significantly greater (  $P < 0.05$  ) than all other sites.
5. Relative abundance at Hogback Ridge is significantly lower (  $P < 0.05$  ) than Coalton and Marshall.
6. Relative abundance at Coalton is significantly greater (  $P < 0.05$  ) than all other sites.

\*see Carter and Barker 1993

Appendix I. Avian abundance and richness across Boulder County point counts, 1998-1999, ranked by Partners-in-Flight weighted by importance for breeding Neotropical migrants.

Ownera	Point No. <sup>F</sup>	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
City	BCP-9	Lowland Riparian	150.00	25.00	16	41.55
CBOS	CASO-4	grassland	86.00	28.67	9	31.03
County	PLUM-2	foothill riparian	36.00	12.00	21	27.48
City	BFRN-8	Foothill Residential	185.00	30.83	18	26.93
City	SBCS-6	Lowland Riparian	100.00	16.67	20	25.70
County	PLUM-6	foothill riparian	37.00	12.33	21	24.71
BMP	BMP-4	foothill riparian	31.00	10.33	13	23.39
CBOS	Towhee-2	foothill riparian	28.00	9.33	13	22.72
BMP	MESA-1	foothill riparian	64.00	10.67	21	22.28
BMP	BMP-32	foothill riparian	27.00	9.00	11	22.05
County	GEER-1	Heil -PONDEROSA	37.00	12.33	20	21.72
City	SBCS-10	Lowland Riparian	82.00	13.67	18	21.38
BMP	GRCA-0	foothill riparian	29.00	9.67	16	21.25
BMP	BMP-42	DOUGFIR	31.00	10.33	10	20.80
BMP	GRCA-2	foothill riparian	57.00	9.50	24	20.08
City	SBCS-5	Lowland Riparian	93.00	15.50	17	19.22
CBOS	NCAS-6	grassland	49.00	8.17	4	19.20
City	SBCS-8	Lowland Riparian	68.00	11.33	22	19.13
BMP	MESA-4	foothill riparian	56.00	9.33	24	19.02
BMP	BMP-43	PONDEROSA	23.00	7.67	19	18.29
BMP	GRCA-1	foothill riparian	56.00	9.33	19	18.20
BMP	BMP-30	Mixed Conifer	40.00	13.33	20	18.09

Ownera	Point No.	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
BMP	GRCA-4	foothill riparian	55.00	9.17	18	17.93
CBOS	NCAS-5	grassland	43.00	7.17	5	17.48
BMP	BMP-21	foothill riparian	25.00	8.33	11	17.44
BMP	BMP-50	DOUGFIR	26.00	8.67	15	17.23
BMP	SKCA-5	foothill riparian	51.00	8.50	17	17.22
BMP	MESA-6	foothill riparian	49.00	8.17	18	17.22
CBOS	CASO-2	grassland	44.00	14.67	6	16.92
County	Heil-7	Heil -PONDEROSA	30.00	10.00	15	16.69
CBOS	CANO-4	grassland	39.00	6.50	5	16.54
CBOS	NCAS-4	grassland	44.00	7.33	10	16.54
CBOS	SOSH-2	PONDEROSA	58.00	9.67	18	16.45
CBOS	Towhee-1	foothill riparian	25.00	8.33	10	16.43
CBOS	CASO-3	grassland	40.00	13.33	6	16.29
BMP	GRCA-3	foothill riparian	48.00	8.00	21	16.02
CBOS	CASO-5	grassland	41.00	13.67	4	15.92
City	SBCS-7	Lowland Riparian	78.00	13.00	22	15.90
City	SBCS-4	Lowland Riparian	72.00	12.00	17	15.85
CBOS	NCAS-7	grassland	38.00	6.33	4	15.81
BMP	BMP-45	Mixed Conifer	26.00	8.67	14	15.62
BMP	BMP-34	DOUGFIR	29.00	9.67	17	15.57
City	SBCS-9	Lowland Riparian	55.00	9.17	17	15.55
County	BEPR-6	PONDEROSA	62.00	10.33	23	15.48
BMP	MESA-7	foothill riparian	48.00	8.00	15	15.27
County	MEGU-2	PONDEROSA	48.00	8.00	16	15.26
BMP	MESA-3	PONDEROSA	39.00	6.50	20	15.19



Ownera	Point No.	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
CBOS	CASO-7	grassland	38.00	12.67	4	15.11
CBOS	NOSH-1	PONDEROSA	53.00	8.83	15	15.04
CBOS	NOSH-7	PONDEROSA	52.00	8.67	19	14.88
County	BEPR-4	PONDEROSA	51.00	8.50	18	14.82
BMP	GRCA-11	foothill riparian	22.00	7.33	12	14.79
BMP	BMP-23	PONDEROSA	30.00	10.00	18	14.66
BMP	GRCA-5	foothill riparian	40.00	6.67	15	14.66
CBOS	CANO-5	grassland	35.00	5.83	7	14.49
BMP	BMP-12	DOUGFIR	27.00	9.00	18	14.47
County	Heil-8	Heil -PONDEROSA	34.00	11.33	17	14.41
City	SBOS-2	Lowland Riparian	72.00	12.00	20	14.35
CBOS	SOSH-5	PONDEROSA	42.00	7.00	15	14.07
BMP	BMP-15	PONDEROSA	26.00	8.67	16	14.05
BMP	BMP-35	DOUGFIR	27.00	9.00	17	13.94
CBOS	NOSH-8	PONDEROSA	55.00	9.17	20	13.86
BMP	BMP-38	MAHOGANY	23.00	7.67	17	13.85
CBOS	SOSH-1	PONDEROSA	42.00	7.00	15	13.65
BMP	GRCA-6	foothill riparian	39.00	6.50	18	13.62
County	PLUM-4	Heil -PONDEROSA	20.00	6.67	14	13.61
BMP	BMP-41	PONDEROSA	19.00	6.33	10	13.53
BMP	MESA-9	PONDEROSA	19.00	6.33	12	13.38
CBOS	CANO-2	grassland	34.00	5.67	5	13.13
BMP	BECA-1	foothill riparian	45.00	7.50	13	13.09
BMP	MESA-5	PONDEROSA	44.00	7.33	19	13.05
BMP	MESA-2	PONDEROSA	43.00	7.17	17	12.86

Ownera	Point No.	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
BMP	BMP-13	foothill riparian	17.00	5.67	8	12.81
CBOS	NOSH-3	PONDEROSA	42.00	7.00	14	12.63
County	MEGU-7	Mixed Conifer	39.00	6.50	17	12.62
County	GEER-2	Heil -PONDEROSA	17.00	5.67	10	12.57
BMP	BMP-18	Mixed Conifer	26.00	8.67	13	12.48
County	BEPR-8	PONDEROSA	52.00	8.67	20	12.43
CBOS	CANO-8	grassland	31.00	5.17	7	12.40
CBOS	SOSH-3	PONDEROSA	38.00	6.33	15	12.38
County	GEER-6	Heil -PONDEROSA	21.00	7.00	16	12.37
CBOS	NOSH-4	PONDEROSA	52.00	8.67	15	12.36
County	BEPR-1	PONDEROSA	49.00	8.17	12	12.23
BMP	GRCA-7	foothill riparian	38.00	6.33	20	12.14
BMP	BMP-48	Mixed Conifer	19.00	6.33	13	12.14
County	MEGU-1	PONDEROSA	41.00	6.83	13	12.09
BMP	BMP-25	DOUGFIR	24.00	8.00	13	12.04
County	Heil-6	Heil -PONDEROSA	18.00	6.00	12	12.02
BMP	BECA-5	foothill riparian	32.00	5.33	14	11.99
CBOS	CASO-1	grassland	32.00	10.67	7	11.98
BMP	SKCA-4	foothill riparian	38.00	6.33	14	11.77
BMP	GRCA-9	foothill riparian	45.00	7.50	19	11.76
city	30th-5	urban	66.00	11.00	12	11.75
BMP	SKCA-3	foothill riparian	31.00	5.17	12	11.67
city	30th-8	urban	133.00	22.17	11	11.65
BMP	BECA-3	foothill riparian	33.00	5.50	11	11.55
County	GEER-4	Heil -PONDEROSA	18.00	6.00	11	11.52

Owner	Point No.	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
CBOS	CANO-9	grassland	29.00	4.83	3	11.49
County	PLUM-5	foothill riparian	13.00	4.33	8	11.42
BMP	MESA-0	foothill riparian	29.00	4.83	17	11.41
City	SBCS-3	Lowland Riparian	54.00	9.00	17	11.36
CBOS	CASO-6	grassland	29.00	9.67	4	11.31
CBOS	CANO-3	grassland	29.00	4.83	3	11.30
County	MEGU-8	DOUGFIR	38.00	6.33	15	11.19
City	SBCS-1	Lowland Riparian	45.00	7.50	20	11.16
County	GEER-3	Heil -PONDEROSA	17.00	5.67	14	11.09
CBOS	NCAN-2	grassland	49.00	8.17	9	11.00
City	SBCN-1	Lowland Riparian	73.00	12.17	17	10.96
BMP	BMP-6	PONDEROSA	19.00	6.33	10	10.95
County	PLUM-1	Heil -PONDEROSA	19.00	6.33	13	10.90
CBOS	NCAS-2	grassland	29.00	4.83	8	10.65
BMP	BMP-39	PONDEROSA	27.00	9.00	15	10.33
CBOS	CANO-7	grassland	35.00	5.83	11	10.21
CBOS	NOSH-6	PONDEROSA	38.00	6.33	16	10.10
BMP	SKCA-1	foothill riparian	12.00	4.00	8	10.05
CBOS	NOSH-2	PONDEROSA	36.00	6.00	13	9.99
BMP	BECA-11	foothill riparian	33.00	5.50	15	9.90
County	MEGU-3	Mixed Conifer	38.00	6.33	15	9.87
CBOS	NCAS-3	grassland	24.00	4.00	4	9.78
County	BEPR-2	PONDEROSA	39.00	6.50	15	9.73
County	BEPR-3	PONDEROSA	37.00	6.17	16	9.68
BMP	BMP-2	PONDEROSA	18.00	6.00	11	9.67

Ownera	Point No.	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
BMP	BECA-6	foothill riparian	28.00	4.67	15	9.46
County	Heil-1	Heil -PONDEROSA	18.00	6.00	14	9.43
City	SBCN-3	Lowland Riparian	36.00	6.00	9	9.37
BMP	BMP-24	DOUGFIR	15.00	5.00	8	9.33
CBOS	NOSH-5	PONDEROSA	53.00	8.83	17	9.22
BMP	MESA-8	PONDEROSA	23.00	3.83	12	9.15
County	BEPR-10	PONDEROSA	28.00	4.67	11	9.04
County	BEPR-9	PONDEROSA	40.00	6.67	14	8.97
BMP	SKCA-6	foothill riparian	28.00	4.67	9	8.97
city	30th-6	urban	145.00	24.17	9	8.96
CBOS	NCAS-1	grassland	29.00	4.83	6	8.74
BMP	BECA-4	foothill riparian	25.00	4.17	15	8.69
County	MEGU-6	DOUGFIR	29.00	4.83	17	8.67
County	BEPR-7	PONDEROSA	38.00	6.33	16	8.59
CBOS	CANO-10	grassland	25.00	4.17	6	8.57
BMP	BMP-47	foothill riparian	17.00	5.67	8	8.53
CBOS	SOSH-9	PONDEROSA	32.00	5.33	13	8.52
CBOS	SOSH-10	PONDEROSA	38.00	6.33	15	8.50
County	Heil-4	Heil -PONDEROSA	19.00	6.33	9	8.47
County	Heil-2	Heil -PONDEROSA	13.00	4.33	9	8.38
CBOS	SOSH-7	PONDEROSA	35.00	5.83	18	8.31
City	SBCN-2	Lowland Riparian	58.00	9.67	13	8.09
County	BEPR-5	PONDEROSA	32.00	5.33	15	8.09
County	Heil-5	Heil -PONDEROSA	14.00	4.67	9	8.04
CBOS	NCAN-4	grassland	22.00	3.67	11	7.90

Ownera	Point No.	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
County	PLUM-3	foothill riparian	13.00	4.33	9	7.90
BMP	GRCA-10	foothill riparian	23.00	3.83	15	7.85
city	BFRS-4	Foothill Residential	71.00	11.83	14	7.84
CBOS	CANO-1	grassland	19.00	3.17	3	7.80
BMP	MESA-10	PONDEROSA	11.00	3.67	8	7.66
County	GEER-5	Heil -PONDEROSA	13.00	4.33	16	7.64
city	BFRN-10	Foothill Residential	104.00	17.33	11	7.63
BMP	BMP-22	Mixed Conifer	20.00	6.67	12	7.42
BMP	GRCA-8	foothill riparian	31.00	5.17	15	7.38
CBOS	NCAN-6	grassland	20.00	3.33	9	7.28
BMP	BMP-36	DOUGFIR	15.00	5.00	10	7.28
CBOS	CANO-6	grassland	22.00	3.67	7	7.07
BMP	BECA-9	foothill riparian	22.00	3.67	10	7.04
city	BCP-10	Lowland Riparian	60.00	10.00	16	6.93
City	SBCN-4	Lowland Riparian	40.00	6.67	17	6.86
BMP	BMP-7	Mixed Conifer	17.00	5.67	9	6.80
CBOS	NCAN-5	grassland	18.00	3.00	6	6.78
city	30th-9	urban	78.00	13.00	11	6.66
city	BCP-1	Lowland Riparian	106.00	17.67	12	6.61
BMP	BMP-1	PONDEROSA	16.00	5.33	11	6.57
County	Heil-3	Heil -PONDEROSA	9.00	3.00	8	6.42
BMP	BMP-3	PONDEROSA	19.00	6.33	14	6.38
city	BFRN-3	Foothill Residential	66.00	11.00	16	6.38
BMP	BECA-8	foothill riparian	22.00	3.67	12	6.27
city	BFRN-1	Foothill Residential	23.00	3.83	9	6.23

<u>Owner</u>	<u>Point No.</u>	<u>Habitat</u>	<u>Abundance<sup>b</sup></u>	<u>RAI<sup>c</sup></u>	<u>Richness<sup>d</sup></u>	<u>PIF Value<sup>e</sup></u>
city	BGP-8	Lowland Riparian	64.00	10.67	16	6.19
County	MEGU-4	DOUGFIR	21.00	3.50	14	6.11
city	BFRS-7	Foothill Residential	59.00	9.83	13	6.09
city	BFRN-7	Foothill Residential	56.00	9.33	11	5.96
County	MEGU-5	Mixed Conifer	34.00	5.67	16	5.79
city	30th-3	urban	102.00	17.00	16	5.77
County	MEGU-10	PONDEROSA	24.00	4.00	12	5.71
CBOS	NCAN-1	grassland	23.00	3.83	7	5.64
CBOS	NCAN-7	grassland	16.00	2.67	6	5.52
BMP	BECA-7	foothill riparian	14.00	2.33	8	5.50
city	BFRN-9	Foothill Residential	81.00	13.50	16	5.50
city	BFRS-3	Foothill Residential	53.00	8.83	12	5.30
BMP	BECA-2	foothill riparian	40.00	6.67	13	5.28
city	BFRN-2	Foothill Residential	73.00	12.17	12	5.08
BMP	BECA-10	foothill riparian	14.00	2.33	6	5.06
CBOS	SOSH-4	PONDEROSA	15.00	2.50	10	4.74
city	BFRS-1	Foothill Residential	46.00	7.67	13	4.72
BMP	BMP-33	DOUGFIR	15.00	5.00	10	4.57
CBOS	NCAN-3	grassland	13.00	2.17	4	4.52
CBOS	SOSH-6	PONDEROSA	20.00	3.33	11	4.50
BMP	BMP-37	LOGGEPOLE	15.00	5.00	10	4.47
city	BFRN-4	Foothill Residential	93.00	15.50	11	4.32
County	MEGU-9	PONDEROSA	23.00	3.83	12	4.29
city	BFRS-6	Foothill Residential	89.00	14.83	11	4.01
BMP	BMP-31	DOUGFIR	15.00	5.00	9	3.86

Ownera	Point No.	Habitat	Abundance <sup>b</sup>	RAI <sup>c</sup>	Richness <sup>d</sup>	PIF Value <sup>e</sup>
city	BFRS-9	Foothill Residential	50.00	8.33	12	3.77
city	30th-4	urban	91.00	15.17	12	3.72
city	30th-10	urban	162.00	27.00	9	3.72
CBOS	SOSH-8	PONDEROSA	15.00	2.50	11	3.69
city	30th-7	urban	144.00	24.00	13	3.63
city	BCP-3	Lowland Riparian	81.00	13.50	12	3.62
city	BFRS-5	Foothill Residential	60.00	10.00	10	3.34
city	BCP-6	Lowland Riparian	39.00	6.50	8	3.24
city	BCP-7	Lowland Riparian	40.00	6.67	12	3.00
city	BCP-5	Lowland Riparian	43.00	7.17	10	2.72
city	BFRS-8	Foothill Residential	57.00	9.50	8	2.70
city	BFRS-10	Foothill Residential	62.00	10.33	8	2.67
city	30th-2	urban	57.00	9.50	9	2.62
city	BCP-4	Lowland Riparian	63.00	10.50	11	2.45
city	30th-1	urban	86.00	14.33	10	2.35
city	BFRS-2	Foothill Residential	45.00	7.50	10	2.27
city	BCP-2	Lowland Riparian	29.00	4.83	14	2.26
city	BFRN-5	Foothill Residential	147.00	24.50	12	1.64
city	BFRN-6	Foothill Residential	95.00	15.83	9	1.43

<u>Owners</u>	BMP	Boulder Mountain Parks
	CBOS	City of Boulder Open Space
	City	City of Boulder
	County	Boulder County Open Space

Abundance Total number of individual birds detected within 150 m of each point.

RAI Relative Abundance Index: abundance divided by total number of counts

Richness Total Avian Diversity

PIF-value Partner's in Flight weighted value for abundance of migratory landbirds.

<sup>F</sup> Point locations established in 1998 were reported in 1998 year-end report, points established in 1999 (mainly BMP and Heil Ranch) are currently being mapped in GIS and will be included in the final report. All points are currently being entered in a GIS modeling program and will be sent out in Final Report. Information on exact locations of any point will be furnished upon request.



Appendix 2. Summary of Research: Lindsay Property, City of Boulder Open Space.

During July 1999, three days were spent nest-searching in an area of the Lindsay Property slated for forest thinning. These surveys revealed that open-cup nesting birds were rather uncommon on the property in general, especially in the more heavily wooded areas. Most breeding activity of open-sup nesters was limited to areas along the edge of the mesa top and the small gullies leading away from the mesa.

A total of 7 open-cup nests were located during the surveys (Table 2.1), two of Western Wood-Pewee (*Contopus sordidulus*), and one each of Blue-gray Gnatcatcher (*Poliophtila caerulea*), Plumbeous Vireo (*Vireo plumbeus*), Chipping Sparrow (*Spizella passerina*), Vesper Sparrow (*Poocetes gramineus*), and Lesser Goldfinch (*Carduelis psaltria*). Nests were located mainly in an area of scattered Ponderosa Pines in the southwestern corner of the area to be thinned. Nests were not monitored often enough to determine whether they were successful, but none of the nests were parasitized by Brown-headed Cowbirds (*Molothrus ater*). In addition to the six species of open-cup nesters for which active nests were located, breeding was confirmed for four other species and suspected for six other species (Table 2.2).

In general, densities of open-cup nesting species seemed low compared to other open-space properties around Boulder County. The concentration of nests in the more open areas of the property suggest that forest thinning may help increase density of these species. The presence of ground-nesting species such as Blue Grouse (*Dendragapus obscurus*), Poorwill (*Phalaenoptilus nuttallii*), and Vesper Sparrow suggest this property is not heavily disturbed by humans and dogs.

Table 2.1: Active nests located during surveys of the Lindsay Property

Species	Nest Contents
Western Wood-Pewee	3 Eggs 2 Eggs
Blue-gray Gnatcatcher	5 Eggs
Plumbeous Vireo	3 Eggs
Chipping Sparrow	4 Eggs
Vesper Sparrow	3 Young
Lesser Goldfinch	3 Eggs

Table 2.2: Species of open-cup nesting birds confirmed, or suspected of breeding on the Lindsay Property.

Species	Status	Reason for Status
Blue Grouse	Confirmed	Fledged Young Seen Common
>Poorwill	Confirmed	Fledged Young Seen
Mourning Dove	Probable	1 Old Nest Located
Western Wood Pewee	Confirmed	2 Nests Located
Steller's Jay	Confirmed	Fledged Young Seen
American Robin	Confirmed	Fledged Young Seen 2 Used Nests Located
Blue-gray Gnatcatcher	Confirmed	1 Nest Located
Plumbeous Vireo	Confirmed	1 Nest Located
Virginia's Warbler	Probable	Territorial Male
Western Tanager	Probable	Territorial Male
Brown-headed Cowbird	Probable	Several Adults Seen
Spotted Towhee	Probable	Territorial Male
Chipping Sparrow	Confirmed	1 Nest Located
Vesper Sparrow	Confirmed	1 Nest Located
Lesser Goldfinch	Confirmed	1 Nest Located
House Finch	Probable	Pairs