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HABITAT USE BY BREEDING BIRDS ON CITY OF BOULDER OPEN SPACE, 1986

A Research Report Prepared for:

City of Boulder
Real Estate Services/Open Space
P.O. Box 791
Boulder, Colorado 80306

Prepared by:

Richard W. Thompson
and
Joseph G. Strauch, Jr.

13 March 1987

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Cover illustration by Clark Scott

TABLE OF CONTENTS

TABLE OF CONTENTS

BOBOLINKS

GRASSHOPPER SPARROWS

TABLES
BREEDING BIRD STUDY

Page

FIGURES

BREEDING BIRD STUDY

BOBOLINKS

GRASSHOPPER SPARROWS

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BREEDING BIRD STUDY

INTRODUCTION

Preserving wildlife habitat and native and/or unique fauna is one purpose of the City of Boulder's Open Space system. Since the advent of the Open Space system in 1967, visitor use has increased as accessibility and the trail system have developed, and as the system itself expanded. Visitor and land use must be managed to insure the system's integrity, and one of the first steps toward proper resource management is a resource inventory.

Breeding avifauna on the City's Open Space lands have not been quantitatively surveyed, yet this information and knowledge of the relative use of avian habitats are required for management of this resource. At the request of the City's Real Estate/Open Space Department, a 3-year research study (1984-86) was initiated to obtain data required for the preservation of avian habitats. Study objectives were to: (1) map Open Space habitats; (2) identify breeding species and determine their densities by habitat type; (3) estimate numbers of each breeding species on Open Space; (4) list breeding and nonbreeding species observed on Open Space and the habitats they utilized; (5) evaluate the relative importance of different habitats to breeding birds; (6) document raptor use including numbers, locations of historic, inactive and active nest sites, and productivity; (7) evaluate effects, particularly on sensitive bird groups, resulting from human use of Open Space; and (8) provide management recommendations. Results of the 1984 and 1985 breeding seasons were presented in Thompson and Strauch (1985, 1986). Results of the 1986 breeding season are presented herein.

STUDY AREA

Open Space parcels were located in a 120 mi^2 area ($40^{o}5'$ to $39^{o}55'$N and $105^{o}19'$ to $105^{o}8'$W) surrounding the City of Boulder, Boulder County, Colorado. Elevations range from 1,545m (5,070 ft) on the Ertl parcels to 2,283m (7,490 ft) on the Campbell property, a difference of 738m (2,420 ft) in 16 km (10 mi). Physiographic and climatic differences over this altitudinal gradient have produced a diversity of habitats supporting a rich avifauna.

The study area contains the interface of the Plains Grassland and Lower Montane Forest life zones (Marr 1961, 1964). Physiographic units running from east to west in the area are plains, floodplains, mesa-terraces, higher mesas, and the foothills (Vestal 1914). The general character of vegetation in the Boulder area is described by Marr (1964) and Weber (1964). Bunin (1985) recently surveyed the vegetation on the Open Space System.

Between the 1984-85 and 1985-86 field seasons, 27 parcels were added to the Open Space system amounting to an additional 1,550.4 ha (3,829.4 acres). Quality and areal extent of habitats present on these parcels significantly contributed to avifauna habitats and the species now observed on Open Space. As of May 1986 the Open Space system totaled approximately 6,196 ha (15,304 acres).

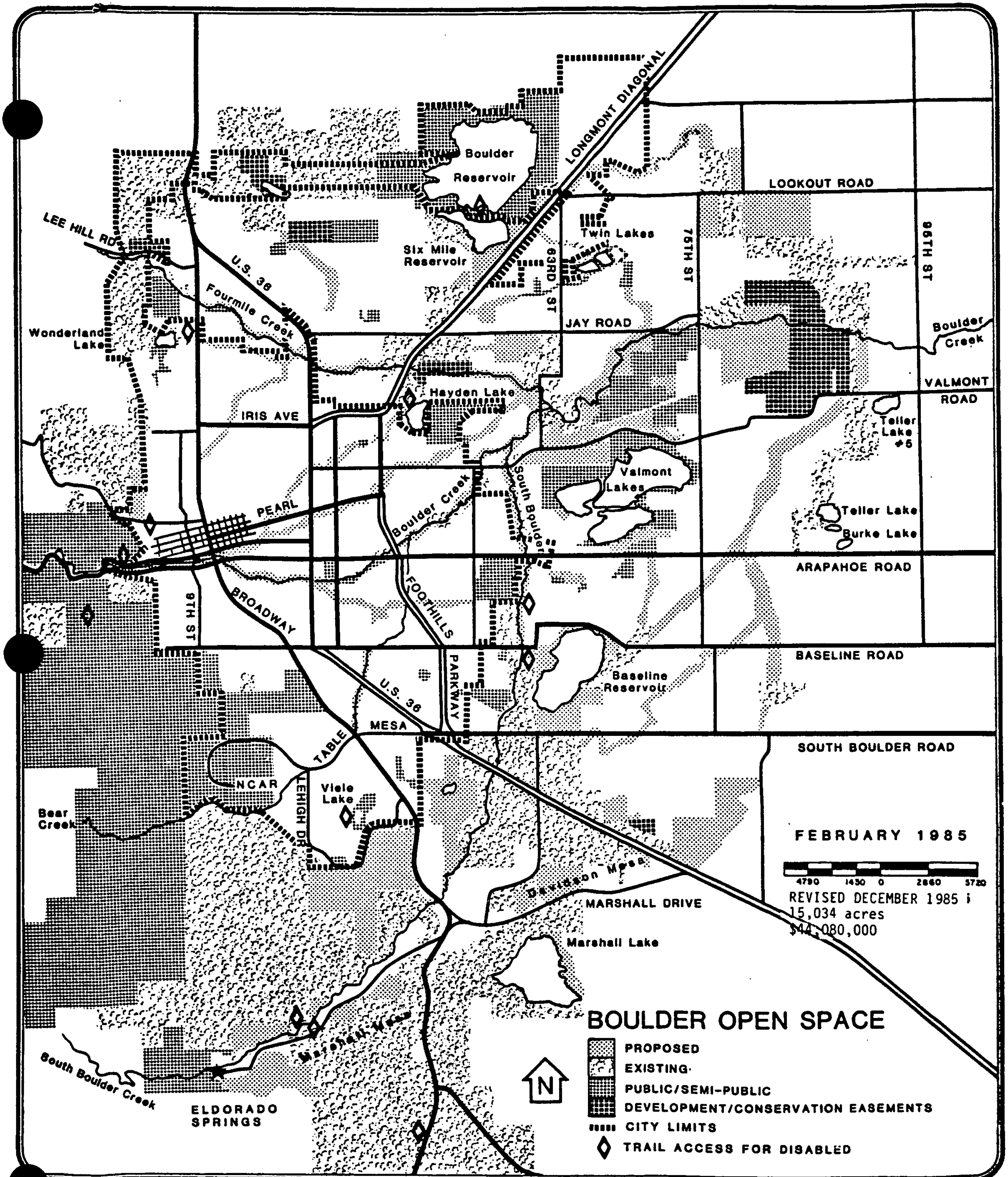
METHODS

HABITAT MAPPING

City of Boulder Open Space (Fig. 1) was stratified by uniform habitat types and mapped on 1" : 24,000" USGS topographic maps using 1" : 12,000" and 1" : 6,000" aerial photographs. All habitat boundaries were ground-truthed. A digital electronic planimeter was used to determine local and cumulative habitat acreage (Table 1).

Six major habitat types were indentified for sampling: (1) riparian (Fig. 2), (2) mountain shrub (Fig. 3), (3) coniferous (ponderosa pine) forest (Fig. 4), (4) "native" grassland (undisturbed or lightly grazed) (Fig. 5), (5) agricultural grasslands (irrigated hayfields and/or heavily grazed pastures) (Fig. 6), and (6) lakes and ponds (Fig. 7). Figures 2-7 illustrate representative areas of these habitats. The 5 terrestrial habitats were sampled by strip transects; lakes and ponds were surveyed by total counts. Agricultural lands (plowed wheat fields), were not surveyed at the City's request.

Minor habitats of limited areal coverage or those representing components of major habitats include (1) disturbed areas (e.g., denuded areas, old residential dump sites, and young, weedy go-back areas like the Reynolds and Boulder Warehouse parcels), (2) rimrock (e.g., Boulder Memorial and Ertl properties), (3) cliffs (e.g.,



BOULDER OPEN SPACE
PROPOSED
EXISTING
PUBLIC/SEMI-PUBLIC
DEVELOPMENT/CONSERVATION EASEMENTS
CITY LIMITS
TRAIL ACCESS FOR DISABLED
FEBRUARY 1985
REVISED DECEMBER 1985
15,034 acres
$44,080,000
N
Boulder Reservoir
LONGMONT DIAGONAL
LOOKOUT ROAD
Six Mile Reservoir
Twin Lakes
63RD ST
75TH ST
95TH ST
LEE HILL RD
U.S. 36
Fourmile Creek
Wonderland Lake
JAY ROAD
Boulder Creek
VALMONT ROAD
Hayden Lake
IRIS AVE
Teller Lake #5
Valmont Lakes
PEARL
Boulder Creek
South Boulder Creek
Teller Lake
Burke Lake
ARAPAHOE ROAD
9TH ST
BROADWAY
FOOTHILLS PARKWAY
BASELINE ROAD
Baseline Reservoir
U.S. 36
TABLE MESA
SOUTH BOULDER ROAD
NCAR
LEHIGH DR
Viele Lake
Bear Creek
Davidson Mesa
MARSHALL DRIVE
Marshall Lake
Marshall Mesa
South Boulder Creek
ELDORADO SPRINGS

Table 1. Areal coverage of habitat types on City of Boulder Open Space, May 1986.

		ACREAGE OF HABITAT TYPES[a]											
PARCEL	ACREAGE	G	C	A/G	MS	AG	R	D	W	B	L&P	CL	T
Flatirons Vista	475.00	398.70	56.2		2.20		13.10			1.4	3.40		
West Rudd 2	504.00	502.75			0.25		1.00						
Salstrand	93.00	93.00											
East Rudd	562.00	453.10	53.4		55.00			0.50					
Corp	135.00	132.35			0.25						2.40		
Neuhauser	69.00	42.85					20.30			5.1	0.75		
THP(W)	140.00	129.70					10.20						
THP(E)	20.00	20.00											
Hedgecock (E)	25.70	12.20		5.4			2.35						
Hedgecock (W)	18.30	16.10					5.20			1.1			
Richardson	66.00	10.70	2.2	36.7	11.90			3.90				0.5	
Church	272.00	33.10		224.1			5.60			8.0	1.00		
Van Vleet	772.00			732.5			15.60			23.9			
Yunker	189.70	115.70		74.1									
Gallucci	50.00	41.10		8.9									
Gebhardt	104.00	6.30		93.7			4.00						
Burke I	87.00			73.8			13.20						
Klein	75.00			75.0									
Hoover Hill	2.30			2.3									
Short	50.15			46.0						4.0			
Arnold	5.70						5.70						
Cottonwood Grove	28.60	3.10					25.50						
Burke 2	68.00			68.0									
Flatirons Ind. Park	32.00	5.10					26.90						
Valmont Ind. Park	3.60	2.85					0.75						
Short & Milne	55.30	1.00		1.0			42.20				14.90		
Andrus	116.00	48.50		59.9			2.00		2.5	3.1			
Reynolds	18.00							18.00					
McKenzie	150.00			142.0			8.00						
Belgrove	89.00			83.0			6.00						
Eccher	8.00			8.0									
Teller	346.00	6.80		65.5		237.7	0.50	8.00		7.0	20.50		

Table 1. Continued.

PARCEL	ACREAGE	ACREAGE OF HABITAT TYPES[a]											
		G	C	A/G	MS	AG	R	D	W	B	L&P	CL	T
Ertl	196.00	8.50		115.30	44.4		23.90	3.90				b	
Kaufman	96.00	1.30		69.20			20.50			5.0			
Jenik & Gunbarrel Hill	80.00					80.00							
Richardson 2	119.00					119.00							
Minnitrista	3.00						3.00						
The Greens	7.50						7.50						
Hart/Jones	17.50	17.50											
Lore	83.00			83.00									
Boulder Valley Ranch	556.00	186.30		251.50	29.60		10.10		68.5	6.8	3.2		
Boulder Warehouse	80.00							80.00					
Boulder Land, Irr., & Power	518.00	488.40			5.60			4.00	20.0				
Gilbert	47.00	47.00											
Mann	226.00	216.10			2.50			7.40					
Parsons (N)	243.50	158.90	61.70		22.90								
Parsons (S)	33.00	26.90		2.90	1.00					2.2			
Moore	75.00	70.00	2.00				3.00						
Erni (N)	46.70	35.80	8.00		2.90								
Proper	19.70	13.70	3.00		3.00								
Erni (S)	180.30	140.80	37.60		8.40								
Leach/Arnold	61.60	24.00						7.40		8.5	21.7		
Whittemeyer (N)	309.40	15.90	293.50										
Whittemeyer (S)	30.30		30.30										
Boulder Memorial	210.00	145.60	50.10		5.20		9.10						
Summers	36.00	21.20	9.70		5.10								
Cunningham/ Hutchinson	52.00	46.70	5.10										
Smith	3.40	3.40											
Kassler	51.00		51.00										
Collins	6.40				6.40								
Merraset	6.40				6.40								
Overlook	19.40		10.40		9.00								
Schnell	163.00	10.90	152.10										

Table 1. Continued.

PARCEL	ACREAGE	ACREAGE OF HABITAT TYPES[a]											
		G	C	A/G	MS	AG	R	D	W	B	L&P	CL	T
Tippet	22.00	21.00					1.00						
Wells	774.00	136.40	568.70		29.60		9.10						
Abbey	160.00	48.20	111.30				0.50						
McStain	17.00	8.70	8.30										
Brammier	23.00	1.50	21.50										
Debacher	157.00	9.50	140.30		4.70							2.5	
Culberson	158.00	7.50	139.40		11.10								
Frasier Farms	123.00	64.50	42.50		16.00								
Stengel	425.00	363.80	45.90		15.30								
Dunn 1	450.00	227.20	86.40	4.70	117.40		12.30	2.0					
McCann (W)	20.00		17.40		0.25							2.4	
McCann	160.00	5.40	91.50		63.10								
McCann (SE)	6.30		4.60		1.70								
Barute	106.00		102.60									2.4	1.0
Campbell	80.00		73.00									7.0	
Dunn 2	280.00	269.00			4.50		5.0				1.50		
Stengel 2	307.00	77.50	156.50	31.30	36.70		2.5			2.3	0.25		
NEW 1985 PARCELS[c]													
Circle of Friends	33.00	5.7	27.3										
Ditzel	56.00			56.00									
Ertl (Cons. Ease.)	231±	59.7					16.4	88.3	14.6		52.0		
Ertl (Devel. Rights)	230±					219.4				9.2	1.4		
Ertl (Fee)	341.07	111.9		142.0	32.5	18.3	18.9		3.4	1.3	12.8		
Greenbelt Plateau	236.14	233.1					3.0						
Gunbarrel Ranch	157.53					157.5							
Haley	79.00					79.0							
Jones	20.57									20.6			
Methvin	25±			25									
Nu-West	73.6			66.2			3.6			3.8			
Tracy Collins	346.52	307.0	7.6		16.7		15.2						
Varra	57.0	57.0											

Table 1. Continued.

PARCEL	ACREAGE	ACREAGE OF HABITAT TYPES[a]											
		G	C	A/G	MS	AG	R	D	W	B	L&P	CL	T
NEW 1986 PARCELS[d]													
Aweida	61.00					61.0							
Boulder Greens Venture	160.00	135.20	24.3				0.5						
Brammier	23.15	3.15	20.0										
Dover - Blacker	160.00	160.00											
East Varra	697.00	580.40					6.0	100.2			10.4		
Hogan Bros.	106.80	106.30			0.5								
Kolb	195.82	190.00					2.0		1.0	3.0			
Minnitrista 2	79.86			79.86									
Shanahan	179.08	68.10		104.9						3.0	3.0		
Spicer	44.75					41.8				3.0			
Steinbach	74.47	74.47											
Waneka	135.74	135.74											
Watt	20.38			19.88						0.5			
Wonderland Lake	4.96	4.96											
TOTALS[e]													
ACRES	15,304.16	7,226.8	2,515.4	2,843.6	572.1	1,013.7	381.2	323.6	110.0	122.8	149.2	15.1	1.0
HECTARES	6,196.02	2,925.8	1,018.4	1,151.3	231.6	410.4	154.3	131.0	44.5	49.7	60.4	6.1	0.4

a Habitat type codes: G=Grassland, C=Conifer, A/G=Agricultural Grassland, MS=Mountain Shrub, AG=Agriculture, R=Riparian, D=Disturbed, W=Wetland, B=Building, L&P=Lakes and Ponds, CL=Cliff, T=Talus.

b Cliff present, but less than 0.25 acres.

c Parcels added to Open Space System between May 1984 and May 1985.

d Parcels added to Open Space System between May 1985 and May 1986.

e The sum of habitat type areas does not equal total Open Space area due to rounding and measurement errors. Combined acreage errors account for 0.19% (29.66 acres) of total Open Space acreage.

Figure 2. Moderate density ponderosa pine on conifer plot C1 located at approximately 1,774m (5,820 ft.) on the Wells Parcel. Photo taken on 1 June 1986 by R. Thompson.

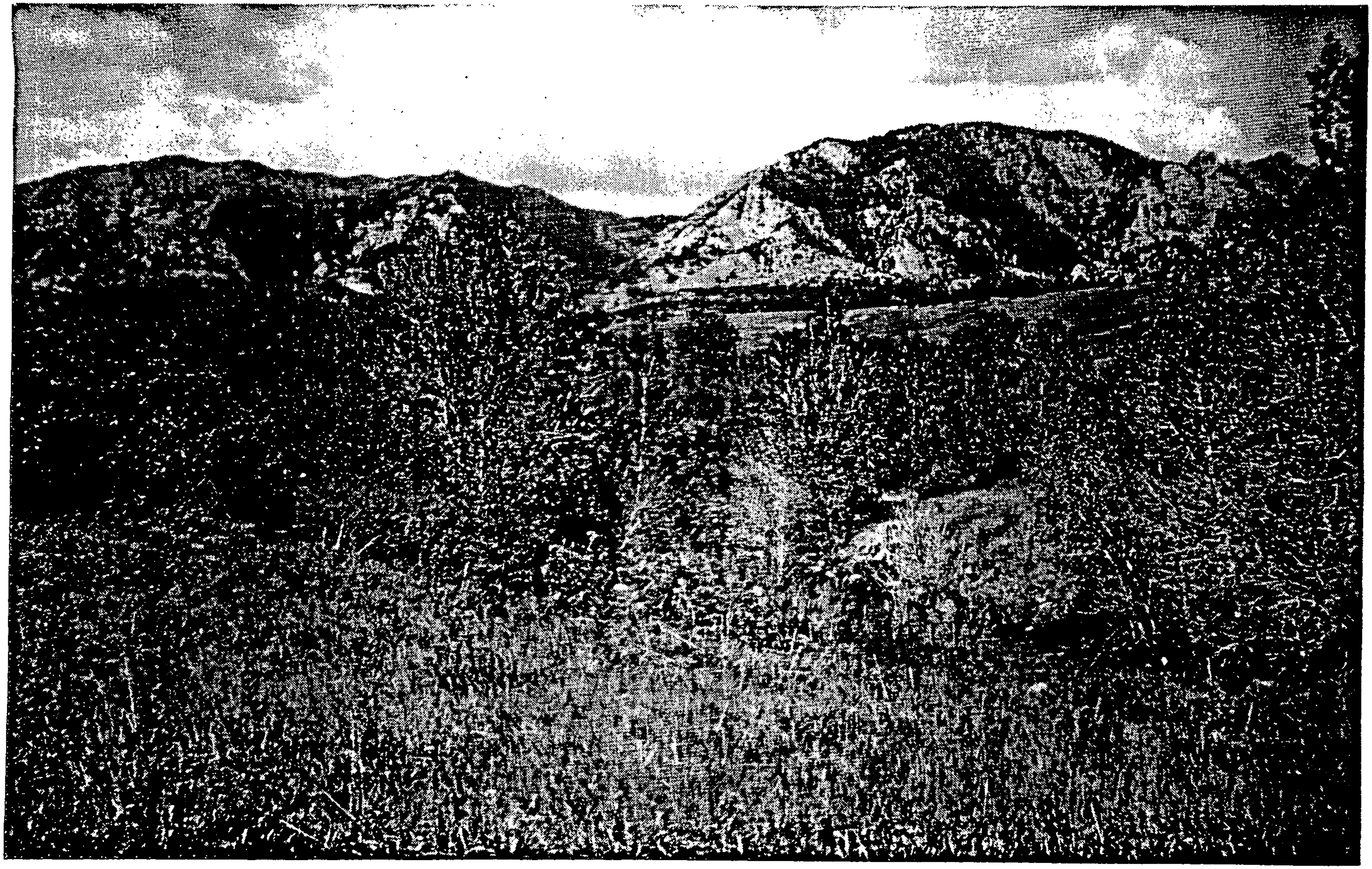


Figure 3. Young riparian vegetation developed along Coal Creek on the Flatirons Vista parcel, immediately west of U.S. Highway 93. Avian richness and density values associated with this riparian plot (R8) were consistently (1984-86) the highest for any plot in the system. Photo taken 31 May 1986 by J. Strauch.

Figure 4. Mountain shrub habitat on plot MS5 near the south end of the Mesa Trail, north of Eldorado Springs. This plot is dominated by skunkbrush, smooth sumac, American plum, and chokecherry. Photo taken 31 May 1986 by J. Strauch.

Figure 5. Grassland plot G6 on the Flatirons Vista parcel. Photo taken 3 June 1986 by R. Thompson.

Figure 6. Irrigated agricultural grassland plot A8 on the Church parcel. The 2 flagged, rebar posts denoting the east boundary of the plot are on the left side of the photo, taken 3 June 1986 by R. Thompson.

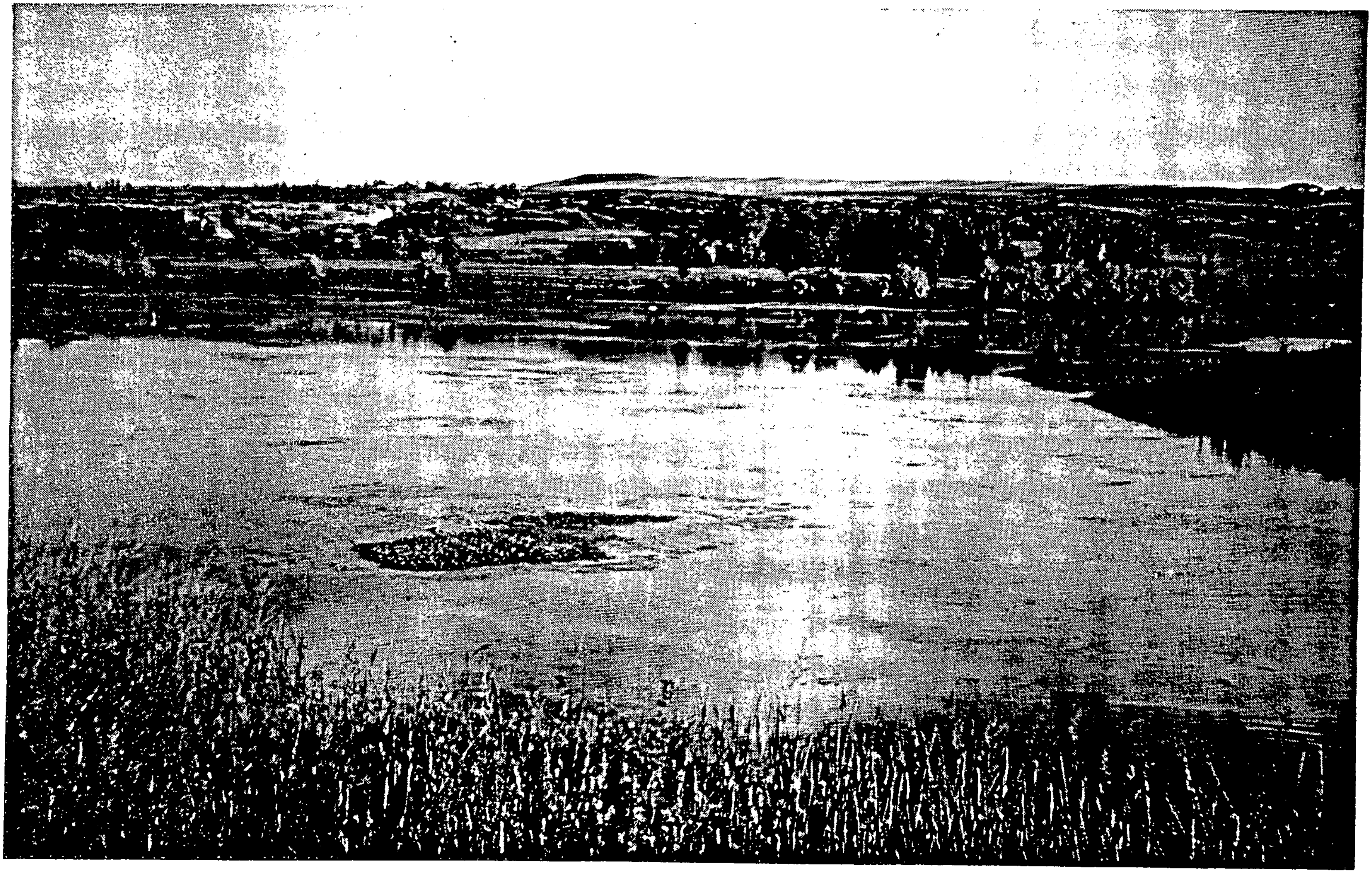


Figure 7. Lake/pond habitat represented by the East Ertl Lake on the Ertl Conservation Easement. Note White Rocks Cliff in the background. Photo by J. Strauch.

Barute and Ertl properties), (4) residence/buildings (e.g., Boulder Valley Ranch and Van Vleet properties), (5) foothills riparian (e.g., Fern and Shadow Canyons), and (6) wetlands (e.g., Short and Milne property and Mesa Reservoir). Minor types were not surveyed separately. Species associated with these minor types were associated with the major habitats surveyed. Similarly, although some species may achieve their maximum densities in ecotones, those species will also be found in the 2 or more homogeneous habitats forming the ecotone.

BREEDING BIRD SURVEYS

Eight, permanent 100x200m (2ha=4.94 acres) breeding bird plots (strip-transects, Emlen 1971, Eberhardt 1978) were randomly established in each of the 5 major, terrestrial habitats in early May 1984. Habitat parcels of sufficient acreage were partitioned into one or more cells large enough to accomodate a plot. Cells throughout the Open Space System were numbered consecutively for each habitat type. A random numbers table was used to select the 8 plot locations out of all possible sites. Habitat cells selected for sampling had plots oriented medially along the cell's long axis. Plot corners (and where appropriate, intermediate points) were permanently marked by 1.22m (4 foot) rebar posts identified with stainless steel adhesive tape and surveyor's flagging.

Each of the 40 permanent plots (8 plots per habitat type x 5 types) was sampled 5 times between 14 May and 17 June (Rep. 1: 14, 15, and 18 May; Rep. 2: 23-27 May; Rep. 3: 31 May - 2 June; Rep. 4: 8-10 June; Rep. 5: 15-17 June), the peak of the 1986 breeding season. The same observers (Thompson and Strauch) which conducted the 1984 and 1985 surveys, traversed the 100x200m plots recording all birds seen or heard within plot boundaries during a 15 minute period. Surveys were conducted between 0.5 hours of sunrise and 0930 hours during favorable weather to minimize variation in bird conspicuousness (Conner and Dickson 1980). A schedule of transect replications for each habitat type was established for both investigators to minimize among- and within-habitat variation. Daily and seasonal temporal detectability bias was reduced by alternating the daily sampling sequence of habitats and by evenly spacing sampling throughout the breeding season. All birds observed on Open Space lands were recorded; however, only those species observed within plot boundaries during surveys and which demonstrated an affinity to the plots were included in quantitative measurements. For example, a gull flying high over a grassland plot was not included. Young-of-the-year were noted, but excluded from quantitative measurements.

Birds demonstrating an affinity towards a plot were considered to be either breeders or transients. Breeders were those birds using habitats in the Boulder area while breeding. However, this does not imply that breeders utilizing a particular habitat were necessarily nesting in that habitat, only that they were using that habitat (e.g., for display purposes, maintainance activities, foraging for young, etc.) during their breeding season. For example, a Great Blue Heron (scientific names are listed in Appendix A) observed fishing in the Ertl Lakes was considered a breeder even though it did not nest on Open Space. Transients were migrants not known to breed in nearby habitats.

Species richness (S, number of species present on a plot during each replication) and density (number of birds present on a 2 ha plot during each replication) values derived for each plot were used to evaluate avian habitat utilization. Mean breeding density for individual species within a habitat was derived from the average number of birds per plot replication (n=5) and then from average values for each of the 8 plots per habitat, where

plot mean (n/2ha)= $\overset{k}{\underset{i=1}{\bar{X}}} = \sum_{i=1}^{5} n/5$ and habitat mean (n/10ha)= $\sum_{i=1}^{8} \bar{X}/8$.

Open Space population estimates were calculated for individual species in each habitat they were observed in by multiplying the mean habitat density estimate by the habitat's area. Population estimates for individual species in all habitats were calculated by summing the individual habitat estimates. Ninety-five percent confidence intervals were constructed about the mean habitat density, habitat population, and Open Space population of each species. Because all species associated with lakes and ponds were assumed to be observed during the 5 total waterfowl counts (discussed below), population estimates for species in this habitat represented the maximum one-day total count. These figures were simply added to the estimates derived from replicated plot counts to obtain total Open Space estimates. Numbers of raptors observed during replicated plot counts are listed by habitat type. Estimates for raptors on the entire Open Space System were derived from these plot counts or from the maximum observed numbers of nesting pairs observed during raptor surveys, whichever number was larger.

During 1984 habitat mapping, a potential difference in habitat quality emerged between irrigated and nonirrigated agricultural grassland habitats. In early spring this difference was not considered large enough to warrant separate habitat status; however, this habitat was subdivided into irrigated and nonirrigated parcels for sampling. Bird plots were allocated proportional to the acreage of irrigated and subirrigated vs. nonirrigated agricultural grasslands on Open Space; 4 plots were established in each of the 2 groups.

WATERFOWL SURVEYS

Waterfowl surveys were conducted on Boulder Open Space lakes and ponds between 18 May and 19 July 1986. Marshall Lake was only surveyed within 100m of the north and west shores where Open Space extends to the water's edge. Cowdrey Reservoir No. 2 was surveyed in its entirety, not just the area on Open Space. As in 1984 and 1985, we surveyed the 4 ponds on and southwest of the Short and Milne property. Although not all these Short and Milne ponds were on Open Space, there were no natural barriers between them and waterfowl appeared to freely move among them. We were unable to obtain access and, therefore, survey the Valmont Lakes. Eggleston Reservoir No. 4 and the small north and south Shanahan Ponds were added to the system for 1986 surveys.

The following wetlands were dried up or showed no sign of waterbird use during early May fieldwork and were not surveyed further: Mesa Reservoir, the pond on the Burke 1 property, the wetlands on the Gebhardt property, and the pond on the Dunn 2 property. The remaining wetlands were surveyed on 7, 24, and 29 June and 9, 12, and 19 July.

Complete counts were made of all waterbirds found on the wetlands regardless of their breeding status. The presence of other species, such as nesting blackbirds, was noted, but no attempt was made to estimate their numbers or productivity. Where possible the age and sex of the birds present were recorded.

RAPTOR SURVEYS

Special emphasis was placed on determining the use of City of Boulder Open Space by breeding raptors. Information on known nesting sites was obtained from the

Colorado Division of Wildlife, Open Space rangers, and local individuals. Sites were then searched for evidence of breeding. In addition, other areas with likely raptor breeding habitat, such as cottonwood stands and prairie dog towns, were searched for evidence of breeding raptors.

All raptor sightings made during work on Open Space were mapped and searches were conducted in areas where repeated sightings occurred. Occurrence maps were developed for each raptor species breeding on Open Space.

DATA ANALYSIS

Species richness and abundance data collected through the aforementioned experimental design were used to construct nested analysis of variance (NANOVA) matrices with equal replication (Sokal and Rohlf 1969, Zar 1974). Differences in breeding bird use among the 5 major terrestrial habitat types were analyzed by NANOVA. Differences within habitat types were analyzed by single factor analysis of variance (ANOVA) and Student-Newman-Keuls (SNK) multiple range tests or least significant difference (LSD) tests. If a significant F resulted from the ANOVA and all possible comparisons between plots were desired, the SNK test was applied. If only several plot comparisons were intended the LSD test was used. Species richness and density data were compared within habitats between 1984, 1985, and 1986 using the NANOVA model; years represented groups and plots represented subgroups. Construction of 95% confidence intervals (CI) about means, variance-ratio tests, t-tests, and confidence limits of the difference between 2 means, followed Sokal and Rohlf (1969). CI reported for 1984 and 1985 at 90% were recalculated to 95% for direct comparison with 1986 data. Tests of significance were at alpha=0.05 unless stated otherwise. Data were screened for normality prior to testing; no transformations were required. Raw data, summary tables, and plot precision estimates are given in Appendix B.

RESULTS AND DISCUSSION

Twenty-seven parcels, representing 1,550.4 ha (3,829.4 acres), were added to the Open Space system since the 1984 field season. Because of the size and quality of these additional habitats, new breeding species as well as a larger bird population are now included in Open Space. As a result, 1984, 1985, and 1986 population estimates, waterfowl productivity, and total species richness are not directly comparable. However, breeding species richness and density estimates, obtained from the 40 permanent census plots, are unaffected by additions to the system. Annual comparisons of these latter estimates can be used as valid indicators of population fluctuations.

BIRDS PRESENT ON OPEN SPACE

One-hundred-twenty-three breeding species and 139 breeders and transients were observed in the 6 major Open Space habitats during the 1986 breeding season (Table 2). This number of breeders is slightly higher than those observed in 1984 and 1985 (references to 1984 and 1985 data are from Thompson and Strauch 1985, 1986, respectively). The greatest number of breeding species occurred in riparian habitats (74) followed by mountain shrub stands (58), agricultural grasslands (51), conifer habitats (48), grasslands (37), and lakes and ponds (34). This order is identical to that of 1985 and similar to that found in 1984, with the exception that conifer and agricultural grassland habitats switched positions. The low number of species associated with lakes and ponds may appear misleading, however, many species using this habitat are migrants which do not breed in the area. This point is illustrated by a comparison of the number of breeding and total species associated with lakes and ponds (Table 2). Thirteen (28%) of the 47 species observed on lakes and ponds were transients, the highest percentage of transients in any habitat.

Breeding species observed on Open Space were, for the most part, expected and representative of the area's avifauna. Few species which are known or suspected to breed on Open Space were undetected. Those undetected and which probably breed are localized or uncommon on Open Space (e.g., Canyon Wren) and/or are difficult to detect (e.g., small owls).

BREEDING BIRD DENSITIES AND POPULATION ESTIMATES.

Forty-two breeding species were observed in conifer habitats during the plot counts. Chipping Sparrows, Western Wood Pewees, Mourning Doves, American Robins, Solitary Vireos, and Mountain Chickadees were the most abundant species and together accounted for 54% of the conifer population (Table 3). These species are consistantly some of the most common birds in conifer habitat.

Table 2. Species of birds observed on Boulder Open Space, 11 April - 28 August 1986. Phylogenetic order and common names follow AOU (1983).

SPECIES	Habitat Type[a] AG	G	R	MS	C	L&P
Pied-billed Grebe						B[b]
Horned Grebe						T
Eared Grebe						T[b]
Western Grebe						B
American White Pelican						B
Double-crested Cormorant						B
American Bittern			B			B
Great Blue Heron	B		B			B
Great Egret						B
Green-backed Heron						B
Black-crowned Night-Heron	B		B			B
White-faced Ibis						T
Canada Goose	B		B			B
Wood Duck			B			B
Mallard	B	B	B			B
Blue-winged Teal	B		B			B
Cinnamon Teal	B		B			B
Green-winged Teal						B
Northern Shoveler						B
Gadwall						B
American Wigeon						B
Redhead						T
[c]Ring-necked Duck						T
Common Merganser			B			B
Ruddy Duck						B
Turkey Vulture	B	B		B	B	
Osprey						T
Northern Harrier	B	B	B	B		B
[c]Sharp-shinned Hawk		B				
Cooper's Hawk	B		B	B		

Table 2. Continued.

SPECIES	Habitat Type[a] AG	G	R	MS	C	L&P
Red-tailed Hawk	B	B	B	B	B	
Swainson's Hawk	B		B	B		
[c]Golden Eagle		B		B	B	
American Kestrel	B	B	B	B		
Prairie Falcon			B	B		
Ring-necked Pheasant	B	B	B	B		
Virginia Rail	B					
Sora			B			
American Coot			B			B
American Avocet						B
Killdeer	B	B	B			B
Greater Yellowlegs						T
Lesser Yellowlegs						T
Spotted Sandpiper						B
Least Sandpiper						T
Common Snipe	B		B			
Wilson's Phalarope	B					B
Ring-billed Gull	T					T
California Gull	T					T
Rock Dove	B	B	B	B	B	
Mourning Dove	B	B	B	B	B	
Common Barn-Owl			B	B		
Eastern Screech Owl			B			
Great Horned Owl	B		B	B	B	
Burrowing Owl	B					
Common Nighthawk	B	B	B		B	
White-throated Swift	B	B		B	B	
Broad-tailed Hummingbird				B	B	
Belted Kingfisher			B			B
Lewis' Woodpecker				B	B	
Downy Woodpecker			B		B	
Hairy Woodpecker					B	

Table 2. Continued.

SPECIES	Habitat Type[a] AG	G	R	MS	C	L&P
Northern Flicker	B	B	B	B	B	
Western Wood Pewee			B	B	B	
Least Flycatcher			B			
Hammond's Flycatcher			B			
Dusky Flycatcher			B	B	B	
[c]Say's Phoebe		B				
Western Kingbird	B	B		B		
Eastern Kingbird	B		B	B		
Horned Lark	B	B				
Tree Swallow						B
Violet-green Swallow	B		B		B	B
Northern Rough-winged Swallow			B			
Bank Swallow			B			B
Cliff Swallow	B	B	B	B	B	B
Barn Swallow	B	B	B	B	B	B
Steller's Jay				B	B	
Blue Jay			B			
Scrub Jay			B			
Black-billed Magpie	B	B	B	B	B	
American Crow	B	B	B	B	B	
Common Raven			B	B	B	
Black-capped Chickadee			B			
Mountain Chickadee					B	
Red-breasted Nuthatch					B	
White-breasted Nuthatch					B	
Pygmy Nuthatch					B	
Rock Wren		B		B		
House Wren			B	B		
Blue-gray Gnatcatcher				B		
Townsend's Solitaire					B	
Swainson's Thrush			T			

Table 2. Continued.

SPECIES	Habitat Type[a] AG	G	R	MS	C	L&P
American Robin	B		B	B	B	
Gray Catbird			B	B	B	
Sage Thrasher		T		T		
Water Pipit						T
European Starling	B	B	B	B	B	
Solitary Vireo					B	
Warbling Vireo					B	
Red-eyed Vireo			B			
Virginia's Warbler				B	B	
Yellow Warbler	B		B	B		
Yellow-rumped Warbler			B	B	B	
Northern Waterthrush						T
McGillivray's Warbler				B		
Common Yellowthroat	B		B			
Wilson's Warbler			B			
Yellow-breasted Chat			B	B		
Western Tanager					B	
Rose-breasted Grosbeak			T			
Black-headed Grosbeak			B	B	B	
Blue Grosbeak		B	B	B		
Lazuli Bunting			B	B		
Indigo Bunting			B	B		
Green-tailed Towhee				B	B	
Rufous-sided Towhee		B	B	B	B	
Chipping Sparrow				B	B	
Brewer's Sparrow		B		B		
Vesper Sparrow	B	B		B	B	
Lark Sparrow		B			B	
Savannah Sparrow	B					
Grasshopper Sparrow	B	B				
Song Sparrow		B	B	B		
Lincoln's Sparrow			B	B		

Table 2. Continued.

SPECIES	Habitat Type[a] AG	G	R	MS	C	L&P
White-crowned Sparrow				B		
Dark-eyed Junco					B	
Bobolink	B		B			
Red-winged Blackbird	B	B	B	B		B
Western Meadowlark	B	B	B	B	B	
Yellow-headed Blackbird	B		B			B
Brewer's Blackbird	B	B	B	B		
Common Grackle	B	B	B		B	
Brown-headed Cowbird	B	B	B	B	B	
Northern Oriole	B	B	B	B		
House Finch	B	B	B	B		
Pine Siskin	B			B	B	
Lesser Goldfinch			B		B	
American Goldfinch	B		B	B	B	
House Sparrow	B		B			
Total Breeding Species	51	37	74	58	48	34
Total Species	53	38	76	59	48	47

Total Breeding Species in all Habitats = 123 (120 in 1984, 120 in 1985)

Total Species in all Habitats = 139 (145 in 1984, 133 in 1985)

[a]Habitat types: AG = agricultural grassland, G = grassland, R = riparian, MS = mountain shrub, C = conifer, L&P = lakes and ponds.

[b]Status: B = habitat used in breeding season (breeder), T = transient in habitat (nonbreeder).

[c]Species seen incidental to breeding bird, raptor, or waterfowl surveys.

Table 3. Mean 1986 plot densities, mean habitat densities, and Boulder Open Space population estimates for breeding birds in conifer habitat.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a] 1	2	3	4	5	6	7	8	MEAN HABITAT DENSITY (n/10ha ± 95% CI)	OPEN SPACE POPULATION[b]
Red-tailed Hawk	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	13 ± 31
Mourning Dove	1.8	1.0	1.6	0	0.6	0.8	0.4	0	3.88 ± 2.81	395 ± 286
Great Horned Owl	0	0.2	0	0	0	0	0	0	0.13 ± 0.30	13 ± 31
Common Nighthawk	0	0.6	0	0	0	0	0	0	0.38 ± 0.89	39 ± 91
White-throated Swift	0	0	0.2	0	0	0.6	0	0	0.50 ± 0.89	51 ± 91
Broad-tailed Hummingbird	0	0	0	0	0.4	0	0	0	0.25 ± 0.59	25 ± 60
Hairy Woodpecker	0	0	0.2	0	0	0.2	0.2	0	0.38 ± 0.43	39 ± 44
Northern Flicker	0.2	0	0	0	0	0.2	0	0.2	0.38 ± 0.43	39 ± 44
Western Wood Pewee	1.0	1.2	2.0	0.2	1.0	0.6	1.0	0	4.38 ± 2.60	446 ± 265
Dusky Flycatcher	0	0	0	0	0	0	0.2	0	0.13 ± 0.30	13 ± 31
Violet-green Swallow	0	0	0	0.4	0.2	0	0	0	0.38 ± 0.62	39 ± 63
Cliff Swallow	0	0.4	0	0	0	0	0	0	0.25 ± 0.59	25 ± 60
Barn Swallow	0	0.2	0	0	0	0	0	0	0.13 ± 0.30	13 ± 31
Steller's Jay	0.2	0	0.2	0.2	0.4	0.8	0.8	0.4	1.88 ± 1.22	191 ± 124
Black-billed Magpie	0.8	0	0.2	0.6	0	0	0	0.8	1.50 ± 1.55	153 ± 158
Common Raven	0	0	0	0	0.2	0	0	0	0.13 ± 0.30	13 ± 31
Mountain Chickadee	0.8	0	0	0	0.2	0.8	1.4	0	2.00 ± 2.23	204 ± 227
Red-breasted Nuthatch	0	0	0	0	0.2	0	0	0	0.13 ± 0.30	13 ± 31
White-breasted Nuthatch	0	0	0	0.2	0	0	0	0	0.13 ± 0.30	13 ± 31
Pygmy Nuthatch	0	0	0.2	0.2	0	0.2	0	0	0.38 ± 0.43	39 ± 44
Townsend's Solitaire	0	0	0	0	0	0.6	0	0.4	0.63 ± 0.99	64 ± 101
American Robin	0.4	1.2	1.6	0.2	0	0.4	0.4	1.6	3.63 ± 2.68	370 ± 273
Gray Catbird	0	0	0	0	0	0.4	0	0	0.25 ± 0.59	25 ± 60
European Starling	0	0	0	0	0	0	0	0.6	0.38 ± 0.89	39 ± 91
Solitary Vireo	1.0	0.4	1.0	0.2	0.6	0.4	0.8	0	2.75 ± 1.53	280 ± 156
Warbling Vireo	0	0.2	0	0	0	0	0	0	0.13 ± 0.30	13 ± 31
Virginia's Warbler	0	0	0.2	0	0	0.2	0	0	0.25 ± 0.39	25 ± 40
Yellow-rumped Warbler	0	0	1.2	0.2	0	0	0	0	0.88 ± 1.76	90 ± 179
Western Tanager	0	0	0	0	0	0.4	0.4	0	0.50 ± 0.77	51 ± 78
Black-headed Grosbeak	0	0	0	0	0	0	0.2	0	0.13 ± 0.30	13 ± 31

Table 3. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 95% CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Green-tailed Towhee	0	0.4	0	0	0	0	0	0.2	0.38 ± 0.62	39 ± 63
Rufous-sided Towhee	0.4	0.2	1.0	0	0	0	0.2	0.4	1.38 ± 1.41	141 ± 144
Chipping Sparrow	3.8	2.0	1.0	1.4	3.4	1.8	0.4	0.6	9.00 ± 5.19	917 ± 529
Vesper Sparrow	0	2.6	0	0	0	0	0	0	1.63 ± 3.84	166 ± 391
Lark Sparrow	0.4	1.0	0	0	0	0	0	0	0.88 ± 1.51	90 ± 154
Dark-eyed Junco	0	0.2	0	0	0	0	0	0.2	0.25 ± 0.39	25 ± 40
Western Meadowlark	0	0.6	0	0	0	0	0	0	0.38 ± 0.89	39 ± 91
Common Grackle	0	0.6	0	0	0	0	0	0	0.38 ± 0.89	39 ± 91
Brown-headed Cowbird	0	0.2	0	0.2	0.2	0.2	0.8	0.6	1.38 ± 1.18	141 ± 120
Pine Siskin	0.2	0	0	0.8	1.0	0	0.2	0	1.38 ± 1.67	141 ± 170
Lesser Goldfinch	0	2.6	0	0	0	0.2	0	0	1.75 ± 3.81	178 ± 388
American Goldfinch	0.6	1.4	0	0	0.2	0	0	0	1.38 ± 2.09	141 ± 213
Unidentified Finch	0	0	0	0.4	0	0	0	0	0.25 ± 0.59	25 ± 60
Total Plot Density	11.6	17.2	10.6	5.2	9.2	9.0	7.4	6.0	47.63 ± 15.83	4,851 ± 1,612
Total Birds Observed	58	86	53	26	46	45	37	30	381[c]	
Total Species Observed	13	20	13	12	13	18	14	11	42[d]	

[a]Plots are each 2 hectares (4.94 acres).

[b]Estimates are number of birds ± 95% confidence interval in 1,018.4 ha (2,515.4 acres) of conifer habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Red Crossbills were not observed anywhere on Open Space during the 1986 fieldwork. This 1986 absence of Crossbills is a statistically significant local decline from 1985 numbers. Red Crossbills were also the only breeding species on Open Space whose 1985 density (43.63 $\pm$ 32.89/10 ha) statistically differed from their 1984 density (5.3 $\pm$ 3.5/10 ha). This pattern of eratic occurrence, where a species may be abundant one year and absent the next, is typical of Red Crossbills and probably represents the most dramatic example of annual population fluctuations for a local species. Crossbill occurrence in a given area is related to the local abundance of cone crops on which the birds feed. In Colorado, Red Crossbills were abundant and bred in the foothills during the good cone crop years of 1947-48, 1951-53, and 1963-64 (Bailey and Niedrach 1965). Red Crossbills and other cone-eating finches were abundant around Boulder from fall 1984 to spring 1985. Red Crossbills will breed anytime of the year when food is abundant and have been recorded breeding in Colorado from January through September (Bailey and Niedrach 1965). Young birds were common among the flocks we observed on Open Space in spring 1985.

Mean breeding bird density in conifer habitat was 47.63 $\pm$ 15.83 birds/10 ha (Table 3), a decrease from 1984's 65 $\pm$ 15 birds/10 ha, and a slight decline from 1985's density when anomalous Crossbill numbers are excluded. The 1986 bird population in conifer habitat was 4,851 $\pm$ 1,612, down from 1984's 6,444 $\pm$ 1,480 birds, and down from 1985's population (9,625 $\pm$ 5,093), even if the estimated 4,365 $\pm$ 4,106 Crossbills are discounted (Table 3). A total of 14.1 and 17.9 ha (34.9 and 44.3 acres) of conifer habitat was added to the system in 1985 and 1986, representing annual additions of 1.4 and 1.8% to the total conifer habitat, respectively. Interannual differences in habitat use are discussed in greater detail below.

Riparian habitats contained more breeding species (58) at a higher mean density (99.50 $\pm$ 25.18 birds/10 ha) than other Open Space habitats (Table 4) in all 3 breeding seasons. The mean 1986 density is similar to 1984's 104.0 $\pm$ 34.9 birds/10ha and 1985's 101.25 $\pm$ 27.36 birds/10ha. The total 1986 riparian population was 1,978 $\pm$501 birds, up from 1,710 $\pm$ 575 birds in 1984 and 1,974 $\pm$ 427 birds in 1985. The 15% population increase in 1985 was probably due to 1985's 18% increase in the area of existing riparian and wetland habitats. Riparian and wetland habitats added to the system in 1986 represented only a 2% increase.

Table 4. Mean 1986 plot densities, mean habitat densities, and Boulder Open Space population estimates for breeding birds in riparian and wetland habitats.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
American Bittern	0	0	0	0	0.2	0	0	0	0.13 ± 0.30	3 ± 6
Great Blue Heron	0	0.2	0.2	0	0	0.4	0	0	0.50 ± 0.63	10 ± 13
Black-crowned Night Heron	0	0	0	0	1.0	0	0	0	0.63 ± 1.48	13 ± 29
Canada Goose	0	0	0.8	0	0.4	0	0	0	0.75 ± 1.24	15 ± 25
Wood Duck	0	0	0.4	0	0	0	0	0	0.25 ± 0.59	5 ± 12
Mallard	0	0.8	2.0	0.6	0.4	0.6	0.2	0	2.88 ± 2.70	57 ± 54
Blue-winged Teal	0	0	0	0	0.8	0	0	0	0.50 ± 1.18	10 ± 23
Cinnamon Teal	0	0	0.4	0	0.2	0	0	0	0.38 ± 0.62	8 ± 12
Red-tailed Hawk	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	3 ± 6
American Kestrel	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	3 ± 6
Prairie Falcon	0	0	0	0.2	0	0	0	0	0.13 ± 0.30	3 ± 6
Sora	0	0	0	0	0.2	0	0	0	0.13 ± 0.30	3 ± 6
American Coot	0	0	0	0	0.2	0	0	0	0.13 ± 0.30	3 ± 6
Common Snipe	0	0	0	0	0.2	0	0	0	0.13 ± 0.30	3 ± 6
Mourning Dove	0	0	0.8	0.8	0	2.0	0.4	0	2.50 ± 2.93	50 ± 58
Great Horned Owl	0	0.8	0	0	0	0	0	0	0.50 ± 1.18	10 ± 23
Belted Kingfisher	0	0	0	0.2	0	0.4	0	0	0.38 ± 0.62	8 ± 12
Downy Woodpecker	0	0	0	1.2	0	0	0	0.2	0.88 ± 1.76	17 ± 35
Northern Flicker	0.4	1.4	0	1.0	0	0.2	0.2	0	2.00 ± 2.19	40 ± 44
Western Wood Pewee	0	0	0	0.2	0	0	0	0	0.13 ± 0.30	3 ± 6
Least Flycatcher	0	0	0	0	0	0	0	0.2	0.13 ± 0.30	3 ± 6
Dusky Flycatcher	0	0	0	0	0	0	0	0.2	0.13 ± 0.30	3 ± 6
Eastern Kingbird	0	0	0	0	0	0	0	0.2	0.13 ± 0.30	3 ± 6
Violet-green Swallow	0	0	0	0	0	0.6	0	0	0.38 ± 0.89	8 ± 18
Northern Rough-winged Swallow	0.6	0	0.2	0	0.6	0	0	0	0.88 ± 1.33	17 ± 26
Cliff Swallow	0.2	0	0.4	0	0	0	0	4.0	2.88 ± 5.82	57 ± 116
Barn Swallow	0.6	0.2	0.4	0.2	0.2	0.2	0	0.2	1.25 ± 0.74	25 ± 15
Blue Jay	0	0	0	0	0	0	0.2	0.2	0.25 ± 0.39	5 ± 8
Black-billed Magpie	0	4.2	0.6	3.4	0.2	1.8	0.4	0.2	6.75 ± 6.79	134 ± 135

Table 4. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a] 1	2	3	4	5	6	7	8	MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
American Crow	0.2	1.4	0	0	0	0	0	0	1.00 ± 2.05	20 ± 41
Common Raven	0.4	0	0	0	0	0	0	0	0.25 ± 0.59	5 ± 12
Black-capped Chickadee	0.4	0	0.2	0.4	0	0.6	0.2	0.8	1.63 ± 1.18	32 ± 23
House Wren	0	0.2	0	0	0	0.4	0	0	0.38 ± 0.62	8 ± 12
American Robin	0	0	2.8	0.2	1.6	1.8	0	0.4	4.25 ± 4.49	84 ± 89
Gray Catbird	0	0	0	0	0	0	0.2	0.2	0.25 ± 0.39	5 ± 8
European Starling	4.2	4.4	1.4	4.2	0.2	1.8	0.4	2.0	11.63 ± 7.21	231 ± 143
Red-eyed Vireo	0	0	0	0.2	0	0	0	0	0.13 ± 0.30	3 ± 6
Yellow Warbler	0.2	0	0.2	0.4	0.4	0	2.0	2.6	3.63 ± 4.17	72 ± 83
Yellow-rumped Warbler	0	0	0	0	0	0	0	0.2	0.13 ± 0.30	3 ± 6
Common Yellowthroat	0.2	0.2	1.2	0.6	2.2	1.8	0	0	3.88 ± 3.59	77 ± 71
Yellow-breasted Chat	0	0	0	0	0	0	0	1.2	0.75 ± 1.77	15 ± 35
Black-headed Grosbeak	0	0.2	0	0.2	0	0	0.6	0.4	0.88 ± 0.94	17 ± 19
Blue Grosbeak	0	0.4	0	0	0	0	0	0	0.25 ± 0.59	5 ± 12
Lazuli Bunting	0	0	0	0	0	0	0.6	0	0.38 ± 0.89	8 ± 18
Indigo Bunting	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	3 ± 6
Rufous-sided Towhee	0	0	0	0	0	0	0.6	0.6	0.75 ± 1.16	15 ± 23
Song Sparrow	0	0	1.0	0.6	2.8	0.4	0.6	0.6	3.75 ± 3.73	75 ± 74
Lincoln's Sparrow	0	0	0	0	0	0	0	0.4	0.25 ± 0.59	5 ± 12
Red-winged Blackbird	1.0	0	6.6	0.8	15.6	0.6	0	0.2	15.50 ± 23.01	308 ± 457
Western Meadowlark	0.2	0	0.4	0	0	0	0	1.4	1.25 ± 2.04	25 ± 41
Yellow-headed Blackbird	0	0	0.2	0	0	0	0	0	0.13 ± 0.30	3 ± 6
Common Grackle	3.4	4.0	1.4	3.6	0.8	1.2	0.2	0	9.13 ± 6.70	182 ± 133
Brown-headed Cowbird	1.6	0.4	2.2	0.8	1.6	0.6	1.0	2.0	6.38 ± 2.79	127 ± 55
Northern Oriole	0.2	0.2	0.2	0	0.2	0	0.6	1.2	1.63 ± 1.67	32 ± 33
House Finch	0	0	0	0.6	0	0	0	0	0.38 ± 0.89	8 ± 18
Lesser Goldfinch	0	0	0	0	0	0	0	0.4	0.25 ± 0.59	5 ± 12
American Goldfinch	1.4	0	0.4	0	0.2	1.0	1.6	2.2	4.25 ± 3.45	84 ± 69
Unident. Finch	0	0	0	0	0	0	0.4	0	0.25 ± 0.59	5 ± 12
House Sparrow	0	0	0	0.4	0	0	0	0	0.25 ± 0.59	5 ± 12

Table 4. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Total Plot Density	15.2	19.0	24.4	20.8	30.2	17.0	10.4	22.2	99.50 ± 25.18	1,978 ± 501
Total Birds Observed	76	95	122	104	151	85	52	111	796[c]	
Total Species Observed	16	15	23	22	22	21	17	25	58[d]	

[a]Plots are each 2 hectares (4.94).

[b]Estimates are number of birds ± 95% confidence interval in 198.8ha (491.2 acres) of riparian and wetland habitats.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Red-winged Blackbirds, European Starlings, Common Grackles, Black-billed Magpies, and Brown-headed Cowbirds were the most abundant species together representing 49.6% of the estimated population. In 1984, Red-winged Blackbirds, European Starlings, Cliff Swallows, Black-billed Magpies, and Common Grackles were the most abundant species and accounted for 46% of the population. In 1985, Red-winged Blackbirds, starlings, magpies, American Goldfinches, and cowbirds were the most common species and accounted for 45.6% of the population. Although numerically dominated by blackbirds, starlings, and magpies, riparian habitats are particularly important to other species such as waterbirds, swallows, Black-capped chickadees, and some warblers and finches.

Forty-seven breeding bird species were observed on plots in mountain shrub habitats, compared to 44 in 1984 and 48 in 1985. Mean 1986 breeding density (56.38 ± 8.04 birds/10ha) in mountain shrub (Table 5) was down from that in 1984 (65.0 ± 12.5 birds/10ha) and 1985 (65.38 ± 6.42 birds/10ha). The 1986 breeding population was estimated at 1,306 ± 186 birds with Rufous-sided Towhees, Lazuli Buntings, Black-billed Magpies, and Green-tailed Towhees comprising 47% of the species present (Table 5). Composition and order of these 4 most abundant species was unchanged from 1984 and 1985 when they together represented 52% and 43% of the species present, respectively. The 10% increase in 1985's population over that of 1984 was consistent with the additional area of recently acquired mountain shrub habitat. Only 0.2 ha (0.5 acres) of mountain shrub habitat was added in 1986.

As in 1984 and 1985, 1986 grassland habitats had the lowest number of breeding species (17) and the lowest mean density (28.88 ± 7.27 birds/10 ha) for major habitats in the Open Space system (Table 6). The 1986 density mean was 29% below that of 1985 (40.50 ± 22.1 birds/10 ha), but 19% higher than in 1984 (24.3 ± 8.70 birds/10 ha). Similarly, the 1986 breeding population of 8,450 ± 2,126 birds was 11% below the 1985 estimate (9,458 ± 6,469 birds), but 72% above the 1984 estimate (4,913 ± 1,759 birds). In 1986, 25% (590 ha) more grassland habitat was added to the system since the 1985 breeding season, and 45% (2,232 ha) more since the 1984 breeding season. Western Meadowlarks, Vesper Sparrows, and Cliff Swallows were the 3 most abundant 1986 species accounting for 71% of breeding birds. Meadowlarks are consistantly the most numerous birds in grassland habitats and in the entire Open Space system. Meadowlarks alone acccounted for 55, 32, and 46% of all grassland birds in 1984, 1985, and 1986, respectively.

Table 5. Mean 1986 plot densities, mean habitat densities, and Boulder Open Space population estimates for breeding birds in mountain shrub.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Red-tailed Hawk	0	0	0	0	0.4	0	0	0	0.25 ± 0.59	6 ± 14
American Kestrel	0	0.2	0	0.4	0	0	0	0	0.38 ± 0.62	9 ± 14
Prairie Falcon	0	0	0	0	0.4	0	0	0.4	0.50 ± 0.77	12 ± 18
Rock Dove	0	0	0	0.6	0	0	0	0	0.38 ± 0.89	9 ± 21
Mourning Dove	0	0.8	0	0.2	0.2	0.4	0	0	1.00 ± 1.18	23 ± 27
Great Horned Owl	0	0.4	0	0	0	0	0	0	0.25 ± 0.59	6 ± 14
White-throated Swift	0	0	0	0	0.8	0	0	0.6	0.88 ± 1.37	20 ± 32
Broad-tailed Hummingbird	0	0	0	0	1.0	0.2	0	1.6	1.75 ± 2.56	41 ± 59
Lewis' Woodpecker	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	3 ± 7
Northern Flicker	0.2	0	0	0	0	0	0	0	0.13 ± 0.30	3 ± 7
Western Wood Pewee	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	3 ± 7
Dusky Flycatcher	0	0	0.4	0	0	0.2	0	0	0.38 ± 0.62	9 ± 14
Western Kingbird	0	0.2	0	0	0	0	0	0	0.13 ± 0.30	3 ± 7
Cliff Swallow	0	2.2	0	0.6	0	0	0	0	1.75 ± 3.25	41 ± 75
Barn Swallow	0	0.4	0.2	0.2	0	0	0	0	0.50 ± 0.63	12 ± 15
Stellar's Jay	0.6	0	0	0	0	0	0	0	0.38 ± 0.89	9 ± 21
Black-billed Magpie	0.6	1.0	1.6	2.4	0.6	0.6	0.6	0.6	5.00 ± 2.79	116 ± 65
American Crow	0	0.2	0	0	0.2	0	0	0	0.25 ± 0.39	6 ± 9
Common Raven	0.2	0	0	0	0.6	0	0	0	0.50 ± 0.89	12 ± 21
Rock Wren	0.6	0.2	0	1.2	0	0	1.2	0	2.00 ± 2.23	46 ± 52
House Wren	0	1.6	0	0.6	0	0	0	0	1.38 ± 2.40	32 ± 56
Blue-gray Gnatcatcher	0	0	0	0	0	0	1.0	0	0.63 ± 1.48	15 ± 34
American Robin	0	0	0	0.2	0	0	0.2	0	0.25 ± 0.39	6 ± 9
European Starling	0	1.6	0	1.2	0	0	0	0	1.75 ± 2.75	41 ± 64
Virginia's Warbler	0.4	0	0.2	0	0.8	0	0	0.6	1.25 ± 1.32	29 ± 31
Yellow Warbler	0	0	0	0	0	0.4	0	0	0.25 ± 0.59	6 ± 14
Yellow-rumped Warbler	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	3 ± 7
McGillivray's Warbler	0.4	0.2	0.4	0	0.2	0	0	0.2	0.88 ± 0.70	20 ± 16
Yellow-breasted Chat	0.4	0	0	0	1.2	1.0	0.2	0.6	2.13 ± 1.97	49 ± 46
Black-headed Grosbeak	0	0	0	0	0	0	0	0.4	0.25 ± 0.59	6 ± 14
Lazuli Bunting	1.0	1.4	3.0	0.8	1.6	0.2	2.0	2.04	7.75 ± 3.79	179 ± 88
Green-tailed Towhee	1.2	0.6	1.0	0	0.8	0.6	0	0.6	3.00 ± 1.79	69 ± 41

Table 5. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Rufous-sided Towhee	1.6	0.2	4.2	0.2	2.8	2.2	2.6	3.0	10.50 ± 5.79	243 ± 134
Chipping Sparrow	0	0	0	0.8	0	0.6	0.6	0	1.25 ± 1.47	29 ± 34
Brewer's Sparrow	0	0.6	0	0.2	0	0	0	0	0.50 ± 0.89	12 ± 21
Vesper Sparrow	0	0	0.2	0	0	0	0	0	0.13 ± 0.30	3 ± 7
Song Sparrow	0.2	0	0	0	0	0	0	0	0.13 ± 0.30	3 ± 7
Lincoln's Sparrow	0	0	0.4	0	0	0	0	0	0.25 ± 0.59	6 ± 14
White-crowned Sparrow	0	0	1.0	0.4	0	1.2	0.2	0	1.75 ± 2.04	41 ± 47
Red-winged Blackbird	0	0.2	0	0.2	0	0	0	0	0.25 ± 0.39	6 ± 9
Western Meadowlark	0	0	0.2	0	0	1.0	0	0	0.75 ± 1.47	17 ± 34
Brewer's Blackbird	0	0	0.2	0	0	0	0	0	0.13 ± 0.30	3 ± 7
Brown-headed Cowbird	0.6	0	0.2	0.2	0.2	1.2	1.2	0.4	2.50 ± 1.95	58 ± 45
Northern Oriole	0	0	0.4	0.4	0	0	0	0	0.50 ± 0.77	12 ± 18
House Finch	0	0	0	0	0	0.4	0	0	0.25 ± 0.59	6 ± 14
Pine Siskin	0	0	0.4	0	0	0	0	0	0.25 ± 0.59	6 ± 14
American Goldfinch	0	0	0.6	0	0	0.2	0	0.8	1.00 ± 1.34	23 ± 31
Total Plot Density	8.0	12.0	14.6	10.8	11.8	11.0	9.8	12.2	56.38 ± 8.04	1,306 ± 186
Total Birds Observed	40	60	73	54	59	55	49	61	451[c]	
Total Species Observed	13	17	17	18	15	18	10	13	47[d]	

[a]Plots are each 2 hectares (4.94 acres).

[b]Estimates are number of birds ± 95% confidence interval in 231.6 ha (572.1 acres) of mountain shrub habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Table 6. Mean 1986 plot densities, mean habitat densities, and Boulder Open Space population estimates for breeding birds in grassland habitat.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a] 1	2	3	4	5	6	7	8	MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
Turkey Vulture	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	38 ± 88
Killdeer	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	38 ± 88
Mourning Dove	0	0	0.4	0.2	0	0.2	0	0	0.50 ± 0.63	146 ± 184
Western Kingbird	0.2	0	0	0	0	0	0	0	0.13 ± 0.30	38 ± 88
Cliff Swallow	0.4	0	0.2	0	0	3.0	0	0.4	2.50 ± 4.29	731 ± 1,255
Barn Swallow	0.4	1.0	0.4	0	0.2	0	0	0	1.25 ± 1.47	366 ± 430
Black-billed Magpie	0	1.0	0	2.0	0.2	0	0.6	0	2.38 ± 3.00	696 ± 878
American Crow	0	0.2	0	0	0	0	0	0	0.13 ± 0.30	38 ± 88
European Starling	0	0.6	0.2	0	0	0.4	0.6	0	1.13 ± 1.13	331 ± 331
Rufous-sided Towhee	0	0	0	0.4	0	0	0	0	0.25 ± 0.59	73 ± 173
Brewer's Sparrow	0	0	0	0	0	0.2	0	0	0.13 ± 0.30	38 ± 88
Vesper Sparrow	1.0	0.6	0.2	0	2.0	1.8	0.8	1.2	4.75 ± 2.96	1,390 ± 866
Lark Sparrow	0	0	0.8	0	0	0	0	0.8	1.00 ± 1.55	293 ± 453
Red-winged Blackbird	0.6	0	0	0	0	0	0.2	0	0.50 ± 0.89	146 ± 260
Western Meadowlark	2.8	1.2	2.6	2.6	2.0	3.8	3.8	2.6	13.38 ± 3.60	3,915 ± 1,053
Common Grackle	0.8	0	0	0	0	0	0	0	0.50 ± 1.18	146 ± 345
Brown-headed Cowbird	0	0.2	0	0	0	0	0	0	0.13 ± 0.30	38 ± 88
Total Plot Density	6.2	4.8	4.8	5.2	4.4	9.8	6.0	5.0	28.88 ± 7.27	8,450 ± 2,126
Total Birds Observed	31	24	24	26	22	49	30	25	231[c]	
Total Species Observed	7	7	7	4	4	8	5	4	17[d]	

[a]Plots are each 2 hectares (4.94 acres).

[b]Estimates are number of birds ± 95% confidence interval in 2,925.8 ha (7,226.8 acres) of grassland habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Twenty-eight breeding species were observed on agricultural grassland plots, one less species than in 1985 and 2 less than in 1984. Red-winged Blackbirds, European Starlings, Western Meadowlarks, and Cliff Swallows accounted for 66% of the population, estimated at 8,794 ± 4,099 birds (Table 7). In 1984, Red-winged Blackbirds, meadowlarks, and Cliff and Barn swallows accounted for 67% of the population, estimated at 5,489 ± 3,036 birds. In 1985, Red-winged Blackbirds, meadowlarks, Common Grackles, and Barn Swallows accounted for 64% of the population, estimated at 8,387 ± 3,957 birds. Red-winged Blackbird numbers, which alone represented 32% of the population in 1986, accounted for 44% and 37% of the 1984 and 1985 population estimates. Mean breeding density on 1986 agricultural grasslands was 76.38 ± 35.60 birds/10 ha (Table 7), down 3% from 1985 (78.5 ± 37.1 birds/10 ha), but up 33% from 1984 (57.5 ± 31.8 birds/10 ha). Agricultural grassland parcels added to the system in 1985 and 1986 represented increases of 12% (117 ha) and 7% (83 ha), respectively.

The aforementioned population estimates represent mean values of species present on survey plots during the 1985 breeding season. These estimates may vary over the season and between plots depending on habitat quality, species' habitat affinities, and breeding activites. Estimates, which are based on sample statistics, are most accurate for common, widespread, territorial species (e.g., Western Meadowlarks) and less accurate for uncommon species with narrow habitat affinities (e.g., Wilson's Phalaropes), difficult to detect species (e.g., Eastern Screech Owl), and colonial nesting species (e.g., Bank Swallows and Red-winged Blackbirds) which can be abundant on, or absent from, a particular plot at any given time. The 95% confidence interval, which follows the density and population estimates, simply means that we are 95% confident that the actual value lies within this interval. For example, there is a 95% probability that the 1986 breeding bird population in Open Space conifer habitat is between 3,239 and 6,463 birds (4,851 ± 1,612) (Table 3).

Table 8 summarizes breeding bird densities in major Open Space habitats by habitat type and provides species specific population estimates for the system as a whole. Table 9 summarizes 1984-86 population estimates for breeding birds in the 6 major habitats. Density estimates for the 5 major terrestrial habitats were derived from replicated plot counts. Estimates for species observed on lakes and ponds are maximum one day total counts. Species listed in Tables 8 and 9 which have no

Table 7. Mean 1986 plot densities, mean habitat densities, and Boulder Open Space population estimates for breeding birds in agricultural grassland habitats.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a] 1	2	3	4	5	6	7	8	MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
Great Blue Heron	0	0	0	0	0	0	0.2	0	0.13 ± 0.30	15 ± 35
Mallard	0.8	0	0	0	0	0	0	1.0	1.13 ± 1.76	130 ± 203
Swainson's Hawk	0	0.4	0	0	0.4	0	0	0	0.50 ± 0.77	58 ± 89
American Kestrel	0	0.4	0	0	0	0	0	0.2	0.38 ± 0.62	44 ± 71
Killdeer	0	0	0.2	0	0	0.2	0	0.6	0.63 ± 0.89	73 ± 102
Common Snipe	0	0	0	0.4	0.2	1.0	0	0	1.00 ± 1.48	115 ± 170
Wilson's Phalarope	1.0	0	0	0	0	0.6	0	1.8	2.13 ± 2.81	245 ± 324
Mourning Dove	0	0.6	0.2	0	0.6	0	0.4	0.6	1.50 ± 1.18	173 ± 136
Western Kingbird	0	0	0	0	0.2	0	0	0	0.13 ± 0.30	15 ± 35
Eastern Kingbird	0	0	0	0	0	0	0.4	0	0.25 ± 0.59	29 ± 68
Horned Lark	0	0	0.2	0	0	0	0	0	0.13 ± 0.30	15 ± 35
Violet-green Swallow	0.2	0	0	0	0	0	0	0	0.13 ± 0.30	15 ± 35
Cliff Swallow	0	0.2	0	0.6	8.0	2.0	1.2	0.4	7.75 ± 11.26	892 ± 1,296
Barn Swallow	1.0	0.2	1.0	0	0.8	0.6	1.2	1.8	4.13 ± 2.38	475 ± 274
Black-billed Magpie	0	0.4	0	0	0	0	0	0	0.25 ± 0.59	29 ± 68
American Robin	0	0.2	0	0	0	0.6	0.2	0.8	1.13 ± 1.30	130 ± 150
European Starling	1.2	1.8	0	0.6	0.4	5.4	0.2	6.8	10.25 ± 10.84	1,180 ± 1,248
Vesper Sparrow	0.8	0	2.0	1.4	0	0	0.4	0	2.88 ± 3.21	332 ± 370
Savannah Sparrow	0	0.2	0	0.4	0	0	0	0	0.38 ± 0.62	44 ± 71
Grasshopper Sparrow	0	0	0.4	0.4	0	0	0	0	0.50 ± 0.77	58 ± 89
Bobolink	2.2	0	0	0	0	0.4	0	0	1.63 ± 3.22	188 ± 371
Red-winged Blackbird	11.6	0.2	1.2	3.6	0.4	15.6	0.2	6.0	24.25 ± 24.50	2,792 ± 2,821
Western Meadowlark	0.4	2.2	2.8	2.2	1.2	0.4	3.4	0.4	8.13 ± 4.97	936 ± 572
Yellow-headed Blackbird	0	0	0	0	0	0	0.2	0	0.13 ± 0.30	15 ± 35
Brewer's Blackbird	0	0.4	0	0	0.4	0	1.2	0	1.25 ± 1.77	144 ± 204
Common Grackle	2.2	0.2	0	0	0	2.4	0	3.4	5.13 ± 5.87	591 ± 676
Brown-headed Cowbird	0.4	0	0	0	0.2	0.2	0	0	0.50 ± 0.63	58 ± 73
House Sparrow	0.2	0	0	0	0	0	0	0	0.13 ± 0.30	15 ± 35

Table 7. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 95%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Total Plot Density	22.0	7.4	8.0	9.6	12.8	29.4	9.2	23.8	76.38 ± 35.60	8,794 ± 4,099
Total Birds Observed	110	37	40	48	64	147	46	119	611[c]	
Total Species Observed	12	13	8	8	11	12	12	11	28[d]	

[a]Plots are each 2 hectares (4.94 acres).

[b]Estimates are number of birds ± 95% confidence interval in 1,151.3ha (2,843.6 acres) of agricultural grassland habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Table 8. Summary of 1986 habitat densities and population estimates for breeding birds in major Boulder Open Space habitats.

SPECIES	MEAN HABITAT DENSITY (n/10ha $\pm$ 95% CI) C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	POPULATION[c]
Pied-billed Grebe						23	26
Western Grebe[d]							
American White Pelican[e]						1	1
Double-crested Cormorant[e]						5	5
American Bittern		0.13 $\pm$ 0.30				1	4 $\pm$ 7
Great Blue Heron		0.50 $\pm$ 0.63			0.13 $\pm$ 0.30	17	42 $\pm$ 65
Great Egret[e]						1	1
Green-backed Heron						1	1
Black-crowned Night-Heron		0.63 $\pm$ 1.48				8	21 $\pm$ 38
Canada Goose		0.75 $\pm$ 1.24				81	96 $\pm$ 106
Wood Duck		0.25 $\pm$ 0.59				2	7 $\pm$ 14
Mallard		2.88 $\pm$ 2.70			1.13 $\pm$ 1.76	68	256 $\pm$ 325
Blue-winged Teal		0.50 $\pm$ 1.18				31	41 $\pm$ 55
Cinnamon Teal		0.38 $\pm$ 0.62				4	12 $\pm$ 17
Green-winged Teal						1	1
Northern Shoveler						1	1
Gadwall						9	9
American Wigeon						3	3
Common Merganser						1	1
Ruddy Duck						2	2
Turkey Vulture[e]				0.13 $\pm$ 0.30			3 $\pm$ 6
Northern Harrier[d]							
Sharp-shinned Hawk[d]							
Cooper's Hawk[d]							
Swainson's Hawk					0.50 $\pm$ 0.77		4-6
Red-tailed Hawk	0.13 $\pm$ 0.30	0.13 $\pm$ 0.30	0.25 $\pm$ 0.59				23 $\pm$ 51
Golden Eagle[e]							
American Kestrel		0.13 $\pm$ 0.30	0.38 $\pm$ 0.62		0.38 $\pm$ 0.62		56 $\pm$ 91
Prairie Falcon[e]		0.13 $\pm$ 0.30	0.50 $\pm$ 0.77				15 $\pm$ 24
Ring-necked Pheasant[d]							
Virginia Rail[d]							

Table 8. Continued.

SPECIES	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	POPULATION[c]
	MEAN HABITAT DENSITY (n/10ha ± 95% CI)						
Sora		0.13 ± 0.30					3 ± 6
American Coot		0.13 ± 0.30				15	18 ± 21
Killdeer				0.13 ± 0.30	0.63 ± 0.89	33	144 ± 224
American Avocet						12	12
Spotted Sandpiper						3	3
Common Snipe		0.13 ± 0.30			1.00 ± 1.48	1	119 ± 177
Wilson's Phalarope					2.13 ± 2.81	5	250 ± 329
Rock Dove			0.38 ± 0.89				9 ± 21
Mourning Dove	3.88 ± 2.81	2.50 ± 2.93	1.00 ± 1.18	0.50 ± 0.63	1.50 ± 1.18		790 ± 695
Common Barn-Owl							6
Eastern Screech Owl							8
Great Horned Owl	0.13 ± 0.30	0.50 ± 1.18	0.25 ± 0.59				30 ± 69
Burrowing Owl							2
Common Nighthawk	0.38 ± 0.89						39 ± 91
White-throated Swift	0.50 ± 0.89		0.88 ± 1.37				72 ± 123
Broad-tailed Hummingbird	0.25 ± 0.59		1.75 ± 2.56				67 ± 121
Belted Kingfisher		0.38 ± 0.62				2	10 ± 15
Lewis' Woodpecker			0.13 ± 0.30				3 ± 7
Downy Woodpecker		0.88 ± 1.76					18 ± 35
Hairy Woodpecker	0.38 ± 0.43						39 ± 44
Northern Flicker	0.38 ± 0.43	2.00 ± 2.19	0.13 ± 0.30				82 ± 95
Western Wood Pewee	4.38 ± 2.60	0.13 ± 0.30	0.13 ± 0.30				452 ± 278
Least Flycatcher		0.13 ± 0.30					3 ± 6
Hammond's Flycatcher[d]							
Dusky Flycatcher	0.13 ± 0.30	0.13 ± 0.30	0.38 ± 0.62				26 ± 52
Say's Phoebe[d]							
Western Kingbird			0.13 ± 0.30	0.13 ± 0.30	0.13 ± 0.30		56 ± 130
Eastern Kingbird		0.13 ± 0.30			0.25 ± 0.59		29 ± 68
Horned Lark					0.13 ± 0.30		15 ± 35
Tree Swallow[d]							

Table 8. Continued.

SPECIES	MEAN HABITAT DENSITY (n/10ha ± 95% CI)						
	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	POPULATION[c]
Violet-green Swallow	0.38 ± 0.62	0.38 ± 0.89			0.13 ± 0.30		62 ± 117
Northern Rough-winged Swallow		0.88 ± 1.33					18 ± 27
Bank Swallow[d]							
Cliff Swallow	0.25 ± 0.59	2.88 ± 5.82	1.75 ± 3.25	2.50 ± 4.29	7.75 ± 11.26		1,750 ± 2,806
Barn Swallow	0.13 ± 0.30	1.25 ± 0.74	0.50 ± 0.63	1.25 ± 1.47	4.13 ± 2.38		893 ± 765
Steller's Jay	1.88 ± 1.22		0.38 ± 0.89				201 ± 146
Blue Jay		0.25 ± 0.39					5 ± 8
Scrub Jay[d]							
Black-billed Magpie	1.50 ± 1.55	6.75 ± 6.79	5.00 ± 2.79	2.38 ± 3.00	0.25 ± 0.59		1,130 ± 1,304
American Crow		1.00 ± 2.05	0.25 ± 0.39	0.13 ± 0.30			65 ± 139
Common Raven	0.13 ± 0.30	0.25 ± 0.59	1.50 ± 0.89				54 ± 64
Black-capped Chickadee		1.63 ± 1.18					33 ± 24
Mountain Chickadee	2.00 ± 2.23						204 ± 228
Red-breasted Nuthatch	0.13 ± 0.30						14 ± 31
White-breasted Nuthatch	0.13 ± 0.30						14 ± 31
Pygmy Nuthatch	0.38 ± 0.43						39 ± 44
Rock Wren			2.00 ± 2.23				26 ± 52
House Wren		0.38 ± 0.62	1.38 ± 2.40				40 ± 69
Blue-gray Gnatcatcher			0.63 ± 1.48				15 ± 35
Townsend's Solitaire	0.63 ± 0.99						65 ± 101
American Robin	3.63 ± 2.68	4.25 ± 4.49	0.25 ± 0.39		1.13 ± 1.30		592 ± 523
Gray Catbird	0.25 ± 0.59	0.25 ± 0.39					31 ± 69
European Starling	0.38 ± 0.89	11.63 ± 7.21	1.75 ± 2.75	1.13 ± 1.13	10.25 ± 10.84		1,824 ± 1,878
Solitary Vireo	2.75 ± 1.53						281 ± 156
Warbling Vireo	0.13 ± 0.30						14 ± 31
Red-eyed Vireo		0.13 ± 0.30					3 ± 6
Virginia's Warbler	0.25 ± 0.39		1.25 ± 1.32				55 ± 71
Yellow Warbler		3.63 ± 4.17	0.25 ± 0.59				79 ± 97

Table 8. Continued.

SPECIES	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	POPULATION[c]
	MEAN HABITAT DENSITY (n/10ha ± 95% CI)						
Yellow-rumped Warbler	0.88 ± 1.76	0.13 ± 0.30	0.13 ± 0.30				96 ± 193
McGillivray's Warbler			0.88 ± 0.70				21 ± 17
Common Yellowthroat		3.88 ± 3.59					78 ± 72
Wilson's Warbler[d]							
Yellow-breasted Chat		0.75 ± 1.77	2.13 ± 1.97				65 ± 82
Western Tanager	0.50 ± 0.77						51 ± 79
Black-headed Grosbeak	0.13 ± 0.30	0.88 ± 0.94	0.25 ± 0.59				38 ± 64
Blue Grosbeak		0.25 ± 0.59					5 ± 12
Lazuli Bunting		0.38 ± 0.89	7.75 ± 3.79				188 ± 106
Indigo Bunting		0.13 ± 0.30					3 ± 6
Green-tailed Towhee	0.38 ± 0.62		3.00 ± 1.79				109 ± 106
Rufous-sided Towhee	1.38 ± 1.41	0.75 ± 1.16	10.50 ± 5.79	0.25 ± 0.59			474 ± 475
Chipping Sparrow	9.00 ± 5.19		1.25 ± 1.47				946 ± 563
Brewer's Sparrow			0.50 ± 0.89	0.13 ± 0.30			50 ± 109
Vesper Sparrow	1.63 ± 3.84		0.13 ± 0.30	4.75 ± 2.96	2.88 ± 3.21		1,891 ± 1,634
Lark Sparrow	0.88 ± 1.51			1.00 ± 1.55			383 ± 608
Savannah Sparrow					0.38 ± 0.62		44 ± 72
Grasshopper Sparrow					0.50 ± 0.77		58 ± 89
Song Sparrow		3.75 ± 3.73	0.13 ± 0.30				78 ± 82
Lincoln's Sparrow		0.25 ± 0.59	0.25 ± 0.59				11 ± 26
White-crowned Sparrow			1.75 ± 2.04				41 ± 48
Dark-eyed Junco	0.25 ± 0.39						26 ± 40
Bobolink					1.63 ± 3.22		188 ± 371
Red-winged Blackbird		15.50 ± 23.01	0.25 ± 0.39	0.50 ± 0.89	24.25 ± 24.50		3,254 ± 3,549
Western Meadowlark	0.38 ± 0.89	1.25 ± 2.04	0.75 ± 1.47	13.38 ± 3.60	8.13 ± 4.97		4,933 ± 1,793
Yellow-headed Blackbird		0.13 ± 0.30			0.13 ± 0.30		18 ± 41
Brewer's Blackbird			0.13 ± 0.30		1.25 ± 1.77		147 ± 211
Common Grackle	0.38 ± 0.89	9.13 ± 6.70		0.50 ± 1.18	5.13 ± 5.87		959 ± 1,247
Brown-headed Cowbird	1.38 ± 1.67	6.38 ± 2.79	2.50 ± 1.95	0.13 ± 0.24	0.50 ± 0.63		422 ± 645
Northern Oriole		1.63 ± 1.67	0.50 ± 0.77				45 ± 52
House Finch		0.38 ± 0.89	0.25 ± 0.59				14 ± 32
Red Crossbill[f]							
Pine Siskin	1.38 ± 2.09		0.25 ± 0.59				147 ± 227
Lesser Goldfinch	1.75 ± 3.81	0.25 ± 0.59					184 ± 400

Table 8. Continued.

SPECIES	MEAN HABITAT DENSITY (n/10ha ± 95% CI)						
	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	POPULATION[c]
American Goldfinch	1.38 ± 2.09	4.25 ± 3.45	1.00 ± 1.34				250 ± 313
House Sparrow		0.25 ± 0.59			0.13 ± 0.30		20 ± 47
Combined Unidentified Species	0.25 ± 0.59	0.25 ± 0.59					31 ± 72

a Estimates based on 8, 2 ha plots per habitat type, each replicated 5 times.

b Estimates based on maximum one day total count. A minimum of 5 counts were made during the peak of waterfowl breeding.

c Estimates are number of birds ± 95% confidence interval in 5,586.4 ha (13,798.3 acres) occupied by the 6 major habitat types and wetlands (a subset of riparian) habitat. Confidence intervals were not calculated for species observed on lakes and ponds.

d Species was observed during the study, but not on quantitative counts. We are, therefore, unable to estimate population size.

e No pairs nested on Open Space in 1986.

f Species was not observed on Open Space during 1986 fieldwork.

Table 9. Summary of 1984-86 population estimates for breeding species on the 6 major City of Boulder Open Space habitats.

SPECIES	POPULATION[a] (Mean ± 95% CI) 1984[b]	1985[b]	1986[b]
Pied-billed Grebe	13	9	26
Western Grebe	e	c	c
American White Pelican[d]	e	e	1
Double-crested Cormorant	e	e	5
American Bittern	1	1	4 ± 7
Great Blue Heron	6	22 ± 30	42 ± 65
Great Egret[d]	e	1	1
Green-backed Heron	e	c	1
Black-crowned Night-Heron	13 ± 15	7 ± 13	21 ± 38
Canada Goose	118 ± 40	110	96 ± 106
Wood Duck	9 ± 14	17 ± 28	7 ± 14
Mallard	149 ± 227	377 ± 356	256 ± 325
Blue-winged Teal	39 ± 60	10 ± 15	41 ± 55
Cinnamon Teal	4	5	12 ± 17
Green-winged Teal	e	2	1
Northern Shoveler	c	c	1
Gadwall	3	1	9
American Wigeon	e	e	3
Common Merganser	2	c	1
Ruddy Duck	3	2	2
Turkey Vulture[d]	c	c	3 ± 6
Northern Harrier	e	17 ± 40	c
[c]Sharp-shinned Hawk	13 ± 30	c	c
Cooper's Hawk	c	e	c
Swainson's Hawk	e	e	4-6
Red-tailed Hawk	41 ± 10	30 ± 49	23 ± 51
Golden Eagle[d]			
American Kestrel	131 ± 656	101 ± 163	56 ± 91
Prairie Falcon[d]	114 ± 262	c	15 ± 24
Chukar	c	e	e

Table 9. Continued.

SPECIES	POPULATION[a] (Mean ± 95% CI)		
	1984[b]	1985[b]	1986[b]
Ring-necked Pheasant	c	7 ± 13	c
Blue Grouse	c	c	e
Virginia Rail	13 ± 29	c	c
Sora	6 ± 10	e	3 ± 6
American Coot	39	25	18 ± 21
Killdeer	207 ± 236	132 ± 176	144 ± 224
American Avocet	e	3	12
Spotted Sandpiper	5	5 ± 12	3
Common Snipe	169 ± 201	297 ± 267	119 ± 177
Wilson's Phalarope	144 ± 230	295 ± 515	250 ± 329
Rock Dove	16 ± 39	146 ± 270	9 ± 21
Mourning Dove	966 ± 882	1,044 ± 984	790 ± 695
Common Barn-Owl	2	4	6
Eastern Screech Owl	3 ± 5	2	8
Great Horned Owl	8 ± 14	15 ± 25	30 ± 69
Northern Pygmy Owl	e	c	e
Burrowing Owl	4	4	2
Long-eared Owl	2	e	e
Common Nighthawk	101 ± 210	146 ± 311	39 ± 91
Common Poorwill	c	e	e
White-throated Swift	49 ± 106	88 ± 201	72 ± 123
Broad-tailed Hummingbird	110 ± 196	84 ± 124	67 ± 121
Belted Kingfisher	5	3	10 ± 15
Lewis' Woodpecker	e	e	3 ± 7
Downy Woodpecker	7 ± 11	16 ± 37	18 ± 35
Hairy Woodpecker	25 ± 39	50 ± 64	39 ± 44
Northern Flicker	118 ± 166	117 ± 170	82 ± 95
Olive-sided Flycatcher	c	e	e
Western Wood Pewee	404 ± 209	584 ± 285	452 ± 278
Least Flycatcher	e	e	3 ± 6
Willow Flycatcher	e	c	e
Hammond's Flycatcher	38 ± 63	19 ± 39	c
Dusky Flycatcher	c	e	26 ± 52

Table 9. Continued.

SPECIES	POPULATION[a] (Mean ± 95% CI) 1984[b]	1985[b]	1986[b]
Western Flycatcher	8 ± 14	e	e
Say's Phoebe	c	2	c
Western Kingbird	27 ± 61	19 ± 47	56 ± 130
Eastern Kingbird	7 ± 15	3 ± 8	29 ± 68
Horned Lark	37 ± 61	53 ± 126	15 ± 35
Tree Swallow	13 ± 29	33 ± 76	c
Violet-green Swallow	16 ± 35	221 ± 421	62 ± 117
Northern Rough-winged Swallow	61 ± 123	10 ± 13	18 ± 27
Bank Swallow	68 ± 132	104 ± 242	c
Cliff Swallow	524 ± 853	2,767 ± 5,753	1,750 ± 2,806
Barn Swallow	507 ± 627	745 ± 573	893 ± 765
Steller's Jay	112 ± 115	238 ± 210	201 ± 146
Blue Jay	3 ± 5	c	5 ± 8
Scrub Jay	c	c	c
Black-billed Magpie	573 ± 640	811 ± 835	1,130 ± 1,304
American Crow	5 ± 7	120 ± 206	65 ± 139
Common Raven	c	16 ± 38	54 ± 64
Black-capped Chickadee	44 ± 71	49 ± 50	33 ± 24
Mountain Chickadee	213 ± 82	228 ± 148	204 ± 228
Bushtit	c	e	e
Red-breasted Nuthatch	13 ± 30	38 ± 63	14 ± 31
White-breasted Nuthatch	e	e	14 ± 31
Pygmy Nuthatch	178 ± 99	88 ± 145	39 ± 44
Rock Wren	41 ± 44	94 ± 135	26 ± 52
House Wren	79 ± 119	84 ± 106	40 ± 69
American Dipper	c	3 ± 7	e
Blue-gray Gnatcatcher	e	e	15 ± 35
Townsend's Solitaire	25 ± 39	50 ± 64	65 ± 101
American Robin	960 ± 546	507 ± 380	592 ± 523
Gray Catbird	11 ± 22	23 ± 38	31 ± 69
Loggerhead Shrike	c	c	e

Table 9. Continued.

SPECIES	POPULATION[a] (Mean ± 95% CI)		
	1984[b]	1985[b]	1986[b]
European Starling	390 ± 469	1,432 ± 2,198	1,824 ± 1,878
Solitary Vireo	277 ± 227	188 ± 164	281 ± 156
Warbling Vireo	3 ± 5	e	14 ± 31
Red-eyed Vireo	13 ± 25	3 ± 7	3 ± 6
Virginia's Warbler	56 ± 70	99 ± 129	55 ± 71
Yellow Warbler	58 ± 53	58 ± 92	79 ± 97
Yellow-rumped Warbler	44 ± 59	92 ± 133	96 ± 193
McGillivray's Warbler	9 ± 22	20 ± 22	21 ± 17
Common Yellowthroat	77 ± 59	93 ± 62	78 ± 72
Wilson's Warbler	11 ± 24	13 ± 20	c
Yellow-breasted Chat	40 ± 50	64 ± 70	65 ± 82
Western Tanager	277 ± 434	63 ± 63	51 ± 79
Black-headed Grosbeak	43 ± 60	20 ± 32	38 ± 64
Blue Grosbeak	8 ± 18	30 ± 70	5 ± 12
Lazuli Bunting	243 ± 208	151 ± 114	188 ± 106
Indigo Bunting	e	6 ± 9	3 ± 6
Dickcissel	e	2	e
Green-tailed Towhee	129 ± 163	98 ± 78	109 ± 106
Rufous-sided Towhee	834 ± 503	691 ± 433	474 ± 475
Chipping Sparrow	740 ± 247	784 ± 550	946 ± 563
Brewer's Sparrow	11 ± 26	78 ± 119	50 ± 109
Vesper Sparrow	1,306 ± 1,992	1,696 ± 2,278	1,891 ± 1,634
Lark Sparrow	588 ± 1,006	516 ± 1,144	383 ± 608
Lark Bunting	e	c	e
Savannah Sparrow	15 ± 34	c	44 ± 72
Grasshopper Sparrow	39 ± 90	117 ± 181	58 ± 89
Song Sparrow	79 ± 95	86 ± 54	78 ± 82
Lincoln's Sparrow	20 ± 37	10 ± 20	11 ± 26
White-crowned Sparrow	3 ± 7	6 ± 14	41 ± 48
Dark-eyed Junco	129 ± 158	91 ± 113	26 ± 40
Bobolink	120 ± 229	121 ± 285	188 ± 371
Red-winged Blackbird	2,751 ± 3,125	3,668 ± 3,512	3,254 ± 3,549

Table 9. Continued.

SPECIES	POPULATION[a] (Mean ± 95% CI) 1984[b]	1985[b]	1986[b]
Western Meadowlark	3,593 ± 961	4,383 ± 1,562	4,933 ± 1,793
Yellow-headed Blackbird	35	27	18 ± 41
Brewer's Blackbird	263 ± 434	107 ± 213	147 ± 211
Common Grackle	249 ± 331	728 ± 686	959 ± 1,247
Brown-headed Cowbird	402 ± 485	397 ± 314	422 ± 645
Northern Oriole	23 ± 33	27 ± 43	45 ± 52
Pine Grosbeak	13 ± 30	e	e
House Finch	17 ± 36	7 ± 18	14 ± 32
Red Crossbill	523 ± 346	4,371 ± 4,120	e
Pine Siskin	296 ± 336	219 ± 151	147 ± 227
Lesser Goldfinch	130 ± 237	8 ± 19	184 ± 400
American Goldfinch	80 ± 96	326 ± 442	250 ± 313
Evening Grosbeak	c	100 ± 149	e
House Sparrow	e	48 ± 79	20 ± 47
Combined Unidentified Species	101 ± 122	16 ± 38	31 ± 72

a Estimates are based on 8, 2 ha plots per habitat type (conifer, riparian and wetlands, mountain shrub, grassland, and agricultural grassland), each replicated 5 times, to which the maximum one day total count was added for birds associated with lakes and ponds.

b Area occupied by the 6 major habitat types totalled 4,366.98 ha in 1984, 4,885.6 ha in 1985, and 5,586.4 ha in 1986. See Table 1 for areas of individual habitats.

c Species was observed during this year of the study, but not on quantitative counts. We are, therefore, unable to estimate population size.

d No pairs nested on Open Space.

e Species was not observed on Open Space this year.

density or population estimates were observed incidental to quantitative surveys. For these less common species no quantitative abundance estimates were possible. See Table 2 for the habitats these species were observed in. Similarly, species not listed in a particular habitat either do not breed in that habitat or were not observed in that habitat during fieldwork.

As discussed above, estimates derived from plot counts are less accurate for uncommon species and some bird groups, such as raptors and waterfowl. For this and additional reasons, raptor and waterfowl numbers were estimated by total counts. Results of these counts provide more accurate abundance estimates and are discussed separately below under "Waterfowl" and "Raptors".

AVIAN USE OF HABITAT TYPES

Breeding Species

Avian species richness on Open Space differed significantly between ($F=23.95$, $P<0.0005$) and within ($F=2.76$, $P<0.0005$) major habitat types (Table B2), a conclusion also reached for the 1984 and 1985 breeding seasons (Fig. 8). Differences in bird use between habitats are related to the different vegetative and physical attributes which characterize a habitat type and to the relative value of that type (habitat quality) in providing various avian life history requirements such as forage, cover, and nesting sites. Differences in use within habitats (i.e., between plots) are related to variation in plot quality within a habitat type.

Breeding species richness differed significantly between all habitats (Table B5) except for comparisons between the following habitats: conifer and agricultural grassland, conifer and mountain shrub, and mountain shrub and agricultural grassland (Table 10). These results are identical to the 1985 test results. In 1984, the only habitats that did not differ in species richness were conifer and mountain shrub. Species richness was highest in 1986 riparian habitats (8.8 species/plot) followed by mountain shrub (6.05), conifer (5.55), agricultural grassland (5.05) and grassland (2.68) habitats (Table B5, Fig. 2). Although mean species richness values varied between years, the relative 1986 ranking of habitats was identical to those of 1984 and 1985, except that conifer and mountain shrub rankings were reversed in 1986.

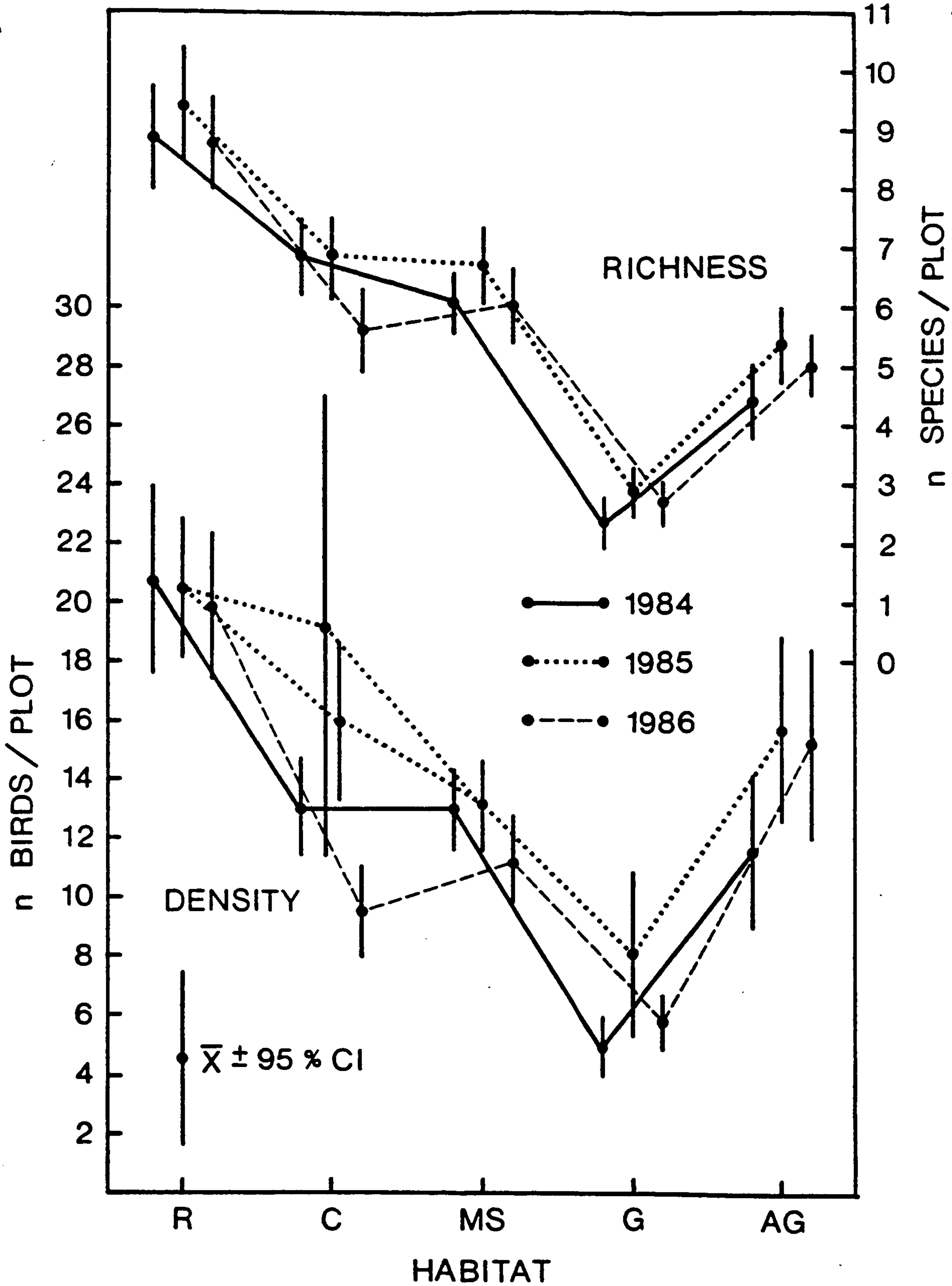


Figure 8. Breeding bird use of riparian (R), conifer (C), mountain shrub (MS), grassland (G), and agricultural grassland (AG) habitats on City of Boulder Open Space, 1984-86. The 1985 conifer density estimate does not include the anomalous Red Crossbill flock from plot C2, rep. 1.

Table 10. Student-Newman-Keuls test results for 1986 breeding bird richness and density. Correlations between riparian (R), conifer (C), mountain shrub (MS), grassland (G), and agricultural grassland (AG) habitats are indicated as significantly different (S) or not significantly different (NS) at alpha = 0.05.

BREEDING SPECIES RICHNESS

	R	C	MS	G	AG
R		S	S	S	S
C			NS	S	NS
MS				S	NS
G					S
AG					

BREEDING SPECIES DENSITY

	R	C	MS	G	AG
R		S	S	S	NS
C			NS	NS	NS
MS				S	NS
G					S
AG					

Density of breeding birds also differed between ($F = 9.08$, $P < 0.0005$) and within ($F = 5.25$, $P < 0.0025$) major habitat types (Table B7, Fig. 2). SNK test results indicate breeding densities in riparian habitat were higher than those in all other habitats, except agricultural grasslands, grasslands had significantly lower densities than mountain shrub and agricultural grassland habitats, and all other habitat comparisons were similar (Table 10). In 1984, riparian and grassland densities differed with those of all other habitats. In 1985, grassland densities were lower than those in riparian and conifer habitats, but all other habitat densities were similar. Breeding density in 1986 was highest in riparian habitats (19.9 birds/plot) followed by agricultural grassland (15.28), mountain shrub (11.28), conifer (9.23) and grassland (5.78) habitats (Table B10, Fig. 8). Densities in all 1986 habitats were lower than in 1985, and with the exception of grassland and agricultural grassland habitats, lower than in 1984 (Fig. 8).

The statistical similarities between bird use of some habitat types does not imply the avifaunas are necessarily the same. Although these habitats may share many of the same species, the statistical similarity indicates only that these habitats support avifaunas numerically comparable in richness and density.

Two Open Space parcels, the Ertl property (White Rocks) and the Cottonwood Grove, are considered relic or unique areas from vegetative and wildlife perspectives. Physiographical and ecological descriptions of these areas may be found in MacPhail et al. (1970), ERTL (1982), Keammerer and Keammerer (1983), Bock and O'Shea-Stone (unpubl. data), and Bunin (1985). Many wildlife investigations have occurred in these areas; however, this is the first study that has comparatively examined avian use of these areas and of other "experimental" areas.

Two bird plots (MS2 and MS4) were located in mountain shrub habitat on the Ertl property. Data obtained from these were compared with that from 6 other mountain shrub plots on Open Space. The 1986 ANOVA results (like those of 1985) showed no statistical difference in species richness between the 8 mountain shrub plots (Table B11). The 1986 LSD test results (LSD = 2.66) yield a similar conclusion (Table B12), as in 1985. ANOVA results from 1984 indicated a borderline result ($F = 1.97$, $0.10 > P > 0.05$) which we conservatively interpreted as no significant difference in species richness. With the exception of MS2, the east Ertl plot, which in 1985 had a significantly lower richness value than MS1, the Shadow Canyon plot, the 2 Ertl plots did not differ from each other ($P > 0.05$), nor did either differ from any other mountain shrub plot during any of the 3 breeding seasons. The mean 1986 richness value for the 8 mountain shrub plots was 6.05 ± 0.31 species/plot (Table B3); the values for the east and west Ertl plots were 6.2 ± 0.86 and 6.8 ± 0.97 species/plot, respectively.

In contrast to the 1984 mountain shrub comparisons and similar to those of 1985, 1986 breeding species densities did not differ between the 8 mountain shrub plots ($F=0.82$, $P > 0.25$) (Table B13). SNK and LSD test results (Table B14) indicate the east and west Ertl plots do not differ from each other or from any other mountain shrub plot. The mean 1985 density value for the 8 mountain shrub plots was 11.28 ± 0.74 birds/plot (Table B8) compared to values of 12.0 ± 2.77 and 10.8 ± 2.29 (Table B9) for the east and west Ertl plots, respectively.

Avian use of the 2 Ertl mountain shrub plots did not differ in species richness or density from other mountain shrub plots in the system. The mountain shrub habitat is only one of several habitats of value to birds on the Ertl property. Avian use of mountain shrub habitat on this parcel is average compared to other mountain shrub stands in the Open Space system, however, it is interesting that this isolated "island" not only supports average numbers of birds, but a species composition similar to shrub stands in the foothills. With the exception of the White Rocks cliff face, none of the habitat types present on the Ertl property (this does not include the Ertl Conservation Easement) provides unique bird habitat that is absent from other Open Space parcels. Species present on the Ertl property will be found in similar numbers in similar habitats elsewhere on Boulder Open Space. What is unique for birds on the Ertl property is (1) the cliff nesting habitat adjacent to Boulder Creek (starlings, Rock Doves, Rock Wrens, American Kestrels, Black-billed Magpies, Great Horned Owls, Common Barn-Owls, and Common Mergansers nested in the Ertl cliff in 1984, 1985, and/or 1986), (2) the isolated mountain shrub habitat interspersed with sandstone rimrock (providing numerous additional nest sites), (3) the close interspersion of several major and minor habitats with Boulder Creek, (4) and the isolation the area receives from public use. Common Barn-Owls have bred there regularly for decades. Barn-Owls probably breed in several areas throughout Boulder County, but White Rocks is the only well known and documented site.

Riparian communities and the Ertl lakes and ponds were not part of the Open Space system at the beginning of this study. The lakes and ponds were added to the study in 1985. The riparian habitat has not been sampled in this study, however, we have no evidence suggesting that it differs from other riparian areas on Open Space.

Two riparian bird plots located in the Cottonwood Grove permitted a comparison with other riparian plots in the system. As in 1984 and 1985, 1986 species richness differed among the 8 riparian plots ($F=3.04$, $P<0.025$) (Table B15). Mean richness for all riparian plots was 8.8 ± 0.40 species/plot (Table B3); the 1986 value for the north Cottonwood Grove plot (R2) was, as in 1984 and 1985, slightly low (R2 = 7.2 ± 0.8 species/plot), however the north plot (R4), which was slightly lower in 1984 and 1985, was slightly above the 1986 mean (R4=9.6 ± 1.12 species/plot). The Cottonwood Grove plots did not differ from each other, however, both plots differed from plot R6, and R2 (north plot) differed from plots R3 and R8 (Table B18). SNK results indicate plot R8 (Coal Creek) had a significantly higher richness value (11.2 ± 1.01 species/plot) than plot R7 (South Boulder Creek, 6.6 ± 0.93 species/plot) (Table B16). LSD results (Table B16) indicate the north Cottonwood plot was significantly lower in richness than the Coal Creek (R8) or Kaufman (R6, 10.0 ± 1.04 species/plot) plots. The south Cottonwood plot was slightly higher than the South Boulder Creek plot.

Like 1984 and 1985, 1986 breeding species density also differed among riparian plots ($F=5.63$, $P<0.0005$, Table B17). Densities for the north (19.0 ± 1.22 birds/plot) and south (20.8 ± 2.89 birds/plot) Cottonwood Grove plots were the closest plots to the mean riparian density (19.9 ± 1.21 birds/plot) (Tables B8 and B17). SNK results (Table B18) indicate the west Short-Milne plot (R5=30.2 ± 3.02 birds/plot) had a significantly higher density than plots R1 (Burke 1), R2 and R4 (north and south Cottonwood Grove), R6 (Kaufman), and R7 (South Boulder Creek). The east Short-Milne plot (R3) had a higher density than R7, and R8 (Coal Creek) had a higher density than R7.

The 2 riparian plots in the Cottonwood Grove were average to slightly below average in avian richness and density. Nevertheless, the Cottonwood Grove does provide an important riparian habitat to the Boulder area for 2 reasons: it is isolated (public access is restricted) and it is one of the broadest stands of riparian habitat in the Boulder Valley. This grove provides breeding habitat for 3 relatively uncommon species, Wood Ducks, Great Horned Owls and Eastern Screech Owls.

Tests between irrigated (I) and nonirrigated agricultural grassland plots indicate that species richness and density on irrigated plots is statistically greater than on nonirrigated plots (Tables 11, B19, B20). Breeding species richness differed between the 8 agricultural grassland plots ($F=5.18$, $P<0.001$). Plots supporting the 3 highest species richness values were all irrigated (Table B20). These conclusions are similar to those reached in 1984 and 1985. Richness differences between irrigated and nonirrigated plots are illustrated in Table 11. Irrigated plot P8 (Church, $S=7.0 \pm 0.63$) had significantly higher richness values than nonirrigated plots P3 (Boulder Valley Ranch, $S=4.0 \pm 0.55$), P4 (Lore, $S=3.6 \pm .060$) (although both plots may be temporarily flooded during a portion of the growing season), P7 (East Yunker, $S=4.2 \pm 0.66$), and irrigated plot P5 (North Yunker, $S=3.6 \pm 5.1$). Irrigated plot P6 (West Yunker, $S=6.8 \pm 0.58$) also had statistically higher richness values than nonirrigated plots P3, P4, P7, and irrigated plot P5. All other agricultural grassland plots had statistically similar richness values, including irrigated plot P1 (Burke 2, $S=6.2 \pm 0.49$) which, like P6 and P8, annually supports above average numbers of birds.

Differences between irrigated and nonirrigated plots were more distinct in terms of breeding species density (Table 11). Density differed between the 8 agricultural grassland plots ($F=7.76$, $P<0.0005$)(Table B21). Three plots supporting the highest species richness values (P8, P6, and P1) also had, by far, the greatest density values (Tables B20 and B22). These plots (also the 3 highest in 1984 and 1985) had a combined mean of 25.07 ± 2.23 birds/plot compared to 9.4 ± 0.94 birds/plot for the 5 other agricultural grassland plots (including irrigated P5). SNK results (Table 11) for 1986 were identical to those for 1985 and only 2 1986 comparisons (P6 vs P1 and P6 vs P8) differed from the 1984 results.

In both species richness and density, irrigated P5 (North Yunker) appears more similar to nonirrigated plots, as it also did in 1984 and 1985. All irrigated plots were flooded for several weeks during the spring and grazed for some period between the hay-harvest and the following spring; however P5 was the only plot that was not managed as a hayfield; P5 is an irrigated pasture. Although P5 is located on remnant tall-grass prairie (66% of the plot is in the tallgrass prairie inclosure), the hayfield plots appeared to have significantly greater and more diverse vegetative cover. This cover difference apparently corresponds to what Red-winged Blackbirds consider suitable vs. unsuitable nesting habitat because it is

Table 11. Student-Newman-Keuls test results for 1986 breeding bird richness and density on irrigated and nonirrigated agricultural grassland plots. Correlations between plots are indicated as significantly different (S) or not significantly different (NS) at alpha = 0.05.

SPECIES RICHNESS

	1[a]	2	3	4	5[a]	6[a]	7	8[a]
1[a]		NS	NS	NS	NS	NS	NS	NS
2			NS	NS	NS	NS	NS	NS
3				NS	NS	S	NS	S
4					NS	S	NS	S
5[a]						S	NS	S
6[a]							S	NS
7								S
8[a]								

SPECIES DENSITY

	1[a]	2	3	4	5[a]	6[a]	7	8[a]
1[a]		S	S	S	S	NS	S	NS
2			NS	NS	NS	S	NS	S
3				NS	NS	S	NS	S
4					NS	S	NS	S
5[a]						S	NS	S
6[a]							S	NS
7								S
8[a]								

[a] Irrigated plot.

this species which effected the density differences between plots. Mean Red-winged Blackbird densities (mean ± SE, n=5) on hayfields P1, P6, and P8 were 11.6 ± 2.16, 15.6 ± 1.69 , and 6.0 ± 0.55 blackbirds/plot, respectively (11.8 ± 1.71, 17.8 ± 3.40, and 7.8 ± 2.11 in 1984; 14.2 ± 1.02, 12.8 ± 0.97, and 12.8 ± 2.63 in 1985), compared to 0.4 ± 0.4 blackbirds/plot for P5(I) (1.2 ± 0.8 in 1984; 1.8 ± 0.73 in 1985), and a mean 1.3 ± 0.80 blackbirds/plot (n=4) (0.55 ± 0.22 in 1984; 1.25 ± 0.59 in 1985) for the 4 nonirrigated plots (see Table 7). Without Red-winged Blackbird density values in plots 1, 6, and 8, the total plot densities would be 10.4, 13.8 and 17.8 birds/plot, respectively (7.0, 7.4, and 10.0 in 1984; 11.2, 16.4, and 10.0 in 1985), values slightly higher, but similar to the mean of 9.4 birds/plot (6.4 in 1984; 9.6 in 1985) for the other 5 agricultural grassland plots combined.

Therefore, while species richness was similar between irrigated and nonirrigated plots, the higher values of hayfield plots were due to the additional species (guilds) associated with more mesic situations (and greater vegetational diversity, structural heterogeneity, and forage availability). Results were entirely consistent between all 3 breeding seasons. Higher bird densities on hayfields were due primarily to nesting Red-winged Blackbird colonies. We conclude that avian communities supported by irrigated hayfields are significantly different than those on irrigated pastures and other nonirrigated agricultural grasslands. Furthermore, these areas should be considered as separate habitat types for future bird studies.

Total Species

Nine transients, representing 4 species, were observed during plot counts. Three of the 4 species (Swainson's Thrush, Rose-breasted Grosbeak, and Northern Waterthrush) are not considered breeders on Open Space although Swainson's Thrushes may breed in higher elevation conifer habitat in the Boulder Mountain Parks.

Thompson and Strauch (1984) analyzed species richness and abundance data for breeding birds and all species (breeders and transients) combined. Because the 22 transients recorded during 1984 plot counts accounted for only 0.87% of all species observed, results of the total species tests were identical to those for breeders. The 9 transients observed in 1986 represented only 0.36% of all birds observed during plot counts. In 1985, the 12 transients observed accounted for only 0.39% of all species recorded. Total species tests were, therefore, not run in 1985 or 1986, but (like those of 1984) were assumed to have provided results identical to those for breeding species.

Habitat Use - 1984 vs 1985 vs 1986

Results of NANOVA tests examining bird use within individual habitat types during the 1984, 1985, and 1986 breeding seasons are summarized in Table 12. Complete test results are provided in Tables B23 - B53. There was no significant difference in breeding species richness within any of the 5 habitats during any of the 3 breeding seasons (compare annual differences within habitats in Figure 8). Mean annual differences in species richness (number of species/plot) were low for all habitat types (Table 13), but were very low for riparian (4.61 $\pm$ 3.07%) and mountain shrub (6.95 $\pm$ 4.99%) habitats. Changes among the 3 remaining habitats only ranged from 12.35% to 13.06% (Table 13).

As anticipated from results of the 1984-86 NANOVA tests comparing bird use between and among the 5 habitats (e.g., Table B2), significant differences in species richness and density occurred between plots in all habitat types except mountain shrub (Table 12). Furthermore, the majority of the total variation is attributable to variability between replications (Table 12).

Although species richness was statistically similar within 1984-86 habitats, the species composing the annual values varied somewhat. Most of this variation was attributable to uncommon species or those that occur at low densities that may not be recorded during plot counts in a habitat one year, but show up once or twice the following year (or vice versa). Examples of such species include the Northern Harrier, Red-tailed Hawk, Ring-necked Pheasant, Sora, Spotted Sandpiper, Eastern Screech Owl, American Dipper, Blue-gray Gnatcatcher, and White-crowned Sparrow. Species richness only considers the number of different species using a habitat. Annual means derived from the 8 plots/habitat, each replicated 5 times, are, as expected, relatively similar between years.

NANOVA results of 1984 vs 1985 vs 1986 breeding bird densities indicate that density within habitats did not differ between breeding seasons, except in conifer habitats ($F=6.06$, $P<0.01$, Table 12). SNK results (Table B35) indicate that 1986

Table 12. Summary of NANOVA results examining avian habitat use between the 1984, 1985, and 1986 breeding seasons on Boulder Open Space. Complete test results and data breakdowns are presented in Tables B23-B70.

INDEX	BETWEEN YEARS			BETWEEN PLOTS[a]			BETWEEN REPS.[b]
Habitat	F	P	Variance(%)	F	P	Variance(%)	Variance(%)(Error)
SPECIES RICHNESS							
Riparian	0.26	>0.25	4.24	3.72	<0.0005	33.77	61.99
Conifer	2.21	>0.1	6.68	3.61	<0.0005	32.00	61.31
Mountain Shrub	1.64	>0.1	1.58	1.01	>0.25	0.25	98.16
Grassland	0.89	>0.25	0.55	2.53	<0.0025	23.40	76.05
Agricultural Grassland	0.93	>0.25	0.47	4.54	<0.0005	41.31	58.21
DENSITY							
Riparian	0.034	>0.25	7.18	7.12	<0.0005	51.10	41.72
Conifer	6.06	<0.01	17.27	1.97	<0.025	13.45	69.29
Mountain Shrub	1.54	>0.1	1.67	1.32	>0.1	5.85	92.48
Grassland	1.88	>0.1	3.76	2.19	<0.01	18.53	77.72
Agricultural Grassland	0.62	>0.25	3.40	11.29	<0.0005	65.02	31.58

a 8, 2 ha plots/habitat.

b 5 annual replications/plot.

Table 13. Annual changes in avian habitat use on City of Boulder Open Space between 1984, 1985, and 1986.

PARAMETER	NANOVA[a] Results		Annual Difference in Bird Habitat Use (%)[b]			
Habitat	F-Value	Variance Among years (%)	1984 vs 86	1984 vs 85	1985 vs 86	Mean ± SD[c]
SPECIES RICHNESS						
Riparian[b]	0.265	4.24	+5.82	-1.12	-6.88	4.61 ± 3.07
Conifer	2.207	6.68	-0.36	-19.27	-18.98	12.87 ± 10.83
Mountain Shrub	1.637	1.58	+9.33	-1.22	-10.37	6.97 ± 4.99
Grassland	0.885	0.55	+19.13	+13.08	-6.96	13.06 ± 6.09
Agric. Grassland	0.929	0.47	+18.14	+12.87	-6.05	12.35 ± 6.06
Mean ± SE(SD)		2.70 ± 1.56				(9.97 ± 6.21)
DENSITY						
Riparian	0.040	7.18	-1.32	-4.21	-2.93	2.82 ± 1.45
Conifer[d]	6.059	17.27	+18.31	-27.05	-40.41	28.59 ± 11.13
Mountain Shrub	1.548	1.67	+0.38	-13.27	-13.77	9.14 ± 7.48
Grassland	1.882	3.76	+39.51	+15.15	-28.70	27.79 ± 12.21
Agric. Grassland	0.618	3.40	+26.75	+24.71	-2.70	18.05 ± 13.34
Mean ± SE(SD)		6.66 ± 3.61				(17.28 ± 9.12)

[a] Comparison of avian habitat use, as measured by breeding species richness and density, between 1984, 1985, and 1986.

[b] Change in habitat use is indicated as an increase or decrease between the preceeding and succeeding years.

[c] Absolute values were used to calculate this statistic.

[d] The anomolous 12 May 1985 Red Crossbill flock on plot C2 was excluded from the 1985 density estimate.

conifer density was significantly lower than in 1985 (40.41%, Table 13); densities between 1984-85 and 1984-86 were statistically similar. Figure 8 illustrates the difference in annual conifer densities. Note that the 1986 95% CI does not overlap those of 1984 or 1985. Mean annual differences in density (birds/2ha) were low for riparian (2.82 $\pm$ 1.45%) and mountain shrub (9.20 $\pm$ 7.48%) habitats and moderate (18.05% to 28.59%) for the other types (Table 13).

Bird densities may exhibit considerable interyear variation as individual species numbers increase and decrease. The most extreme example documented during this study was illustrated by Red Crossbills. Their Open Space population was estimated at 523 $\pm$ 345 birds (mean $\pm$ 95% CI) in 1984 and at 4,371 $\pm$4,120 birds in 1985. However in 1986, crossbills were not only absent during all plot counts, they were not observed anywhere in the Boulder area during 1986 fieldwork (April - August). Nevertheless, with the exception of the 1985-86 conifer densities, the intraspecific variations in common and uncommon species averaged out to yield habitat densities statistically similar between the 3 breeding seasons.

Overall, riparian habitat showed almost no variation in mean richness or density values between the 3 years (Table 13). Variability in mountain shrub richness and density was also quite low, followed by low-moderate fluctuations in agricultural grasslands. Grasslands and conifer habitats were the least consistent of the 5 habitat types, however considering the factors which support and can influence bird numbers on a given area, fluctuations observed in these 2 latter habitats must still be considered minor.

The rationale of conducting baseline research over several consecutive years is to establish to what extent populations normally fluctuate. Bird populations can fluctuate widely between years in response to such factors as insect or seed availability, climatic regimes, or because of peturbations to wintering populations in Central or South America that have no relation to habitat quality or natural cycles in the Boulder area.

The relationship between 1984-86 variations in bird populations and local weather conditions is unclear. Compared to monthly March-June averages since 1950, 1984 was cool and dry (March was unusually wet, but May and June were drier than normal), 1985 was warm and dry, and 1986 was warm and wet (Callahan 1986, NOOA 1984-1986). Plant phenology at the advent of the 1985 and 1986 breeding seasons was 1-2 weeks more advanced than in 1984. Different early growing season conditions on early vs. warm season plants, subsequent seed crops, insect cycles, as well as the cumulative influence of prior spring conditions can probably effect significant responses in avian populations, provided the population is not limited by density dependent factors, such as the availability of nest cavities for piciformes and secondary cavity nesters. If earlier plant growth and development of insect populations occurred as springs became increasingly warmer and wetter, bird populatons might be expected to have been higher in 1986 than in prior years. However, bird populations are also influenced by factors operating over longer time periods than the immediate breeding season; the effects of any particular growing season and its resultant food supply may not be manifested in bird numbers until the following year or two when offspring produced during that growing season return to breed. Winter survival of both birds and prey will also affect local avian populations. Winter 1985-86 was unusually cold and dry, a condition which was credited with the death of many trees in the Boulder area, and may have resulted in the extremely low grasshopper population in the Gunbarrel area in 1986. Thus, regardless of mild spring 1986 weather, prey populations may have been too low to support an increased breeding bird population. Whatever factors affected 1984-86 bird populations, their influence was insufficient to effect statistically significant differences in breeding species richness and density (excluding 1985-86 conifer habitat densities) between the 3 breeding seasons.

WATERFOWL AND SHOREBIRDS

Survey results on Open Space lakes and ponds for 1986 are listed in Table 14 approximately in order of decreasing productivity. The productivity and average number of birds/census for the three years of the survey are compared in Tables 15 and 16.

In 1986, the highest waterbird populations and production occurred on the Ertl Ponds and Cowdrey Reservoir No. 2. No birds were found on Church Pond or the southern Shanahan pond.

Productivity on the Ertl Ponds was almost five times higher in 1986 than in 1985, mostly because of the increased production of Canada Geese and Mallards. At the Ertl Ponds, waterfowl populations were high throughout June and dropped rapidly in early July as most of the waterfowl and shorebirds left the area. By mid-July, total numbers were about one-tenth of what they were at the end of June. Water levels appeared to fluctuate less in 1986 than they did in 1985 and this might have enhanced waterfowl production by providing a more stable shoreline.

Numbers and productivity on Cowdrey Reservoir No. 2 were up considerably from 1985, but neither were as high as in 1984. Differences in productivity among the years were primarily due to the low productivity of American Coots in 1985. (In 1985, the number of coots using the reservoir decreased about two-thirds between our first and second censuses. On the second census we found evidence that someone had been target shooting on or near the reservoir.) The cattails on the reservoir recovered little from the 1984-85 winter die-off and lack of cover may account for productivity remaining lower than in 1984. We found no evidence of human disturbance at Cowdrey this year.

The productivity of Canada Geese and Mallards on Teller and Wonderland Lakes showed a decrease over the 3 years. Goose production has decreased each year at Wonderland Lake. Mallards didn't breed this year on Teller Lake and last bred on Wonderland Lake in 1984. These decreases coincide with increased human use of these lakes. We continued to find free-running dogs at Wonderland Lake and found increasing numbers of fisherpersons and hikers at Teller Lake in 1986 as a result of encouraged public use and easier access to this parcel.

Table 14. Waterfowl and shorebirds observed on 1986 surveys of Boulder Open Space ponds and lakes.

Waterbody / Species		SURVEY DATE 18[a] May	7[a] June	24 June	29 June	9 July	12 July	19 July
Ertl Ponds		b						
Pied-billed Grebe				2	1	1	1	
American White Pelican				1				
Double-crested Cormorant			1	1	1			
American Bittern							1	
Great Blue Heron			7	6	6	7	12	6
Great Egret							1	
Green-backed Heron			1					
Black-crowned Night-Heron			2	4				
Canada Goose:	adults		25	9	24	18	26	1
	chicks		44(8)[c]	39(3)[c]	58(7)[c]			
Wood Duck			2					
Green-winged Teal					1			
Mallard:	adults		29	2		38	16	
	males		7	12	7			
	females		1	25	20			3
	chicks				30(4)[c]			6(2)[c]
Blue-winged Teal			2	2	2	5	3	
Cinnamon Teal				2			2	
Gadwall				6	1			2
American Wigeon							3	
Common Merganser				1				
Killdeer:	adults		7	15	10	8	7	
	chicks			3	3			
American Avocet:	adults		12	11	8	1	3	
	chicks			8	1		1	
Greater Yellowlegs					1	4	3	
Spotted Sandpiper:	adults		2		3	3	2	
	chicks				1			
Common Snipe					1		1	
Wilson's Phalarope					1		1	
Belted Kingfisher							1	
	Totals		142	149	185	82	81	19

Table 14. Continued.

Waterbody / Species		SURVEY DATE 18[a] May	7[a] June	24 June	29 June	9 July	12 July	19 July
Cowdrey Reservoir No. 2		b						
Pied-billed Grebe:	adults		7	11	11	8	7	6
	chicks		7	13	16	14	10	8
Great Blue Heron			1				2	1
Black-crowned Night-Heron				3	1	2	3	6
Green-winged Teal							1	
Mallard:	adults		5	5		16		9
	males				1		3	
	females				3		7	
	chicks				6		12	4
Blue-winged Teal			3	24	3	3	6	
Cinnamon Teal				2	4	2	2	
Blue-winged/Cinnamon Teal							2	
Northern Shoveler			1					
Gadwall			2	3				
American Wigeon				1				
Ruddy Duck			2	2	2			
American Coot:	adults		15	10	14	10	6	13
	chicks		2	4	20	12	19	24
Killdeer:	adults		1		1	2	2	3
	chicks						3	
Wilson's Phalarope			5					
	Totals		51	78	82	69	94	76
Teller Lake		b						
Pied-billed Grebe:	adults		3	2	2	2	1	2
	chicks					4	7	5
Great Blue Heron			1			1		1
Canada Goose:	adults			5	6			
	chicks			13(3)[c]	12(3)[c]			
Mallard					1			
American Wigeon								1
American Coot:	adults						5	1
	chicks							3
	Totals		4	20	21	7	13	13

Table 14. Continued.

Waterbody Species		SURVEY DATE 18[a] May	7[a] June	24 June	29 June	9 July	12 July	19 July
Wonderland Lake								
Pied-billed Grebe:	adults		3	2	4	6	6	4
	chicks					4	7(2)[c]	8(2)[c]
Horned Grebe							1	
Great Blue Heron			1			1		1
Black-crowned Night-Heron:								
	adults			1	1		3	2
	chicks				1			1
Canada Goose:	adults	8	26	28	26	25	28	15
	chicks	5				3		
Mallard		1			2			
Ring-necked Duck		2						
Killdeer		2	1			2		1
Eggleston Reservoir No. 4		b						
Pied-billed Grebe					2			
Double-crested Cormorant				2				
Great Blue Heron			1	1	1		1	1
Mallard:	adults			2	2	5	7	10
	chicks				2			13(2)[c]
Blue-winged Teal				1	4	8	1	2
Gadwall			2					
Ring-necked Duck				1				
Killdeer:	adults		4	8	4	10	3	8
	chicks						2	
Greater Yellowlegs								1
	Totals		7	15	15	23	14	35
Short-Milne		b						
Pied-billed Grebe:	adults			2	2	2	2	1
	chicks			1	2			
Double-crested Cormorant					1			
Black-crowned Night-Heron			2					

Table 14. Continued.

Waterbody Species		SURVEY DATE 18[a] May	 7[a] June	 24 June	 29 June	 9 July	 12 July	 19 July
Short-Milne Con't.		b						
Canada Goose:	adults		16		18	20	13	
	chicks		3			5		
Mallard			2				1	
Belted Kingfisher				2				
	Totals		23	5	23	27	16	1
Flatirons Vista Reservoir		b						
Double-crested Cormorant							1	
Mallard:	adults		1					2
	chicks		1					
Killdeer:	adults		2	2	4	6	1	5
	chicks			2	2		1	
Spotted Sandpiper				1				
California Gull								1
	Totals		4	5	6	6	3	8
Marshall Lake		b						
Great Blue Heron							2	2
Canada Goose:	adults		2		7			
	chicks		1					
Mallard						1		
Blue-winged Teal				2				
Killdeer				2	1			1
Least Sandpiper							3	
Ring-billed Gull							2	7
California Gull			12					1
	Totals		15	4	8	1	7	11

Table 14. Continued.

Waterbody Species		SURVEY DATE 18[a] May	7[a] June	24 June	29 June	9 July	12 July	19 July
Boulder Valley Ranch Reservoir		b	b					b
Great Blue Heron				1				
Mallard:	adults					1		
	chicks					7		
Killdeer						1		
	Totals			1	0	9	0	
Hogan Pond		b	b					
Great Blue Heron								1
Mallard:	adults			2		5	1	17
	chicks						7	2
Blue-winged Teal				2	2			
Killdeer:	adults			2	4	4		1
	chicks							2
Spotted Sandpiper								1
	Totals			6	6	9	9	23
Ranger Pond		b						
Mallard					1		2	
Killdeer					1			2
	Totals		0	0	2	0	2	2
Church Pond		b						
	Totals		0	0	0	0	0	0
Shanahan North		b						
Great Blue Heron								1
Mallard:	adults					2	1	2
	chicks						1	
	Totals		0	0	0	2	2	3

Table 14. Continued.

Waterbody / Species	18[a] May	7[a] June	24 June	29 June	9 July	12 July	19 July
	SURVEY DATE						
Shanahan South	b						
Totals		0	0	0	0	0	0

a Samples taken before scheduled sampling period.

b Waterbody not sampled on this date.

c Minimum number of broods observed.

Table 15. Maximum observed waterbird productivity on Boulder Open Space ponds and lakes, 1984, 1985, and 1986

Waterbody / Species		MAXIMUM PRODUCTIVITY 1984	1985	1986
Ertl Ponds		a		
Canada Goose			14	58
Mallard			0	30
Killdeer			1	3
American Avocet			3	8
Spotted Sandpiper			0	1
	Total		18	100
Cowdrey Reservoir No. 2				
Pied-billed Grebe		13	2	16
Mallard		18	15	12
Ruddy Duck		6	3	0
American Coot		35	6	24
Killdeer		0	0	3
	Total	72	26	55
Teller Lake				
Pied-billed Grebe		5	5	7
Canada Goose		14	13	13
Mallard		9	9	0
American Coot		3	4	3
	Total	31	31	23
Wonderland Lake				
Pied-billed Grebe		0	3	8
Canada Goose		27	11	5
Mallard		7	0	0
	Total	34	14	13

Table 15. Continued.

Waterbody / Species		MAXIMUM PRODUCTIVITY 1984	1985	1986
Eggleston Reservoir No. 4		a	a	
Mallard				13
Killdeer				2
	Total			15
Short-Milne				
Pied-billed Grebe		0	3	2
Canada Goose		17	11	5
	Total	17	14	7
Flatirons Vista Reservoir				
Mallard		8	0	1
Killdeer		0	1	2
	Total	8	1	3
Marshall Lake				
Canada Goose		0	0	1
Mallard		7	0	0
	Total	7	0	1
Boulder Valley Ranch Reservoir				
Mallard		0	0	7
Hogan Pond				
Mallard		0	13	7
Blue-winged/Cinnamon Teal		0	8	0
Killdeer		0	0	2
	Total	0	21	9

Table 15. Continued.

Waterbody	MAXIMUM PRODUCTIVITY		
Species	1984	1985	1986
Shanahan North	a	a	
Mallard			1
Total of all Waterbodies	169	125	227

[a] Waterbody not yet part of the Open Space system.

Table 16. Average number of waterbirds/census on Boulder Open Space ponds and lakes, 1984, 1985, and 1986.

Waterbody	AVERAGE NUMBER OF BIRDS/CENSUS		
	1984	1985	1986[a]
Ertl Ponds	b	74.8	103.2
Cowdrey Reservoir No. 2	107.2	42.8	79.8
Teller Lake	29.0	25.8	14.8
Wonderland Lake	53.2	40.8	36.6
Eggleston Reservoir No. 4	b	b	20.4
Short-Milne	26.0	21.2	14.4
Flatirons Vista Reservoir	6.2	7.6	5.6
Marshall Lake	13.4	2.4	6.2
Boulder Valley Ranch Reservoir	3.6	2.4	2.4
Hogan Pond	8.6	13.6	10.6
Ranger Pond	2.8	1.2	1.2
Church Pond	0.2	0.0	0.0
Shanahan North	b	b	1.4
Shanahan South	b	b	0.0

[a] Based only on regular census periods, 24 June - 19 July.

[b] Waterbody not yet part of the Open Space system.

Populations and productivity on the other Open Space lakes and ponds were too small to indicate significant trends in use.

Seven species (Pied-billed Grebe, Canada Goose, Mallard, American Coot, Killdeer, American Avocet, and Spotted Sandpiper) produced young on Open Space lakes and ponds in 1986. The total production of all 7 species increased over that found found in 1985. Two species, Blue-winged/Cinnamon Teal and Ruddy Ducks, which bred in 1985 were not observed with young in 1986. Total productivity on the lakes and ponds for which we have 3 year's data dropped about 30% in 1985, but returned to the 1984 level in 1986. The main contribution to the overall rise in 1986 productivity was the increase on the Ertl Ponds, which have been sampled for only the last 2 years.

Variations found in waterbird numbers on Open Space for the last 3 years probably represent natural fluctuation. The only exceptions to this are cases where human disturbance is evident. Increased human use of the shoreline, where nests and young are often hidden, especially at Wonderland and Teller lakes, coincide with decreased productivity at these sites. Shooting at Cowdrey Reservoir No. 2 in 1985 was followed by a large decrease in American Coot numbers.

The waterfowl and shorebird populations on City of Boulder Open Space are not very large, but have great value locally. Preservation of these populations will necessitate management practices which do not allow further increases in disturbance to breeding birds. The Open Space waterbody now most jeopardized by human disturbance is the Ertl Ponds. Although this area will remain off-limits to the general public, the trail system was routed along the eastern periphery of the area in 1986, within sight of the ponds. This area will be extremely attractive to birdwatchers, yet it is likely that unrestricted or unmanaged public use could preclude nesting by some sensitive species which now nest in the area (e.g., Red-tailed Hawks) and reduce the numbers of other breeding and migrating waterbirds that now use the area.

Even low levels of chronic human disturbance can be incompatible with some waterbird use on moderate to large waterbodies with inadequate buffer zones. For example, waterbird production and use of Teller and Wonderland Lakes should be comparable or exceed that of Cowdrey Reservoir No. 2. Habitat features such as lake area, emergent vegetation, peripheral riparian vegetation, and the apparent submerged aquatic flora, are similarly or better deverloped on these two former lakes, yet productivity and waterbird use are consistantly higher on Cowdrey Reservoir No. 2. This difference is apparently due to human use of these areas. Wonderland Lake is surrounded by homes and heavily utilized by local residents. Teller Lake is bounded by a residential development on the east and has recently experienced increased recreational use, particularly fishing, as the trail system, with two trailhead parking areas, was routed through this parcel in 1986. Both areas are now well recognized by the public as Open Space and both areas are attractive for recreational pursuits. However, Cowdrey Reservoir No. 2 is not recognized by the public as Open Space (indeed a portion of it isn't Open Space). The Reservoir is not posted, it is out of sight of any roads or well used public areas, and legal access to the area is difficult. In short, few people know it exists. As a result, it supports the densest waterbird production area of any waterbody on the system, including the Ertl Ponds. The only reason that Wonderland and Teller Lakes are even close to Cowdrey Reservoir No. 2 in waterbird use is the moderate numbers of Canada Geese that use these two former lakes. Canada Geese require smaller buffer zones and are relatively tolerant of human presence.

Waterbodies and their surrounding riparian communities are the most productive bird habitats on the Open Space system. Because of this and their aesthetic attractions, these areas are also the areas most sought for recreational pursuits. Human disturbance around waterbodies reduces seasonal waterbird utilization. The conflicting management objectives of habitat preservation and recreational opportunities must be evaluated for each parcel and for that parcel's role in the overall Open Space system. In a broader context, waterbird use is only one of many multiple use considerations that are evaluated in the long-term management of the system. However, management of high-value waterbird habitats, to the exclusion of all other potentially conflicting uses, is also justifiable.

RAPTORS

Seven species of raptors have been found breeding on Open Space (Swainson's Hawk, Red-tailed Hawk, American Kestrel, Common Barn-Owl, Great Horned Owl, Eastern Screech-Owl, and Burrowing Owl) (Table 17). In 1984, 1985, and 1986, 16 pairs of 5 species, 18 pairs of 6 species, and 26 pairs of 6 species of raptors were found nesting on Open Space, respectively. Red-tailed Hawks, American Kestrels, Common Barn-Owls, and Great Horned Owls nested during all 3 years of the study. Swainson's Hawks were found breeding only in 1986. Eastern Screech-Owls were found nesting in 1985 and 1986; they were probably overlooked in 1984. Burrowing Owls bred on Open Space in 1984 and 1985; in 1986 a pair appeared to start breeding, but abandoned the site on Open Space and may have moved to nearby private land where a pair was recorded breeding.

In addition to the raptors found breeding on Open Space, 12 species (Northern Harrier, Cooper's Hawk, Red-tailed Hawk, Golden Eagle, American Kestrel, Prairie Falcon, Flammulated Owl, Great Horned Owl, Northern Pygmy-Owl, Burrowing Owl, and Northern Saw-whet Owl) have been found nesting on areas adjacent to Open Space. At least 3 other species (Turkey Vulture, Sharp-shinned Hawk, and Goshawk) have been observed on or near Open Space during the breeding season.

Swainson's Hawks, Red-tailed Hawks, and Great Horned Owls nested in large trees; Golden Eagles and Prairie Falcons nested on cliff faces; American Kestrels, Common Barn-Owls, Northern Pygmy-Owls, Northern Saw-whet Owls, and Eastern Screech-Owls nested in holes in trees or cliffs; and Burrowing Owls nested in prairie-dog towns. The habitat feature common to all of these species except for the Eastern Screech-Owl was the location of nests in isolated areas where there was little human activity.

Turkey Vulture

This species may have been more common in Boulder County than at present. Henderson (1909) stated that it was "no longer common." The only nest reported for Boulder County was found in a Great Blue Heron colony near Lyons in 1888 (Henderson 1909). Betts (1913) reported that a few were found near Boulder in the yellow pine zone, but he thought the species "infrequent," as did Alexander (1937).

Table 17. Breeding raptors on City of Boulder Open Space, 1984-86.

SPECIES	BREEDING OBSERVATIONS
Turkey Vulture	Suspected of nesting.
Northern Harrier	Nested on Mountain Parks land near Boulder Reservoir in 1983 and 1985.
Sharp-shinned Hawk	Suspected of nesting.
Cooper's Hawk	At least two pairs nested on Mountain Parks in 1986.
Northern Goshawk	Present during 1986 breeding season on Mountain Parks adjacent to Open Space.
Swainson's Hawk	Nested on the Belgrove and VanVleet parcels in 1986.
Red-tailed Hawk	Nested on Boulder Valley Ranch, the McCann parcel, and on or near the Ertl Easement in 1984 and 1985. One pair nested on the McKenzie parcel in 1986. Additional pairs may have nested on or near the Kaufman parcel, VanVleet Ranch, and Dowdy Draw.
Golden Eagle	At least 3 pairs nested in the foothills near Open Space in 1984 and 1985. In 1986 3 pairs occupied breeding sites, but only 2 pair bred.
American Kestrel	At least 10 known or suspected nests scattered throughout Open Space.
Peregrine Falcon	Not known to have nested in Boulder area since 1958.
Prairie Falcon	Four nests in 1984 and 5 nests in 1985 and 1986 on Mountain Parks adjacent to Open Space.
Common Barn-Owl	One nest in White Rocks and another near the Minnitrista parcel in 1984. Two nests in White Rocks in 1985 and 3 in 1986.
Flammulated Owl	Two nests found on Mountain Parks in 1986.
Eastern Screech-Owl	May have nested on or near Burke 2 and Kaufman parcels in 1984. A pair raised 3 young in north Boulder in 1984. A pair nested near Burke 2 in 1985 and 1986. Three pairs nested in the Cottonwood Grove and Arnold parcels in 1986.

Table 17. Continued.

SPECIES	BREEDING OBSERVATIONS
Great Horned Owl	Nested on McKenzie and THP parcels in 1984; at Boulder Valley Ranch, in or near the Cottonwood Grove, on the East Rudd, and on VanVleet Ranch in 1984, 1985 and 1986. McKenzie and THP parcels in 1984. One nest at Sawhill Ponds in 1984, 1985, and 1986.
Northern Pygmy-Owl	One nest on Enchanted Mesa in 1985.
Burrowing Owl	Two pairs nested on Boulder Valley Ranch in 1984 and 1985. One pair nested adjacent to Open Space in 1986.
Long-eared Owl	Nested near White Rocks and in Skunk Canyon in 1984.
Northern Saw-whet Owl	One nest on Enchanted Mesa in 1985.

Colorado Division of Wildlife files indicate that this species is regularly observed at the south end of the Flatirons. The Boulder Audubon Society Wildlife Inventory (BASWI) reports many sightings of Turkey Vultures, mostly in April through September, with few birds seen in June and July.

We made 15 sightings of the species during this study in 1984, most of them concentrated between Shirttail Peak and South Boulder Peak (Fig. 9). Turkey Vultures were seen as far east as the Kaufman property. On 3 July 1984 we searched Shirttail Peak but found no sign of breeding. We saw vultures only once in 1985. We had 9 sightings in 1986, 2 in the breeding season. It is likely that the species breeds in this general area.

Osprey

The earliest records of Ospreys in Boulder County are of 5 birds collected at Valmont and Longmont in 1901 (Bailey and Niedrach 1965). Henderson (1909) did not list the species, Betts (1913) said the species was "not uncommon" during migration, and Alexander (1937) said it was a rare or infrequent transient. Bailey and Niedrach (1965) report a sighting at Allenspark in 1960. The BASWI lists about 6 birds/year since 1979. Most observations have been made during migration, but there are also a few winter records. Ospreys are most frequently seen at Sawhill Ponds or near other wetland areas. We found 1 bird on the Ertl Conservation Easement in September 1985. Others reported 6 observations at Sawhill Ponds in September and October 1985.

Ospreys breed in Colorado above 8000 feet (Bailey and Niedrach 1965). They have been regular around Boulder during migration in recent years. Many of these may be Colorado birds.

Northern Harrier

Henderson (1909) reported the Northern Harrier as a common summer resident of the plains and mountains in Boulder County. Betts (1913) observed, however, that the only definite summer record was one just north of the County. Alexander (1937) reported the species as an infrequent to common summer resident.

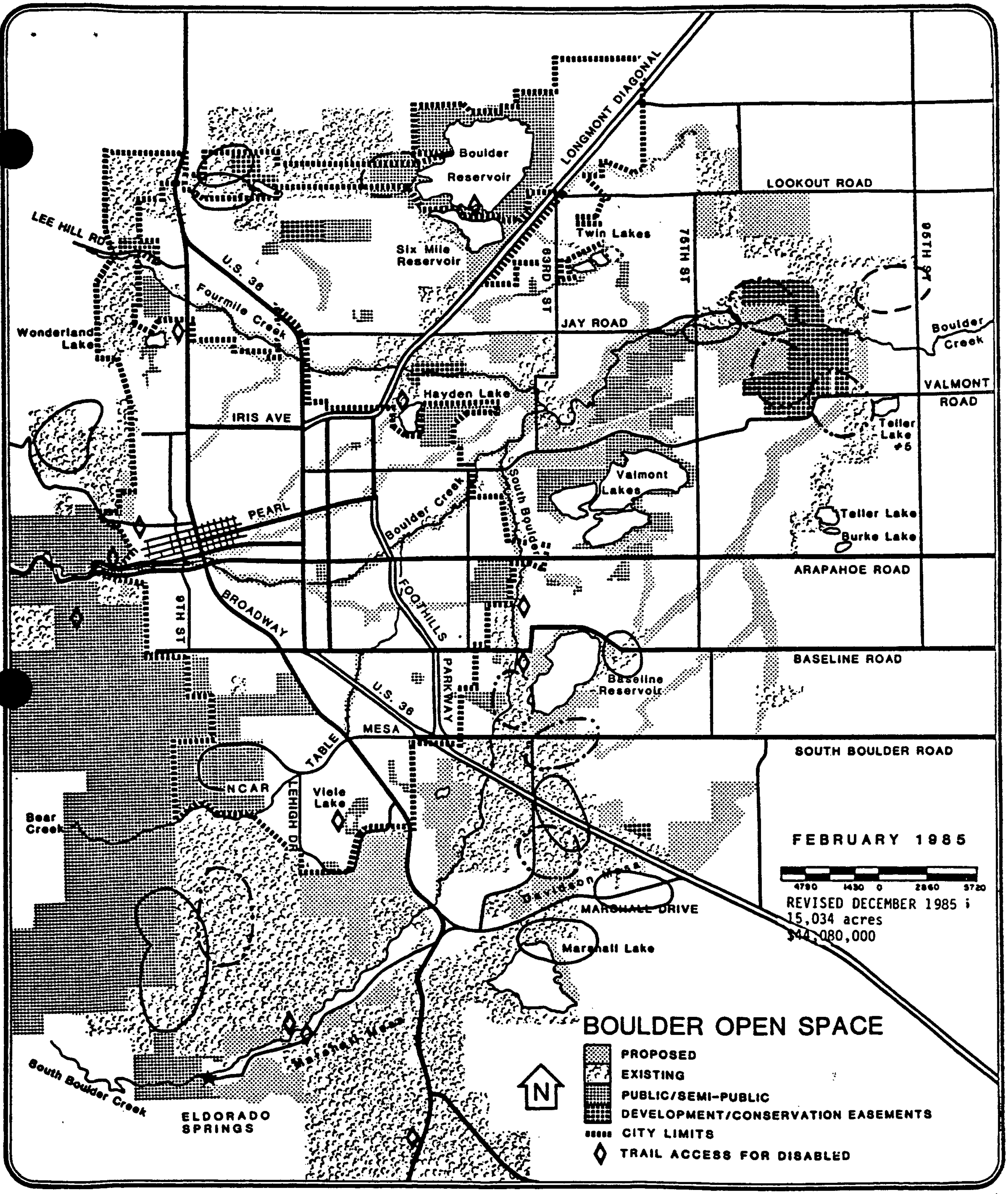


Figure 9. Locations of Turkey Vulture observations made during 1984 (solid line), 1985 (dashed line), and 1986 (dashed-dotted line).

The BASWI records sightings throughout the year, most often during migration and winter, with few in June and July. Steve Jones found a pair of Northern Harriers nesting on the west side of Boulder Reservoir in 1983. He found a female on the nest on 19 May and saw 2 young with both parents on 25 August.

In December 1984 as many as 11 Northern Harriers roosted in the drainage area between the Boulder Valley Ranch Reservoir and Boulder Reservoir (Lyn Roberts, pers. commun.). Three females and a male courted in this area just before the 1985 Kinetics Conveyance Race. Two of the females disappeared after the race. A pair nested in Little Dry Creek and fledged 4 young on or about 21 July (Lyn Roberts, pers. commun.; this study)(Fig. 10). We observed the adults and immature birds in this area from May to August. Lyn Roberts saw a second female in the area after the young had fledged. We saw a female flying over the Ertl Ponds in early May. We had 3 sightings in 1986, 1 each in March, April and May, at White Rocks.

The species appears to have decreased since 1937 as a breeding bird in Boulder County. It has now bred in the same area 2 of the last 3 years. Every effort should be made to protect this site, which has been threatened with flooding by the proposed enlargement of Boulder Reservoir and by intense disturbance by the crowds attending the Kinetic Conveyance Races.

Sharp-shinned Hawk

Henderson (1909), Betts (1913), and Alexander (1937) reported the Sharp-shinned Hawk as a resident of Boulder county, but could cite no definite breeding records. The BASWI records the species throughout the year, with peaks during migration and few birds in June and July.

We had 2 sightings of the species in 1984, 1 in 1985, and 2 in 1986, all on the southern part of City of Boulder Open Space (Fig. 11). Howard Weinberg (pers. commun.) found a suspected nest in the Mountain Parks in 1986. There is abundant habitat for the species in the foothills. Since the species is quite secretive, we suspect it is more common than reports indicate.

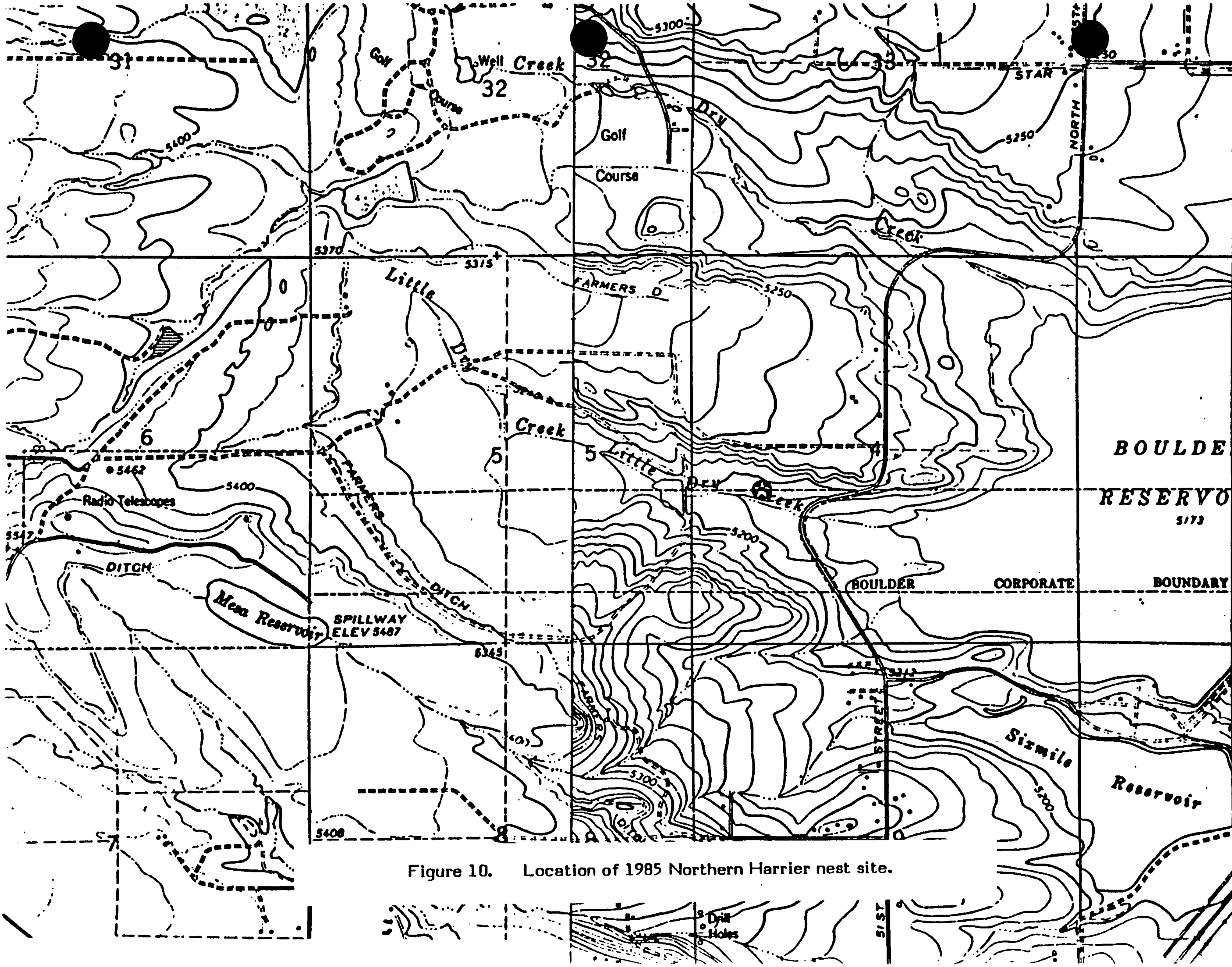


Figure 10. Location of 1985 Northern Harrier nest site.

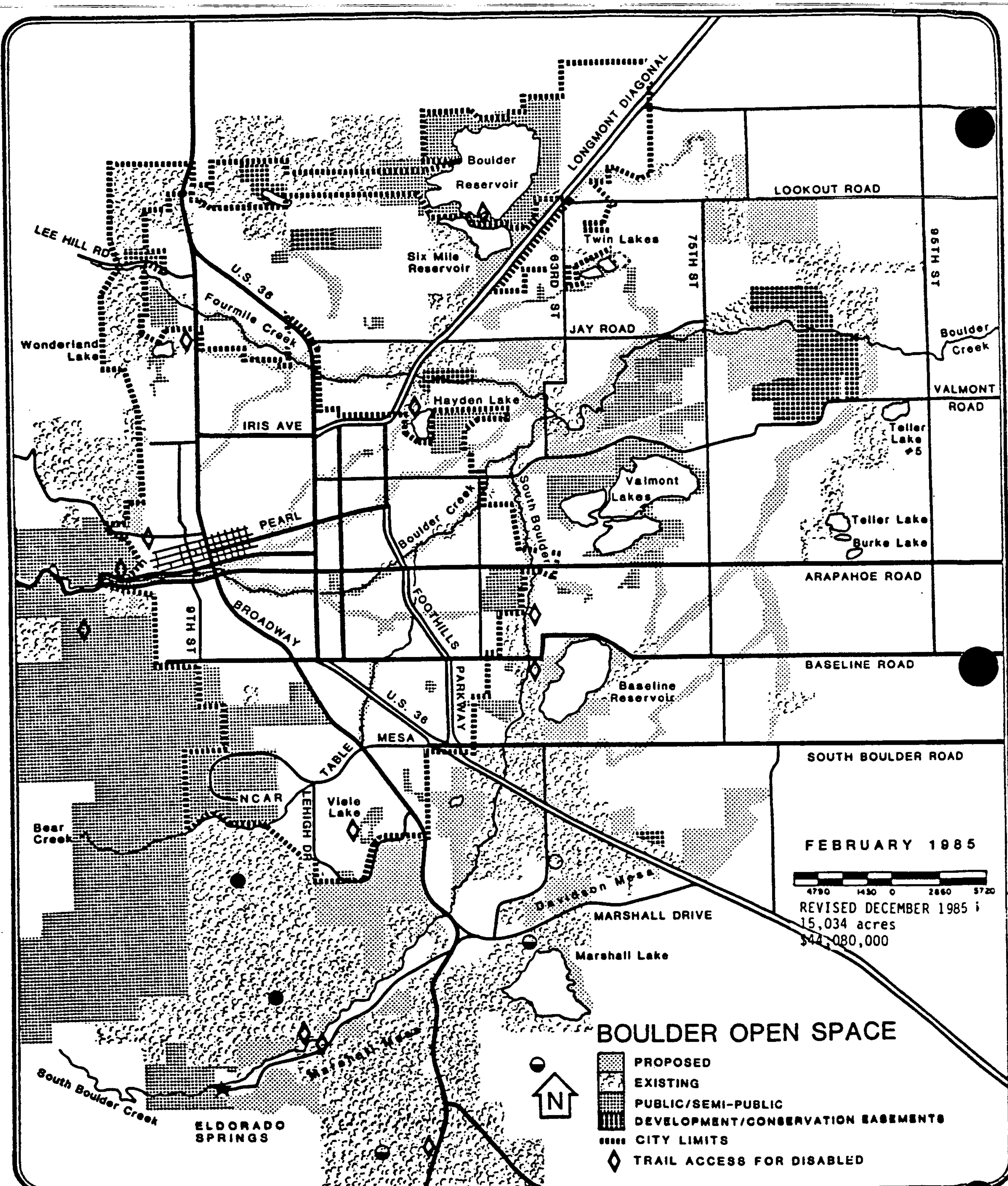


Figure 11. Locations of 1984 (closed circles), 1985 (open circles), and 1986 (half-closed circles) Sharp-shinned Hawk observations.

Cooper's Hawk

Henderson (1909) called the Cooper's Hawk a common resident of the plains and mountains in Boulder County and reported nests found in Left Hand Canyon in 1889 and 1890. Betts (1913) and Alexander (1937), however, reported the species to be infrequent.

The BASWI records the species in low numbers throughout the year with somewhat greater numbers during migration.

We had 1 sighting of a Cooper's Hawk just north of Marshall Mesa in 1984, none in 1985, and 2 in 1986 (Fig. 12). Howard Weinberg (pers. commun.) found 5 active nests in the foothills in 1986, 2 on Mountain Parks. Like the Sharp-shinned Hawk, this species may be more common than reports indicate.

Northern Goshawk

Howard Weinberg (pers. commun.) reported that at least one adult Northern Goshawk spent summer 1986 on Flagstaff Mountain.

Swainson's Hawk

Henderson (1909), Betts (1913), and Alexander (1937) reported the Swainson's Hawk to be common on the plains of Boulder County with nests being found 12 May to 10 June. The BASWI records small numbers of Swainson's Hawks from April to November, with a slight increase during fall migration. Nests were found in the eastern part of the county in 1981 and 1983.

We had 3 sightings of Swainson's Hawks, all presumably migrants, in 1984. In 1985 3 sightings of the species were made along 75th Street from Lookout Road south to Valmont Road, in late June through August.

We found 2 active Swainson's Hawk nests on Open Space in 1986 (Fig. 13). One bird was observed at a nest on the Yunker parcel from 27 May to 14 June. No chicks were seen, and the nest was abandoned by 24 June.

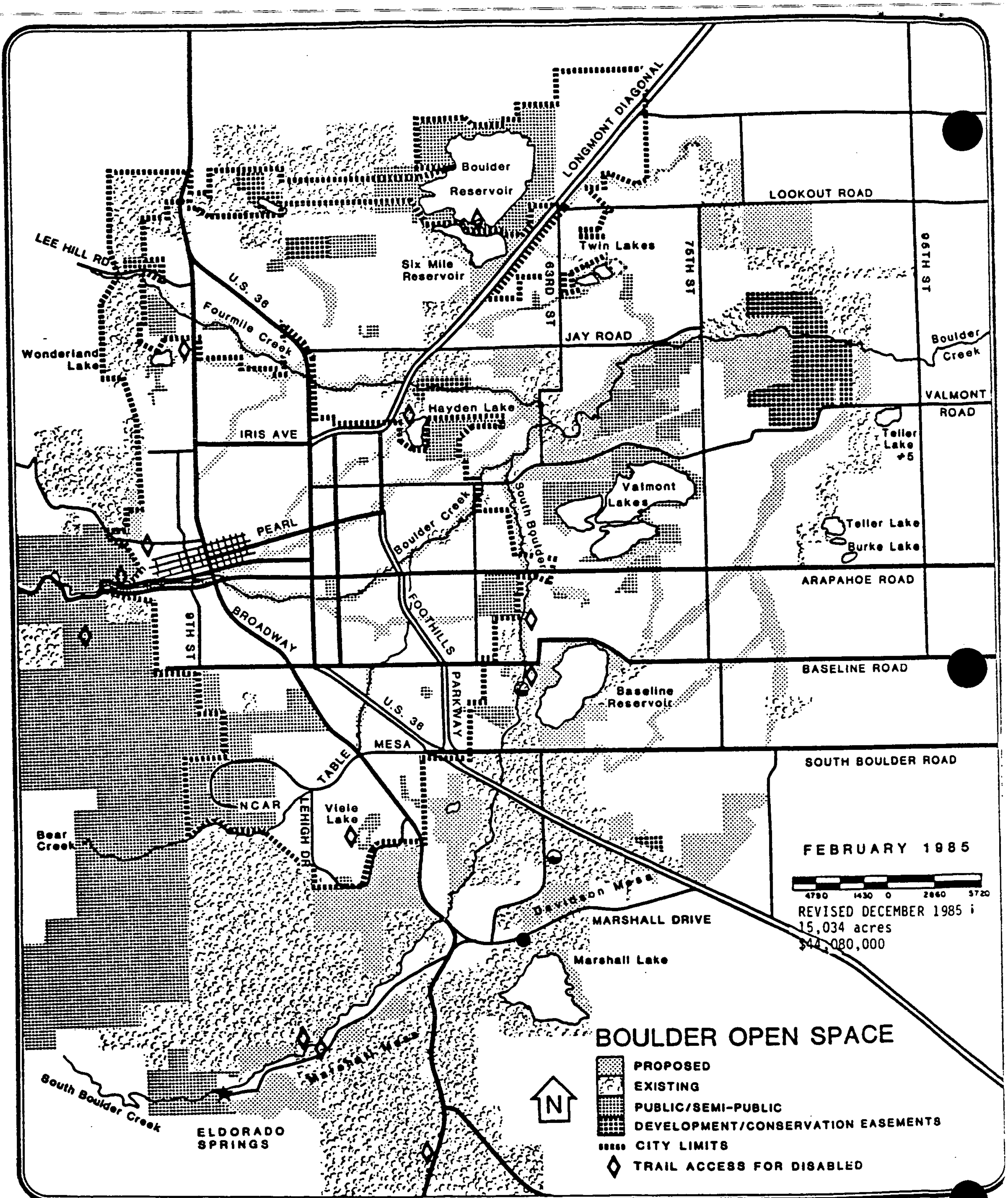


Figure 12. Location of 1984 (closed circle) and 1986 (half-closed circle) Cooper's Hawk observations.

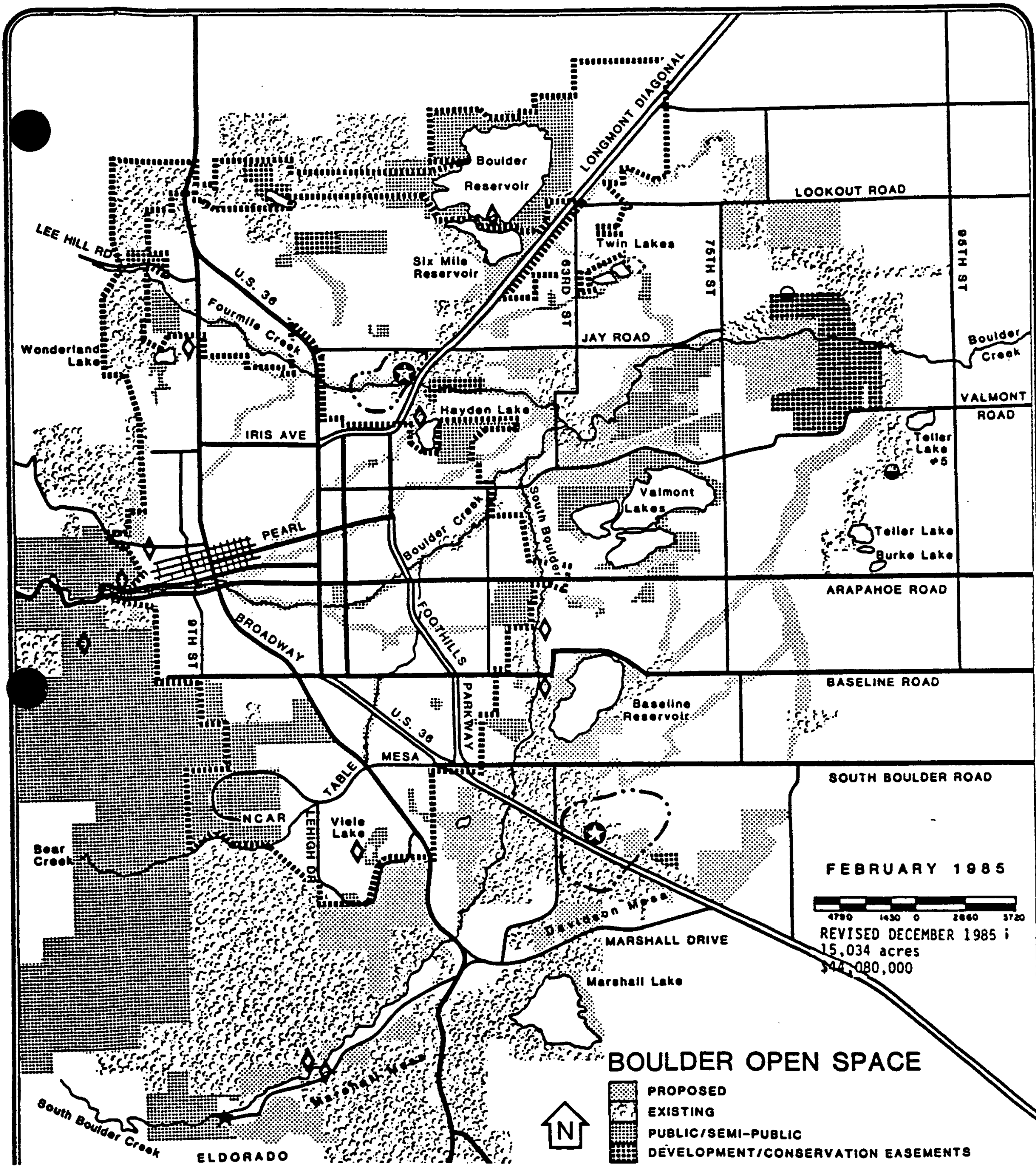


Figure 13. Locations of 1986 Swainson's Hawk nest sites (stars) and areas where the nesting pairs were observed (dashed-dotted). Observations of other 1986 sightings are shown by half-open circles.

A second nest was found on the Belgrove parcel on 26 May. The adults were first seen feeding young on 12 July. Two young, almost ready to fly, were on the nest on 3 August. At least one bird roosted in the nest tree until 28 August.

We also had 3 sightings of Swainson's Hawks between February and August at White Rocks. Martha Weiser (pers. commun.) reported that a pair nested on her land in 1986 and that the female was a dark phase. The "Swainson's Hawk" that had been observed along Boulder Creek and adjacent lands between 75th and 95th streets in December 1986 was a dark phase Rough-legged Hawk.

Red-tailed Hawk

The Red-tailed Hawk is a permanent resident that is common in summer (Henderson 1909, Betts 1913, Alexander 1937). Nests with eggs have been found between 26 March and 3 June. The BASWI reports good numbers of Red-tailed Hawks throughout the year with peaks during spring and fall migration.

There appear to be at least 4 well-established pairs of Red-tailed Hawks breeding on or near City of Boulder Open Space (Fig. 14). A pair has bred for the last 5 years on Boulder Valley Ranch on or near Farmer's Ditch. The species bred there in 1982 and 1983 (Steve Jones, pers. commun.); in 1984 the pair raised 1 chick, and in 1985 the pair nested in trees away from the 1984 nest, but apparently was unsuccessful. The 1985 nest was used again in 1986. Adults were at the nest from 16 April to 1 June, but not on 14 June or thereafter. Two sightings of young birds on the Boulder Land, Irrigation & Power parcel may have been young from this nest.

Red-tailed Hawks have nested near the Matron Rock for the last 4 years (Mike Figgs, Dan Blumstein, pers. commun.; this study). Two young were seen on the nest in 1984 and 1 in 1985. The nest was active in 1986, but it is not known if any chicks were fledged.

We found a pair of Red-tailed Hawks nesting on the Ertl Conservation Easement along Boulder Creek in 1984 and 1985. They raised 2 young in 1984 and 1 in 1985. Red-tailed Hawks have nested in this area for many years (Drake Sullivan, pers. commun.).

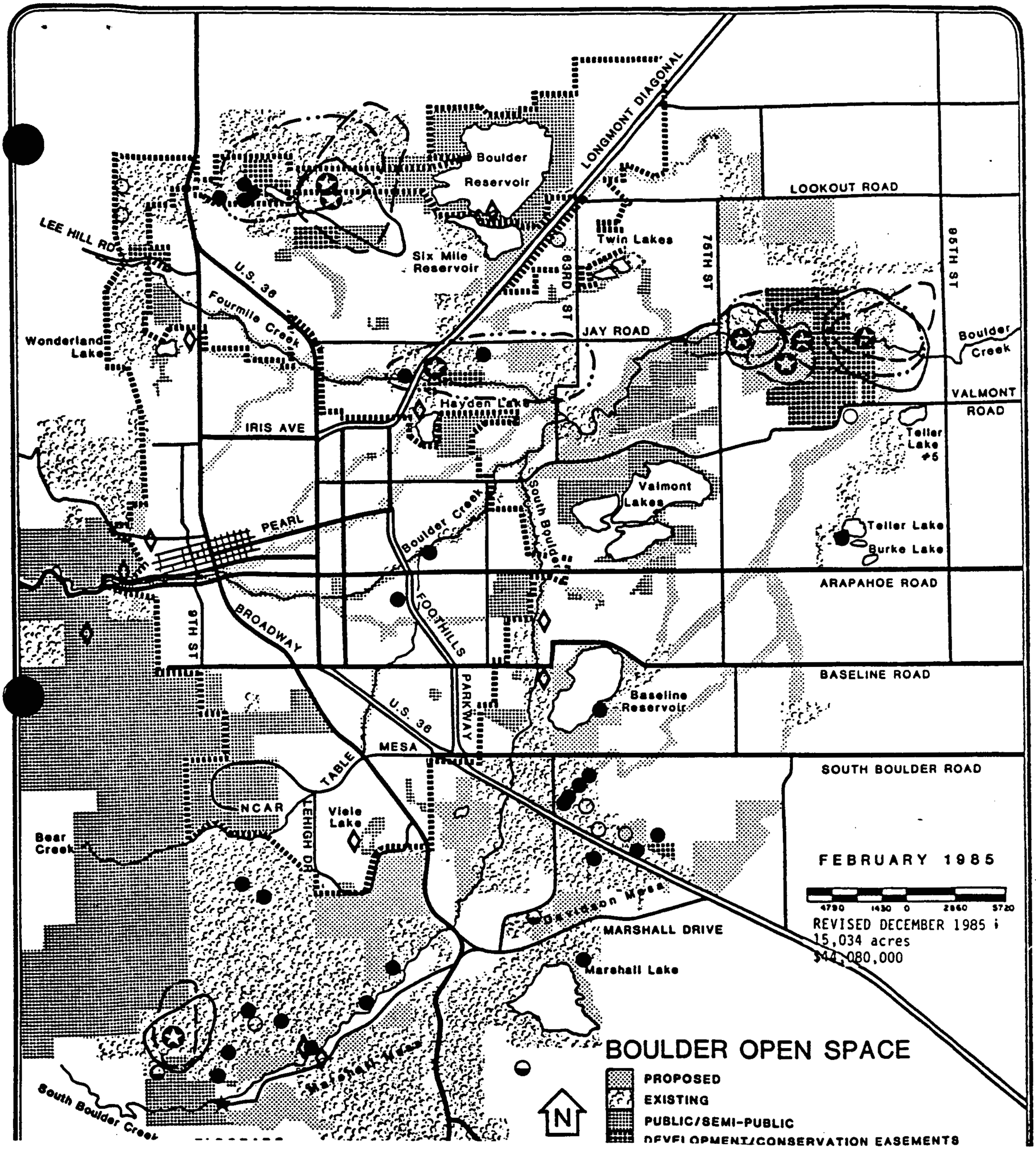


Figure 14. Location of 1984 (closed circles), 1985 (open circles), and 1986 (half-closed circles) Red-tailed Hawk observations and nest sites (star in circle). Lines around nests, which delineate areas where the nesting pair was observed, are solid for 1984, dashed for 1985, and dashed-dotted for 1986.

A pair of Red-tailed Hawks has nested on the Weiser property for at least the last 2 years. In 1985 they fledged 3 young (Dan Blumstein, pers. commun.; this study).

In 1986 at least 1 pair nested on the Weiser property immediately adjacent to the west boundary of the Ertl Conservation Easement. A pair was seen at the nest from 16 April to 23 May. An adult Red-tailed Hawk was seen near the 1985 Ertl Easement nest in February, March, and June 1986; in July, it was accompanied by an immature bird. These birds are suspected to be the birds that nested on the Weiser property as are a pair of adults and an immature bird seen on 19 July just east of White Rocks.

Martha Weiser (pers. commun.) reported that a pair of Red-tailed Hawks have nested on the Kolb parcel near Boulder Creek in 1984-86. That nest was destroyed in the October 1986 windstorm.

A pair of Red-tailed Hawks were found nesting on the McKenzie parcel on 18 April. At least 1 fledged young was found near the nest site on 25 July.

At least 2 other pairs of Red-tailed Hawks probably nest on or near Open Space. Red-tailed Hawks have been seen many times on the VanVleet Ranch in 1984 and 1985. We have searched for a nest in the area without success. Another nest is probably in or near Dowdy Draw, where adults are frequently seen during the breeding season. An immature bird seen on Flatirons Vista in June 1984 might have come from the suspected nest. A pair may have nested along Coal Creek near the East Varra parcel; an adult was seen there on 7 June. There is what appears to be an old Red-tailed Hawk nest along South Boulder Creek west of the Open Space Ranger Station. There is no evidence that it has been used recently by Red-tailed Hawks. We found an immature Great Horned Owl near this nest in 1984.

With protection from disturbance, Red-tails will probably remain a common breeding species on City of Boulder Open Space.

Golden Eagle

Henderson (1909), Betts (1913), and Alexander (1937) reported the Golden Eagle to be an uncommon or infrequent permanent resident in Boulder County. Nests with eggs were reported for the period 21 March to 11 April. The Colorado Division of Wildlife recorded 2 active nests in the foothills near Boulder in 1978.

The BASWI lists moderate to low numbers of sightings of this species throughout the year. Numbers of sightings are highest during spring and fall migration. Figgs and Lederer (1985) have summarized the history of all known Golden Eagle nests along the Front Range from Golden north to the Wyoming line. We have seen the species several times during this study (Fig. 15). All of our observations appear to coincide with the hunting area of the Eldorado Springs and Lefthand Palisades breeding pairs.

Mike Figgs and Nancy Lederer, Boulder County Nature Association, have been monitoring the status of Golden Eagle nests in the Boulder area and have provided a summary of their recent observations (for data up to and including 1985 see Appendix B of Thompson and Strauch 1986). There are 4 nesting sites or groups of nesting sites that have been used in recent years. The histories of these sites are given in Thompson and Strauch (1986). One nest site is on City of Boulder Open Space and may have been used in 1978. Two sites are on Boulder Mountain Parks land. The fourth site is near the mouth of Left Hand Canyon. At least 3 young were fledged from 2 of these nests in 1984 and 5 young fledged from 3 nests in 1985. In 1986 3 young were fledged from 2 nests (Figgs and Lederer, pers. commun.).

As Golden Eagles are easily disturbed by human activity near their nests, future maintenance of the local breeding population will require protection from the growing human population and from increasing numbers of rock climbers.

American Kestrel

Henderson (1909), Betts (1913), and Alexander (1937) reported the American Kestrel to be a common resident in Boulder County. The BASWI reports many sightings of this species throughout the year.

We recorded numerous sightings of this species on City of Boulder Open Space during this study (Fig. 16). We found 16 active nests and 11 probable nests scattered throughout Open Space in the last 3 years (Fig. 16). Flying young were

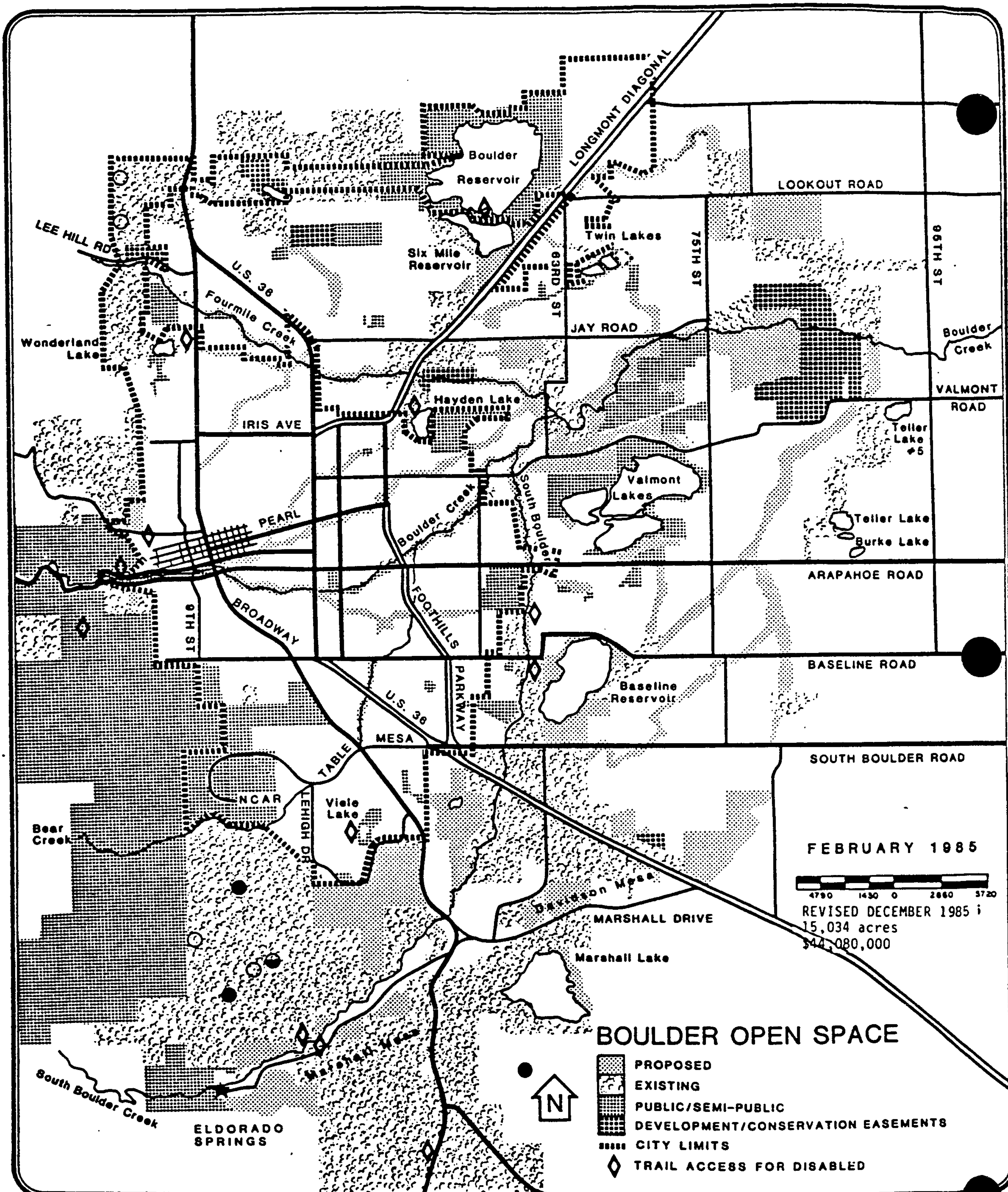
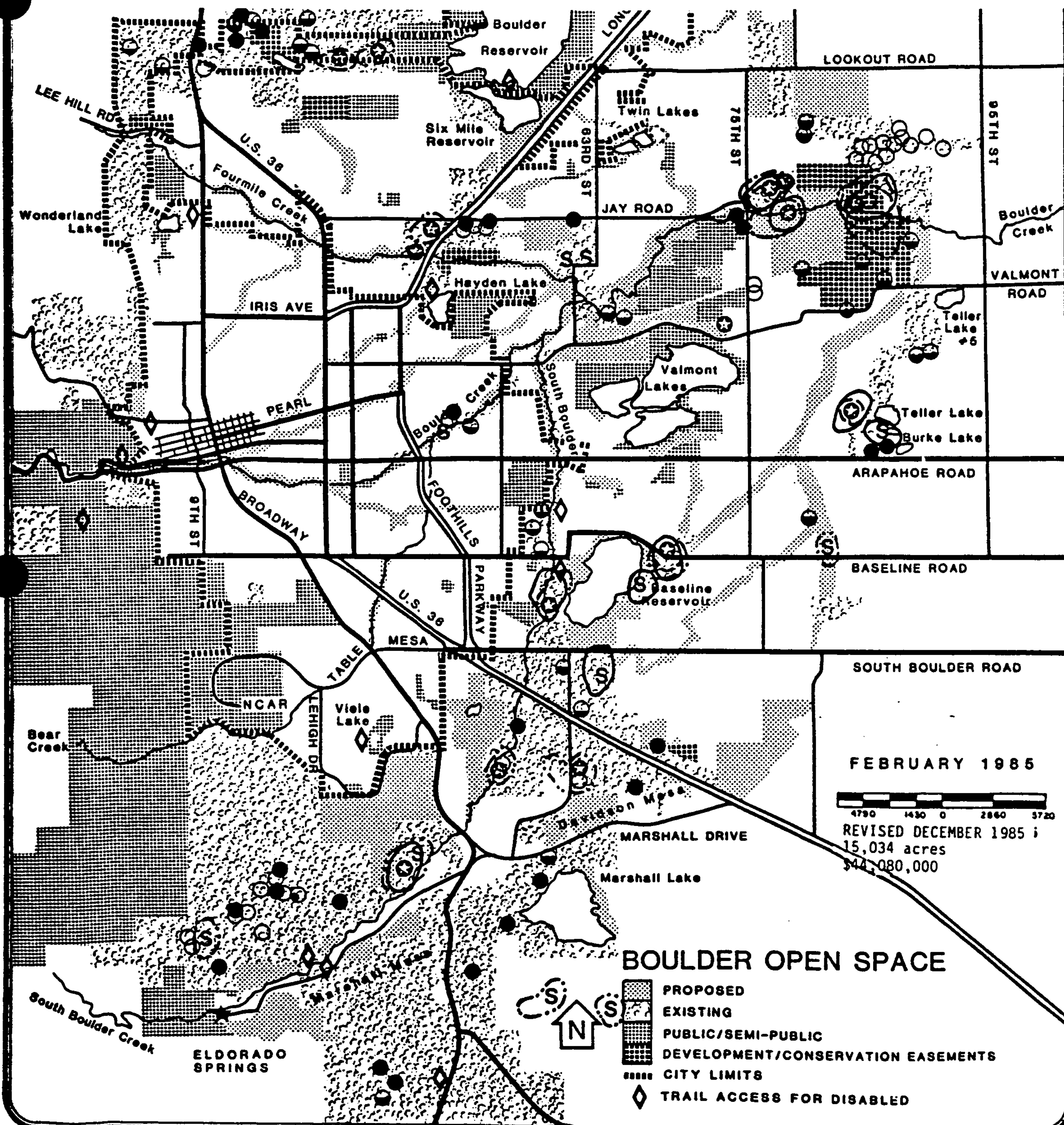


Figure 15. Locations of Golden Eagle observations in 1984 (closed circles), 1985 (open circles), and 1986 (half-closed circle).

Figure 16. Locations of 1984 (closed circles), 1985 (open circles), and 1986 (half-closed circles) American Kestrel observations and nest sites (star in circle). Lines around nests, which delineate areas where the nesting pair was observed, are solid for 1984, dashed for 1985, and dashed-dotted for 1986. Suspected nests are identified by an "S."



frequently seen in late June and early July. Most nests were in holes in cottonwood trees. One nest was in a hole in White Rocks in 1984, 2 pair nested in the cliff in 1985, and at least 1 pair raised 2 young there in 1986. At least 3 young were fledged at White Rocks in 1985. On 20 July 1985, we found 2-3 dozen American Kestrels feeding on grasshoppers in the wheat fields just north of White Rocks. About half that number were still present a week later. In 1986, when grasshopper populations were very low around Gunbarrel Hill, no large number of kestrels were found in the wheat fields. Numerous kestrels, however, were found in the Heatherwood subdivision in July 1986, presumably feeding on birds.

Peregrine Falcon

Henderson (1909) reported the Peregrine Falcon nesting just north of Boulder County in 1889. Alexander (1937) called the species a rare or infrequent transient in Boulder County. The BASWI recorded 9 sightings of the species between 1978 and 1984.

French (1951) reported a nest with 4 eggs on the Third Flatiron on 16 April 1950. The species nested regularly in this area through 1958 (Bailey and Niedrach 1965). Another nest was observed near Eldorado Springs in 1953 and 1954 (Bailey and Niedrach 1965).

We saw no Peregrine Falcons during this study.

Prairie Falcon

Henderson (1909) reported Prairie Falcons nesting on the St. Vrain River in 1893 and 1899. Betts (1913) and Alexander (1937) reported the species as an infrequent summer resident. The Colorado Division of Wildlife recorded nests on the Flatirons just outside City of Boulder Open Space and near Devil's Thumb (1977) which may be on Open Space. The BASWI recorded sightings in low numbers throughout the year.

Mike Figgs and Nancy Lederer have been monitoring this species in the Boulder area and reported 6 active nests sites in 1984 and 1985 (see Thompson and Strauch 1986) and 5 active nests in 1986. None of these nests are on City of Boulder Open

Space, but 4 are located immediately adjacent to it in the Mountain Parks, and the birds use Open Space for hunting. One of these sites was found by French (1951). At least 7 young were produced from these nests in 1984 and 17 in 1985. In 1986 at least 3 young were fledged from one nest, a "fledged" young which could not fly was seen at a second nest, one nest failed during incubation, and the outcome of 2 other active nests is unknown (Figgs and Lederer, pers. commun.).

We had several sightings of Prairie Falcons during this study (Fig. 17), some near the known nest sites. In 1985, the species was seen 3 times hunting over the prairie dog town on the Andrus Parcel, south of Jay Road. One bird was seen on Boulder Creek near and over the Cottonwood Grove and another on Marshall Mesa. In 1986, we had 5 sightings of 7 birds, 1 near the Cottonwood Grove and the others scattered along the foothills.

Preventing disturbance of nests by hikers and climbers will be necessary to preserve the local breeding population. More systematic observations are needed at the prairie dog town on the Andrus Parcel to determine whether this is an important hunting area for Prairie Falcons. Target shooting and hunting in the prairie dog town should be controlled to prevent disturbance and maintain the prey base of birds using the area.

Common Barn-Owl

Betts (1913) and Alexander (1937) reported that the Common Barn-Owl was rare in Colorado. The BASWI reports only 18 scattered observations of the species during the last 7 years.

Barn-Owls were found nesting in 1983 and 1984 along Boulder and Whiterock Ditch, just east of the Minitrista Parcel (Todd DiCello, pers. commun.)(Fig. 18). Four young were fledged in 1983; the outcome of the 1984 nesting attempt is unknown.

Breeding at White Rocks was first suspected in 1941 (Jollie 1945); 7 young were found on a nest there in 1947 (Bailey and Niedrach 1965). The species nested there in 1972 and in each year from 1978 to 1983 (Bob Stoecker, pers. commun.).

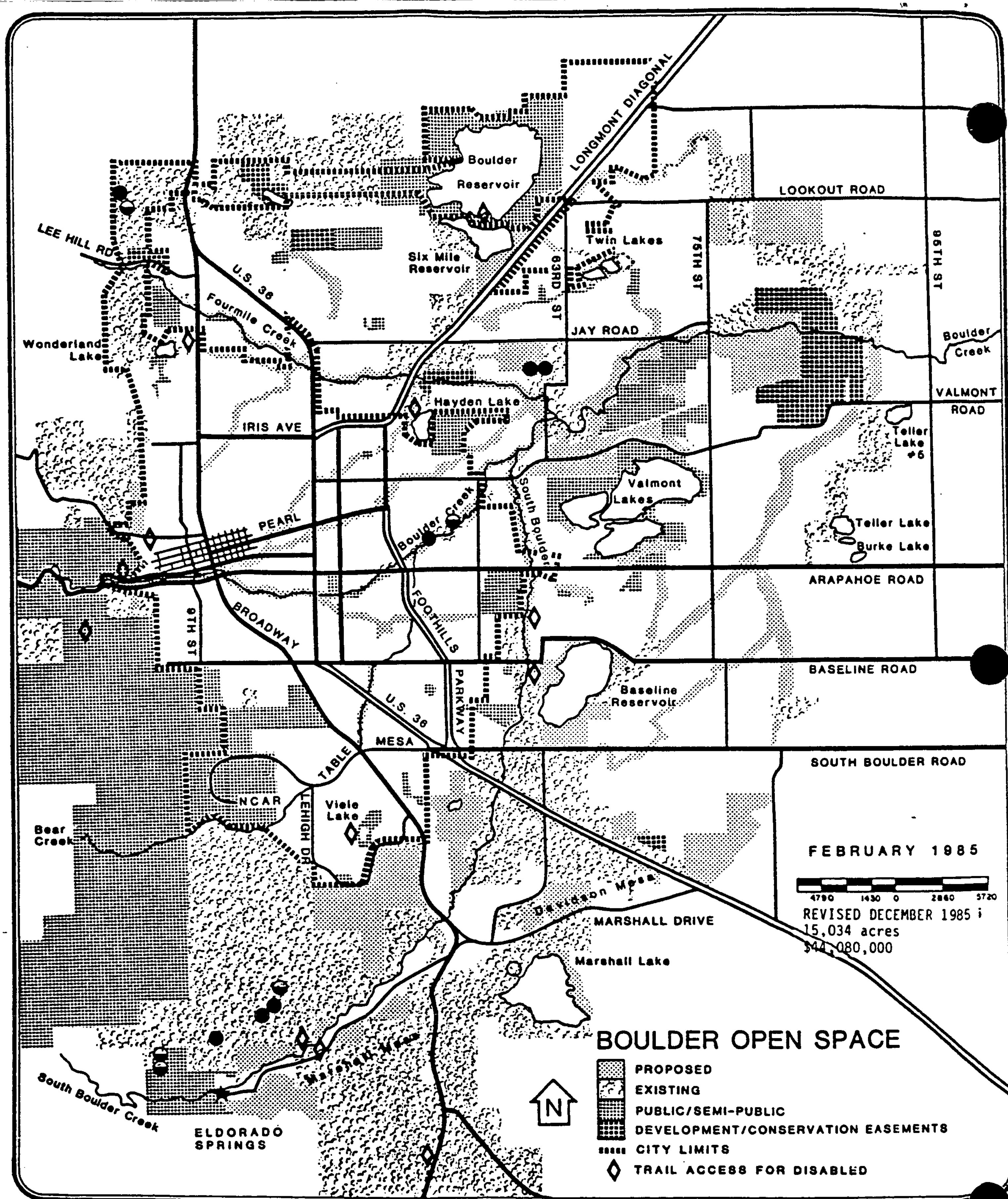


Figure 17. Locations of 1984 (closed circles), 1985 (open circles), and 1986 (half-closed circles) Prairie Falcon observations.

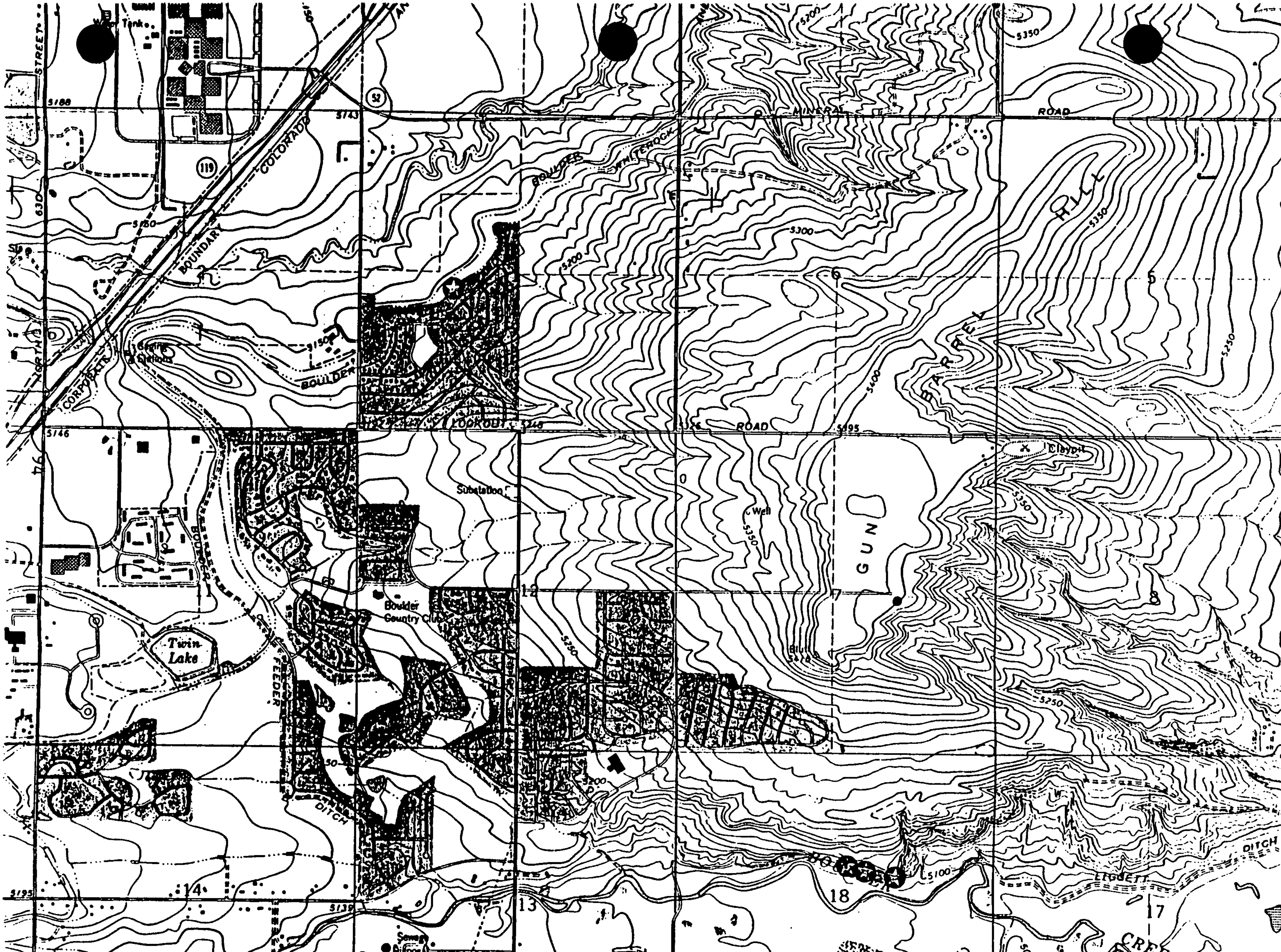


Figure 18. Locations of 1984-86 Common Barn-Owl nest sites.

We found an adult Barn-Owl in a hole (east nest) White Rocks on 15 July 1984 and on 24 July saw 2 adults and at least 1 young bird (Fig. 18). A large pile of fresh Barn-Owl pellets was found under the nest hole. In 1985 we observed Barn-Owls at White Rocks from late April to early September. In July we determined that 2 pairs were nesting, but not in the east nest hole used in 1984. One nest produced 3 young; we never saw young from the second nest.

In 1986 we observed Common Barn-Owls at White Rocks from 16 April to 4 August and found 3 nests. The 1985 east nest and "5-hole nest" were reoccupied, and a third site west of the main grotto also was used. The eastern nest produced at least 3 young, the 1985 western ("5-hole") nest site produced at least 2 young, and the new nest produced at least 2 young.

The species probably nests in small numbers thoughout the County. Preservation of dead cottonwoods might encourage them to use other Open Space parcels.

Flammulated Owl

Flammulated Owls are residents of Boulder County (Henderson 1909, Betts 1913, Alexander 1937), but they are seldom recorded and their status is unknown.

The Boulder County Nature Association (BCNA) Small Owl Survey of the foothills and mountains of Boulder County found 2 Flammulated Owls in Boulder County in 1985. In 1986 the survey found 8 territories and 2 nests on Mountain Parks.

Eastern Screech-Owl

Henderson (1909), Betts (1913), and Alexander (1937) reported the Eastern Screech-Owl to be a common resident in Boulder County and cite egg dates from 11 April to 19 May. The BASWI reported low numbers of sightings scattered throughout the year.

We had 4 sightings of Eastern Screech-Owls on City of Boulder Open Space during this study (Fig. 19). Three birds were found by Steve Jones on 9 July 1984 in cottonwoods at the north end of the Burke 2 parcel; a pair fledged 3 young there in 1985. We found 1 bird in the Kaufman Parcel. We also observed a pair with 3

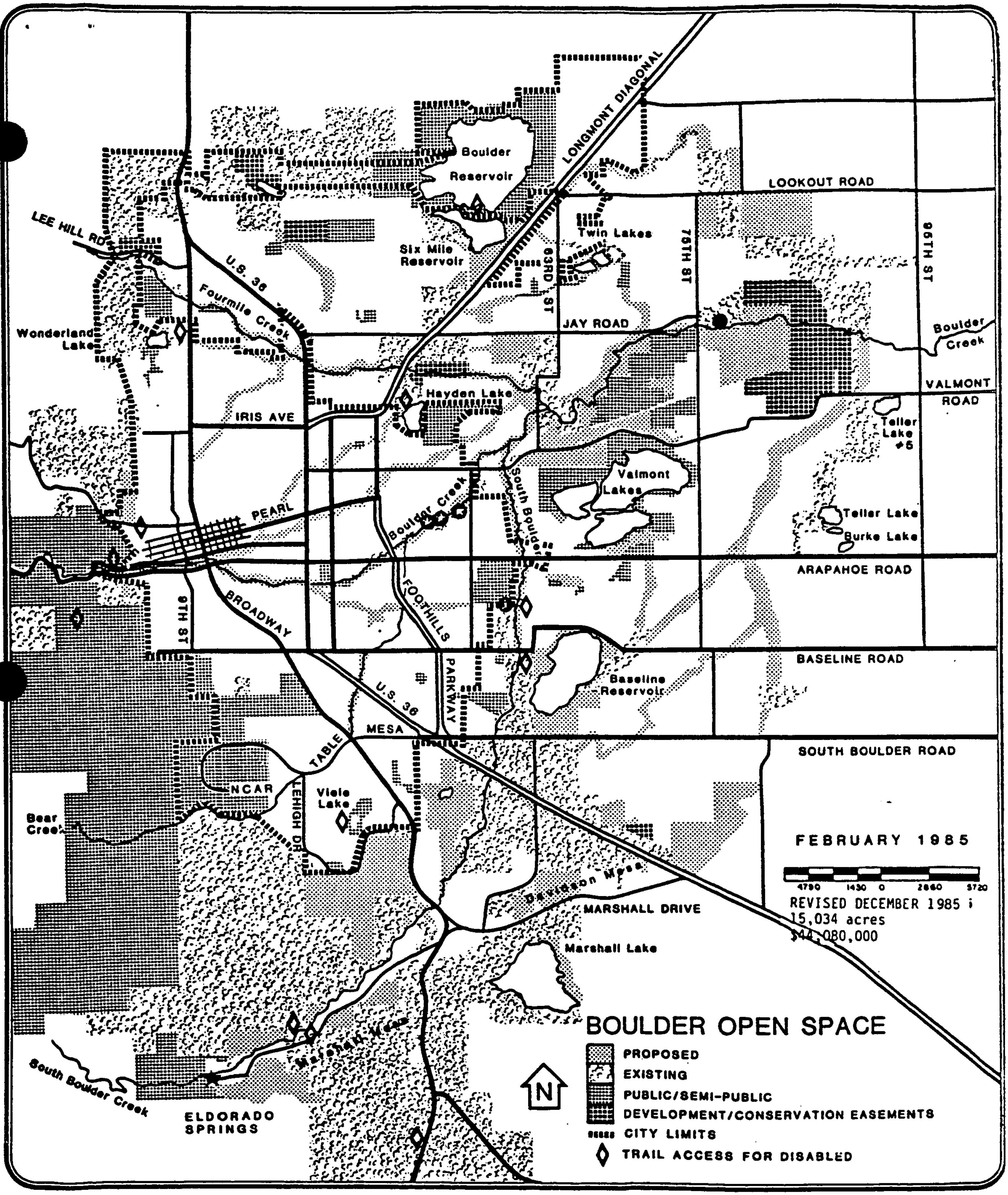


Figure 19. Locations of 1984 Eastern Screech-Owl observations (closed circle) and 1985-86 nest sites (star in circle).

flying young in the 800-block of Juniper Street in 1984. Screech-Owls were seen regularly in that neighborhood in 1983-84.

In 1986 Bob Palmer (pers. commun.) found that the nest on the edge of Burke 2 parcel produced 4 young. He also found a pair in the Cottonwood Grove that produced 2 young and 2 pairs and on the Arnold parcel along Boulder Creek that produced 3 and 4 young, respectively.

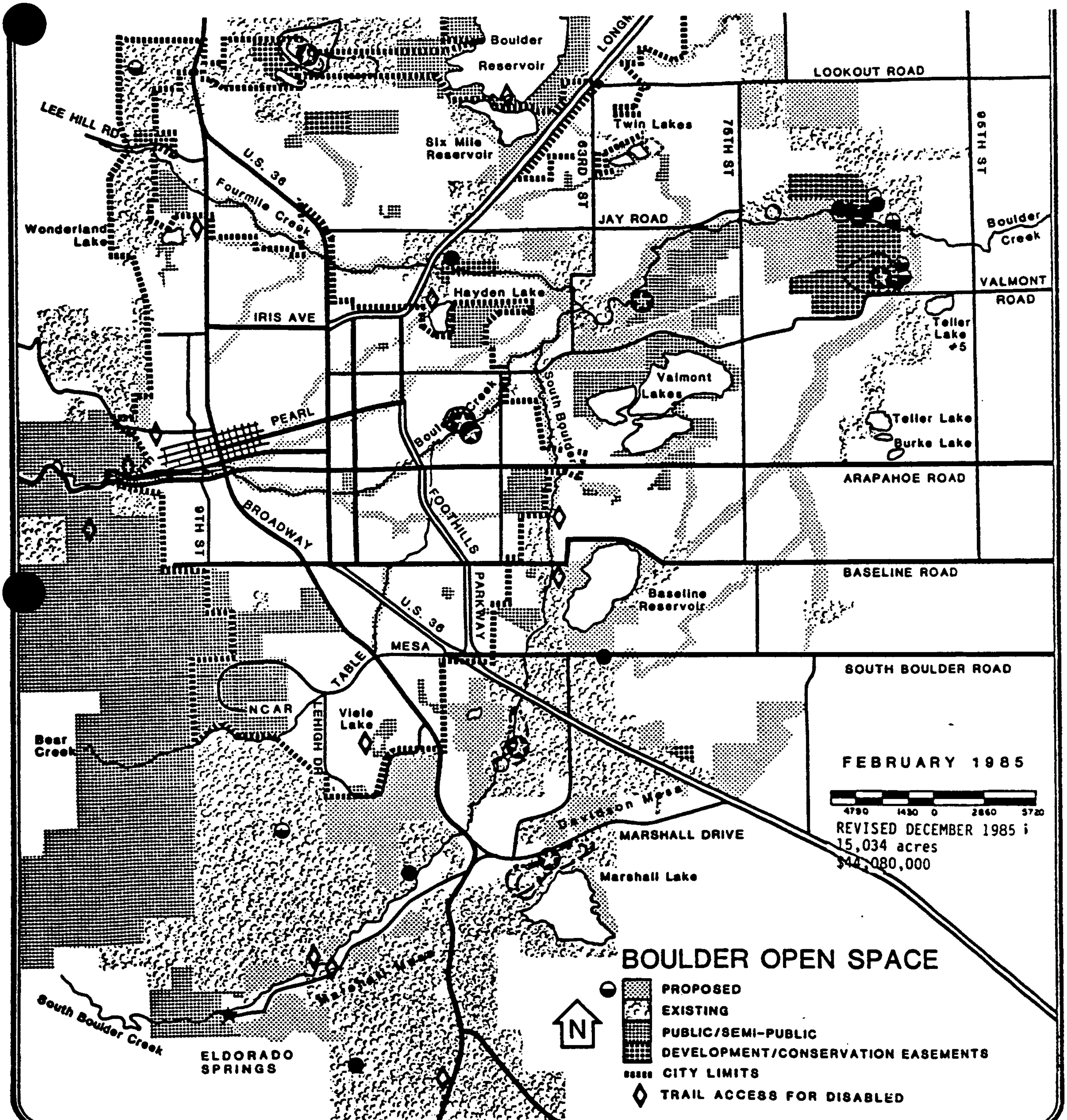
(Note: We have assumed that the local breeding Screech-Owls are Eastern Screech-Owls; however, the specific status of the Screech-Owls breeding in the Front Range has not been critically evaluated yet.)

Great Horned Owl

Henderson (1909), Betts (1913), and Alexander (1937) reported the Great Horned Owl to be a moderately common to common resident of the plains and foothills near Boulder. The BASWI reported moderate numbers throughout the year.

We saw Great Horned Owls many times during this study. There are at least 6 regularly used nesting areas on or near Open Space: Boulder Valley Ranch, Sawhill Ponds, the Ertl Conservation Easement, the Cottonwood Grove, Van Vleet Ranch, and Marshall Mesa (Fig. 20). There is probably at least 1 pair nesting regularly in or near White Rocks. The Boulder Valley Ranch nest fledged 3 young in 1984 and 1985. Although a bird was found on a nest on 16 April 1986, no young were found. The Sawhill Pond nest fledged 1 young in 1984 and 2 each year in 1985 and 1986 (Steve Jones, pers. commun.). At least one young was fledged each year in 1985 and 1986 from nests on the Ertl Conservation Easement. The nest on Marshall Mesa fledged 4 young in 1984, 3 in 1985, and 1 in 1986. The nests in the Cottonwood Grove fledged 2 young each year 1984-1986 (this study; Bob Palmer, pers. commun.). Nests on the Van Vleet Ranch produced 3 young in 1983 and 2 young each year 1984-1986 (Bob Palmer, pers. commun.). These nests thus produced at least 12 young in 1984, 13 in 1985, and 8 in 1986.

This species is the most easily observed, and perhaps the most common, owl breeding in the Boulder area and on City of Boulder Open Space. The species breeds early in the year (egg dates 2 March to 22 April (Bailey and Niedrach 1965)), open circles) Great Horned Owl observations and nest sites (star in circle). Lines around nests, which delineate areas where the nesting pair was observed, are solid for 1984, dashed for 1985, and dashed-dotted for 1986.



and most young we observed were already flying. The species appears to be moderately tolerant of human disturbance, but isolated nesting habitat needs to be preserved to insure maintenance of the local breeding population.

Northern Pygmy-Owl

Early records of Northern Pygmy-Owls (Henderson 1909, Betts 1913, Henderson 1937) indicated that they were rare or infrequent residents in Boulder County. Bailey and Niedrach (1965) considered them as uncommon residents in mountainous areas of Colorado. Webb (1982) pointed out that most records for the species in Colorado were for wintering birds which presumably had moved to lower elevations between breeding seasons. The BASWI lists 10 sightings of 14 birds from 1978 through 1984.

The 1985 BCNA Small Owl Survey found 13 calling Northern Pygmy-Owls and 1 nesting pair in the Boulder Mountain Parks. Two other nests and another calling bird were found in areas not regularly surveyed. At least 1 bird was found on City of Boulder Open Space. The 1986 survey had 2 sightings of Northern Pygmy-Owls but no nests. Since large areas of suitable habitat on Open Space were not surveyed, we suspect that several pairs of Northern Pygmy-Owls may nest on Open Space. Management policies which encourage cavity-nesting birds will benefit this species.

Burrowing Owl

The history of the Burrowing Owl in Boulder County has been one of steady decline. Henderson (1909) reported it a "rather common" resident, Betts (1913) reported it common, but Alexander (1937) reported that it occurred locally, but was "much less common than a few years ago." The Colorado Division of Wildlife recorded Burrowing Owls present on 3 sites near Boulder in 1978. Two of these, near Dodd Reservoir and just north of IBM, were not on City of Boulder Open Space. The third site was on the Klein/Hoover parcel just east of Baseline Reservoir. The BASWI reported small numbers of sightings of Burrowing Owls from April through September.

A pair of Burrowing Owls nested near Mesa Reservoir and another in Field 7 on Boulder Valley Ranch in 1981, but it is not known whether they produced any young (Steve Jones, pers. commun.). In 1983 a pair raised 5 young on Boulder Parks land just north of Boulder Reservoir (Steve Jones, pers. commun.). Burrowing Owls have been seen on or near the Lore parcel in recent years, but details on the number of birds present and possible nesting success were not recorded (Ann Wichmann, pers. commun.).

We searched prairie dog towns on the mesa next to Mesa Reservoir, on the Klein parcel, and the mesa on the Andrus parcel, but found no evidence of use by Burrowing Owls.

Burrowing Owls again nested in Field 7 on Boulder Valley Ranch in 1984 and 1985 (Fig. 21). Two pairs nested and were monitored by Steve Jones, Deb Amerman, and us through July. In 1984 each nest produced 4 young, but predators appeared to have killed 2 owlets from the western nest between 10 and 14 July; 2 were still present on 19 July. In 1985 2 pairs each produced 4 young. The young and adults at the eastern nest were seen through mid-July, when the young could fly. The birds at the western nest all disappeared between 30 June and 16 July (Deb Amerman, pers. commun.). In 1985, the eastern pair used the 1984 burrow, or one near it; the western birds used a new burrow (Deb Amerman, pers. commun.).

In 1986 we found 3 adult Burrowing Owls in Field 7 on 16 April. No owls were found in the field on 18 May, one was present on 26 May, and none could be found on 14 June. The prairie dogs on Field 7 disappeared during spring 1986, presumably killed by the local bubonic plague epidemic. After the prairie dogs disappeared, the vegetation in the field became denser and taller than in past years. Because Burrowing Owls require open areas with good visibility around the nest site, the field may have become unsuitable for them.

On 3 August 1986 Steve Jones (pers. commun.) found a pair of Burrowing Owls with 4 young on the Axelton property just west of Boulder Reservoir. This pair of owls may have represented some of the birds that abandoned Field 7.

Zarn (1974) reported that burrow availability is the chief limiting factor in controlling Burrowing Owl numbers and that they depend primarily on active burrowing mammal colonies for nest sites.

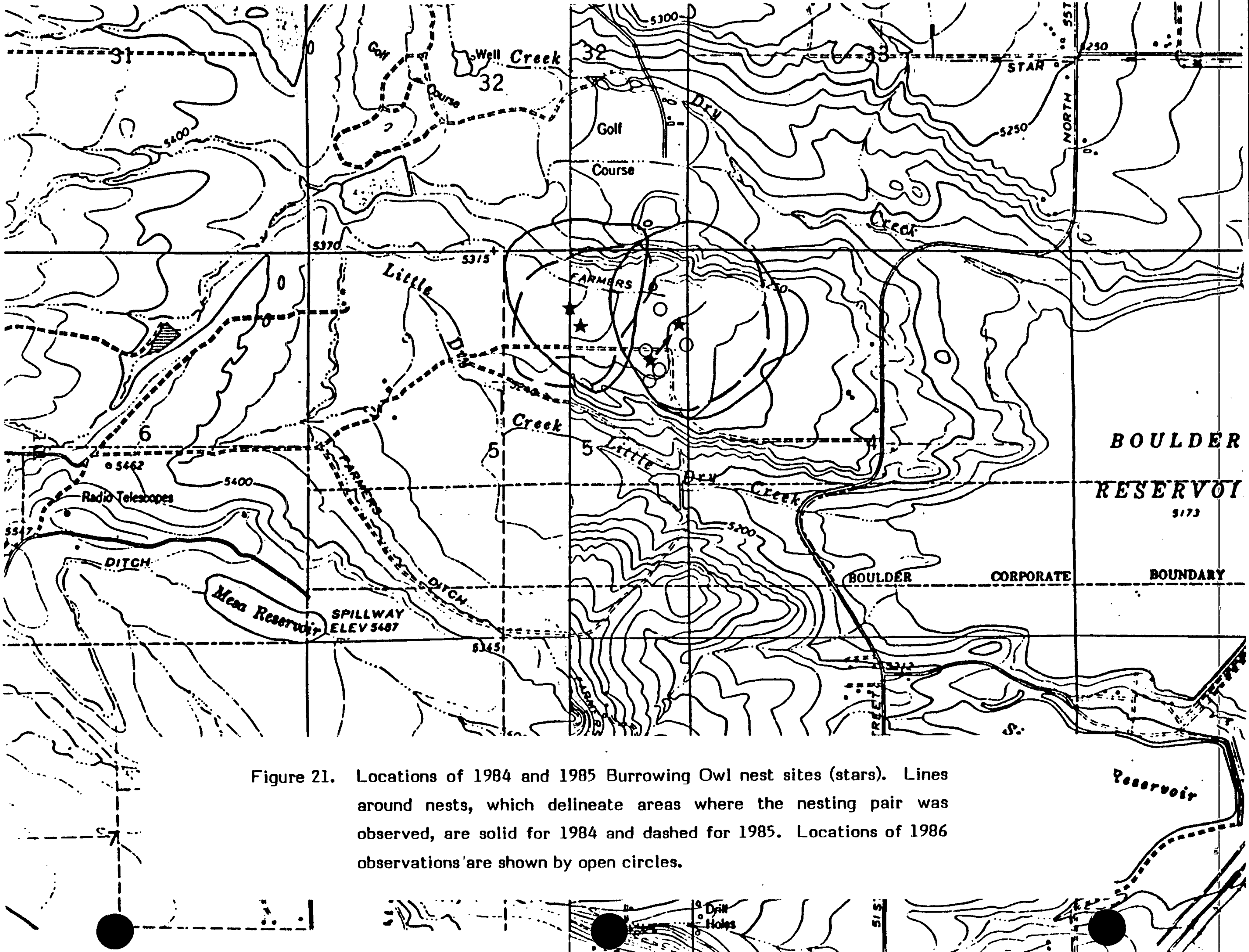


Figure 21. Locations of 1984 and 1985 Burrowing Owl nest sites (stars). Lines around nests, which delineate areas where the nesting pair was observed, are solid for 1984 and dashed for 1985. Locations of 1986 observations are shown by open circles.

Long-eared Owl

Henderson (1909) and Betts (1913) reported the Long-eared Owl, as a common resident of the plains and mountains in Boulder County. Eggs were reported from 13 April to 16 May. By 1937, however, Alexander (1937) reported that the species was infrequent around Boulder. The BASWI reports only a few sightings of the species, mainly in the winter.

We found a Long-eared Owl in a grotto in the cliffs on the Ertl property just east of White Rocks in March, 1984 before the beginning of this study (Fig. 22). A bird was still present on 29 May, but we could not find a nest. On 29 June we found 3 fledged young and 1 adult at the site. By 24 July the birds were no longer present. Another pair of Long-eared Owls with 5 young was found in Skunk Canyon in 1984 by Steve Jones. An immature bird was seen at Sawhill Ponds on 28 June 1984 by Steve Jones.

Boreal Owl

The Boreal Owl is also known from Boulder County (BASWI). The BCNA small owl survey found one Boreal Owl near Brainard Lake in Boulder County.

Northern Saw-whet Owl

Northern Saw-whet Owls have been known to nest in Boulder County for many years (Henderson 1909, Betts 1913, Alexander 1937). Saw-whets have been considered infrequent (Alexander 1937) to "probably rather common" (Betts 1913). Bailey and Niedrach (1965) consider the species an uncommon resident in Colorado. The BASWI lists only 6 sightings of the species from 1978 to 1985. The BCNA Small Owl Survey recorded 12 Northern Saw-whet Owls and 1 nest in the foothills. Three other sightings of the species were made in areas not regularly surveyed. The 1986 survey reported 4 sightings of Northern Saw-whet Owls.

It appears that the status of ths species is similar to that of the Northern Pygmy-Owl; it probably breeds on Open Space.

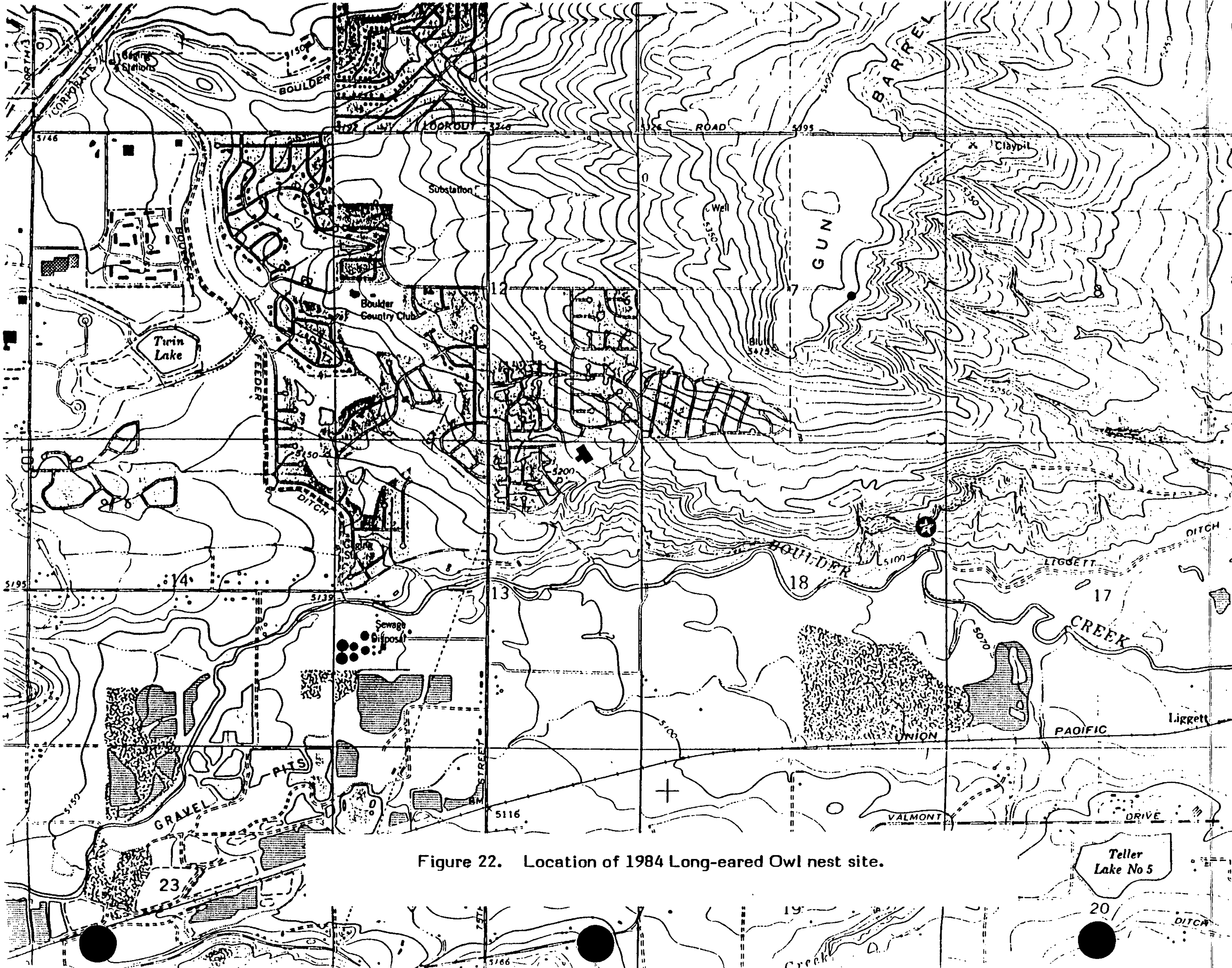


Figure 22. Location of 1984 Long-eared Owl nest site.

HUMAN ACTIVITY AND DISTURBANCE

We observed evidence of human activity on 20 of our 40 study plots. We found people hiking, jogging, and walking dogs on 7 plots, most of which overlapped established trails. We found a person gathering firewood by tumbling it down the hill on the west part of the Whittemeyer parcel when we were setting up a study plot. Our rebar posts and flagging were removed from part of 11 plots. We found the remains of 2 fires, assorted beverage containers, and discarded fishing tackle and its packaging along the shore of Marshall Lake. Pieces of clay pigeons were found on 1 of the Yunker plots, indicating that someone had been trapshooting on Open Space.

Dogs were seen several times on 4 of our study plots, usually accompanying people walking on established trails. Dogs, some of which we saw come from nearby houses, were seen several times running free on the Yunker parcels. Wilson's Phalarope and probably Common Snipe bred in these fields. The young of these ground-nesting species would be particularly vulnerable to dog predation during the 3 weeks in which they forage around the nesting area before they can fly. One morning at dawn we found a party at the south end of the Mesa Trail searching for a dog which had disappeared while chasing deer the previous afternoon.

With the exception of some uncommon species with narrow habitat preferences (e.g., Bobolinks, Grasshopper Sparrows, and some raptors), the influence of human activity on most breeding species is inconsequential, particularly when viewed from a local population perspective. Most of these species are quite tolerant of chronic activity and even moderate levels of acute disturbances. Nests are generally inconspicuous and inaccessible to humans. However, human disturbance is of special management concern for uncommon species that nest in only 1 or 2 fields. For these species, if management goals are to maintain their local numbers, any disturbance is too much.

MANAGEMENT RECOMMENDATIONS

The best management policy for most of the area is to allow natural processes to take their course and to passively discourage human use into new areas (e.g., minimize the construction of new trails to isolated tracts). We do, however, have special concerns about some of the effects of current or past range and forest management practices and some recreational uses of Open Space.

Most of the species of birds breeding in the Boulder area are tolerant of a wide variety of ecological conditions. Their populations appear to be healthy and do not appear to have changed significantly in recent years. A few species or species groups, however, are of concern because their populations are small, have shown recent decreases, or are especially sensitive to human disturbance.

The major areas of management concern that we have identified are grassland management, protection of riparian habitat, snag management, and protection of breeding raptors.

Grassland Management

Grasslands typically support only about 4 breeding-bird species. They are usually dominated by 1 or 2 widespread species and include a few species with restricted habitat preferences (Graul 1980). Within a local area the grasslands are often a mosaic of subtypes, each of which have some species restricted to it. Management concerns should concentrate on the species with restricted habitat requirements. These species have a restricted distribution during 1 or more phases of the nesting cycle, a patchy distribution throughout their range, and are especially sensitive to habitat disturbances (Graul 1980). We identified 2 species of grassland birds, the Bobolink and the Grasshopper Sparrow, on Boulder Open Space which fall into this category. Management recommendations for each species are discussed in separate sections of this report.

Protection of Riparian Habitat

Ryder (1980) reported that riparian habitats in the West are especially vulnerable to overgrazing. Grazing may cause destruction of understory and, in some cases, midstory vegetation (Buttery and Shields 1975). Forbs and shrubs, unlike grasses, do not regenerate well after heavy grazing or browsing. The problem is especially acute near water, since livestock are reluctant to leave such areas during the hottest part of the day. Habitat near water often becomes a loafing area where ground cover and bird-nesting habitat are destroyed and trees damaged or destroyed by rubbing, browsing, and trampling. Szaro (1980) reports that "no grazing plan short of complete removal of livestock by fencing has any significant effect on riparian habitat." We found that several of the Open Space riparian areas had been trampled by cattle and had a poor understory, particularly the Burke 1 parcel. In response to recommendations made in Thompson and Strauch (1985), the City fenced off the riparian zone on the Burke 1 parcel to restrict cattle use.

We recommend that access of livestock to riparian habitats on Open Space be severely restricted and prevented wherever possible. In addition, heavy use of riparian habitats by humans and their pets appears to depress their use by birds. We observed fewer breeding birds on the west side of South Boulder Creek in the Burke 1 parcel, where there is a heavily used trail, than on the west side, where there is no trail. We, therefore, recommend that trails not be constructed in riparian habitats if there are acceptable alternative routes. If no alternate routes are feasible, locate the trail away from the creek and on only one side to minimize disturbance to the adjacent side.

Snag Management

Snags provide nest sites for cavity-nesting birds, perches for raptors and fly-catching species, and sites for foraging and food storage for some birds. Woodpeckers usually excavate new holes every year, whereas chickadees, swallows, bluebirds, and some owls use old holes. Snags are under increased pressure from firewood cutters. Scott et al. (1980) estimated that 800,000 snags were gathered for firewood in the Front Range between Denver and the Wyoming border in 1978 alone.

Cavity-nesting species usually comprise about 30 to 45% of the breeding-bird populations in forests (Scott et al. 1980). We found that they accounted for only 8.3% and 6.3% of the respective 1984 and 1985 bird populations on City of Boulder Open Space conifer habitat. This suggests that snags have been overharvested in this area, causing a decrease in populations of cavity-nesting species. Red-headed and Lewis Woodpeckers were formerly common in Boulder County (Alexander 1937) but are rare or uncommon now.

Studies in ponderosa pine forests (Scott et al. 1980, Diem and Zeveloff 1980) have shown that 5 or 6 snags/ha of mixed sizes are adequate to support normal populations of cavity-nesting birds. Preferred snags are those that have been dead for at least 5 years, are larger than 19" dbh, and retain more than 40% of their bark (Scott et al. 1980). Snags should be left within wooded areas as well as on forest margins. Swallows and bluebirds especially prefer snags facing open areas. Living trees with broken crowns and lightning scars are often used by cavity nesters. Selective thinning by a City contractor on the Stengel 2 parcel in 1985 incorporated considerations for maintaining suitable existing snags and producing additional snags via girdling.

We recommend that forest management plans for Open Space include provisions for returning snag densities to natural levels. In cases where snags cannot be maintained, nesting boxes will encourage many cavity-nesting species. Nesting boxes, however are temporary enhancers and require periodic maintenance: they must be cleaned every year between breeding seasons and often need repair because of damage from woodpeckers, rodents, and insects. Nesting boxes made from sawdust and cement are more durable that wooden ones; they have been used in Germany for years.

Raptors

Raptors appear to be particularly susceptible to human disturbance, perhaps because they and their nests are large and easily found and because people are strongly attracted to them. In a study that included the Colorado Front Range, Boeker and Ray (1971) found that human disturbance accounted for at least 85% of all known nest losses and failures for Golden Eagles. In Wisconsin, Petersen (1979) reported that human interference was probably responsible for most of the desertion of nests by Red-tailed Hawks.

Boulder County is fortunate in having a wide variety of raptors still nesting in it. On the other hand, most populations are small, some critically so, and the loss of one nesting season could affect the future success of some species. It is therefore extemely important that every effort be made to ensure that these species are unmolested.

Fyfe and Olendorff (1976) discuss the major effects of human interference on nesting raptors. Parent birds may become so disturbed that they desert their eggs or young. The most critical times appear to be when the territory is first established and just prior to egg laying, when the female spends much time at or near the nest. Prairie Falcons have been observed to desert after even a short visit by humans before or during egg laying, but rarely desert once incubation has begun. Prairie Falcons and Golden Eagles usually sit very tight for a few days just before and after hatching. Most raptors will not desert after the young hatch. On the other hand, Great Horned Owls are quite tolerant of disturbance throughout the nesting cycle. The tolerance to disturbance of most species is not known.

Even if parent birds do not desert, they may break their eggs, trample their young, or eject eggs or young from the nest, especially if startled. In addition, disturbed adults will often remain away from a nest longer than normal, exposing young or eggs to chilling, overheating, desiccation, and predators. Such disturbance is most serious during the egg stage and until the young are about 2-3 weeks old. Anyone coming upon a raptor nest should leave the area as soon as possible.

Another critical period is when the young are almost ready to fledge. Disturbance at this time may cause the young birds to leave the nest prematurely, damaging still-growing feathers and bones. Even if not injured in leaving the nest, flightless young may be forced to spend several nights on the ground, where they are highly vulnerable to predators. Young falcons and eagles are especially predisposed to leave the nest early if disturbed (Fyfe and Olendorff 1976).

Visitation to nests by humans often leads to increased visitation as others learn of the nest site. Mammalian predators, especially coyotes and raccoons, may follow human scent trails to eggs or young.

We agree with Fyfe and Olendorff (1976) that unless there is good reason, raptor nests should be left undisturbed. Management plans should be designed to keep casual visitors away from nests and to minimize disturbance during monitoring activities. Most observations can be made from a distance. If a visit to a nest is necessary, it should be done at a noncritical time and be as short as possible. The location of active nests should be kept confidential. Golden Eagles and Prairie Falcons, which nest on cliffs , are a special case. Casual visitors are unlikely to come upon their nests, but rock climbers are particularly likely to disturb them. The current effort of Mike Figgs to educate climbers to the problems of raptor disturbance and to obtain voluntary avoidance of nest sites by climbers should be commended and encouraged. However, we think that compliance should be monitored and possible closure of areas be considered as a possible management tool.

Burrowing Owls present additional management problems. They seem to do best in active prairie dog towns. If a town is abandoned they will use fewer burrows (Zarn 1974). In Oklahoma, burrows abandoned when the prairie dogs occupying them were poisoned deteriorated so fast that they were useless to Burrowing Owls within a year. Burrowing Owls are mainly insectivorous and thus may be adversely affected if pesticides are used on their feeding grounds. They will also eat carrion if it is readily available and could be secondarily poisoned if rodents are poisoned near Burrowing Owl nesting sites.

Burrowing Owl management should include conservation of active prairie dog towns and closure of field 7 at Boulder Valley Ranch during the breeding season. Steve Jones and his co-workers should be encouraged to monitor the owl populations. The proposed housing development north of Boulder Valley Ranch may pose a serious threat to Burrowing Owls through increased human activity in the area and from pets allowed to run free. A sheep-proof fence might discourage dogs from entering field 7. For the benefit of Burrowing Owls and all raptors, the poisoning of prairie dogs should be discontinued throughout Boulder Valley Ranch.

Miscellaneous Recommendations

We recommend that dogs on Open Space be subject to greater control or entirely prohibited. While many nesting birds may habituate to constant car or foot traffic near their nests, they will not habituate to free-running dogs. Almost all of the dogs we saw on Open space were running free. The restraining effect of "voice control" is illustrated by a dog which followed us for at least a mile on the Burke 1 and Gebhart parcels despite its owner's repeated calls.

We found that Cowdrey Reservoir No. 2 was the most productive wetland on Open Space and recommend that the non-Open Space part of the reservoir be included in Open Space. Mesa Reservoir is quite attractive to wetland birds when there is water in it. No water was present during the 1984-86 breeding seasons. Maintaining water in the reservoir would add an important waterbird habitat to Open Space and we recommend this be done.

Long-range Management

City of Boulder Open Space is only part of the publically owned land in Boulder County. Management policies on Boulder Mountain Parks and Boulder County Open Space could strongly affect the results of management plans on City of Boulder Open Space. We recommend that city and county personnel responsible for the management of natural habitat develop policies to coordinate their management plans. To do this the type of baseline data being gathered on City of Boulder Open Space must also be gathered on the other areas.

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APPENDIX A

Scientific names of birds mentioned in text.

Table A1. Scientific names of birds mentioned in text. Phylogenetic order and names follow AOU (1983).

FAMILY COMMON NAME	SCIENTIFIC NAME
Podicipedidae	
Pied-billed Grebe	*Podilymbus podiceps*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
Pelecanidae	
American White Pelican	*Pelecanus erythrorhynchos*
Phalacrocoracidae	
Double-crested Cormorant	*Phalacrocorax auritus*
Ardeidae	
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Adrea herodias*
Great Egret	*Casmerodius albus*
Snowy Egret	*Egretta thula*
Green-backed Heron	*Butorides striatus*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Threskiornithidae	
White-faced Ibis	*Plegadis chihi*
Anatidae	
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Green-winged Teal	*Anas crecca*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Gadwall	*Anas strepera*
American Widgeon	*Anas americana*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Common Goldeneye	*Bucephala clangula*

Table A1. Continued.

FAMILY COMMON NAME	SCIENTIFIC NAME
Bufflehead	Bucephala albeola
Common Merganser	Mergus merganser
Cathartidae	
Turkey Vulture	Cathartes aura
Accipitridae	
Osprey	Pandion haliaetus
Northern Harrier	Circus cyaneus
Sharp-shinned Hawk	Accipiter striatus
Cooper's Hawk	Accipiter cooperii
Broad-winged Hawk	Buteo platypterus
Swainson's Hawk	Buteo swainsoni
Red-tailed Hawk	Buteo jamaicensis
Golden Eagle	Aquila chrysaetos
Falconidae	
American Kestrel	Falco sparverius
Prairie Falcon	Falco mexicanus
Phasianidae	
Chuckar	Alectoris chukar
Ring-necked Pheasant	Phasianus colchicus
Blue Grouse	Dendragapus obscurus
Rallidae	
Virginia Rail	Rallus limicola
Sora	Porzana carolina
American Coot	Fulica americana
Charadriidae	
Killdeer	Charadrius vociferus
Recurvirostridae	
American Avocet	Recurvirostra americana
Scolopacidae	
Greater Yellowlegs	Tringa melanoleuca
Lesser Yellowlegs	Tringa flavipes
Solitary Sandpiper	Tringa solitaria
Spotted Sandpiper	Actitis macularia

Table A1. Continued.

FAMILY COMMON NAME	SCIENTIFIC NAME
Pectoral Sandpiper	Calidris melanotos
Common Snipe	Gallinago gallinago
Wilson's Phalarope	Phalaropus tricolor
Laridae	
Ring-billed Gull	Larus delawarensis
California Gull	Larus californicus
Forster's Tern	Sterna forsteri
Columbidae	
Rock Dove	Columba livia
Mourning Dove	Zenaida macroura
Cuculidae	
Black-billed Cuckoo	Coccyzus erythropthalmus
Tytonidae	
Common Barn-Owl	Tyto alba
Strigidae	
Eastern Screech Owl	Otus asio
Great Horned Owl	Bubo virginianus
Northern Pygmy-Owl	Glaucidium gnoma
Burrowing Owl	Athene cunicularia
Long-eared Owl	Asio otus
Caprimulgidae	
Common Nighthawk	Chordeiles minor
Common Poorwill	Phalaenoptilus nuttallii
Apodidae	
White-throated Swift	Aeronautes saxatalis
Trochilidae	
Broad-tailed Hummingbird	Selasphorus platycercus
Alcedinidae	
Belted Kingfisher	Ceryle alcyon
Picidae	
Lewis' Woodpecker	Melanerpes lewis
Downy Woodpecker	Picoides pubescens
Hairy Woodpecker	Picoides villosus

Table A1. Continued.

FAMILY		
	COMMON NAME	SCIENTIFIC NAME
	Northern Flicker	Colaptes auratus
Tyrannidae		
	Olive-sided Flycatcher	Contopus borealis
	Western Wood Pewee	Contopus sordidulus
	Willow Flycatcher	Empidonax traillii
	Least Flycatcher	Empidonax minimus
	Hammond's Flycatcher	Empidonax hammondii
	Dusky Flycatcher	Empidonax oberholseri
	Western Flycatcher	Empidonax difficilis
	Ash-throated Flycatcher	Myiarchus cinerascens
	Western Kingbird	Tyrannus verticalis
	Eastern Kingbird	Tyrannus tyrannus
Alaudidae		
	Horned Lark	Eremophila alpestris
Hirundiade		
	Tree Swallow	Tachycineta bicolor
	Violet-green Swallow	Tachycineta thalassina
	Northern Rough-winged Swallow	Stelgidopteryx serripennis
	Bank Swallow	Riparia riparia
	Cliff Swallow	Hirundo pyrrhonota
	Barn Swallow	Hirundo rustica
Corvidae		
	Steller's Jay	Cyanocitta stelleri
	Blue Jay	Cyanocitta cristata
	Scrub Jay	Aphelocoma coerulescens
	Black-billed Magpie	Pica pica
	American Crow	Corvus brachyrhynchos
	Common Raven	Corvus corax
Paridae		
	Black-capped Chickadee	Parus atricapillus
	Mountain Chickadee	Parus gambeli
Aegithalidae		
	Bushtit	Psaltriparus minimus

Table A1. Continued.

FAMILY COMMON NAME	SCIENTIFIC NAME
Sittidae	
Red-breasted Nuthatch	Sitta canadensis
White-breasted Nuthatch	Sitta carolinensis
Pygmy Nuthatch	Sitta pygmaea
Troglodytidae	
Rock Wren	Salpinctes obsoletus
House Wren	Troglodytes aedon
Cinclidae	
American Dipper	Cinclus mexicanus
Muscicapidae	
Blue-gray Gnatcatcher	Polioptila caerulea
Townsend's Solitaire	Myadestes townsendi
Swainson's Thrush	Catharus ustulatus
Hermit Thrush	Catharus guttatus
American Robin	Turdus migratorius
Mimidae	
Gray Catbird	Dumetella carolinensis
Sage Thrasher	Oreoscoptes montanus
Motacillidae	
Water Pipit	Anthus spinoletta
Laniidae	
Loggerhead Shrike	Lanius ludovicianus
Sturnidae	
European Starling	Sturnus vulgaris
Vireonidae	
Solitary Vireo	Vireo solitarius
Warbling Vireo	Vireo gilvus
Red-eyed Vireo	Vireo olivaceus
Emberizidae	
Orange-crowned Warbler	Vermivora celata
Virginia's Warbler	Vermivora virginiae
Yellow Warbler	Dedroica petechia
Yellow-rumped Warbler	Dendroica coronata

Table A1. Continued.

FAMILY	
COMMON NAME	SCIENTIFIC NAME
Northern Waterthrush	Seiurus noveboracensis
McGillivray's Warbler	Oporornis tolmiei
Common Yellowthroat	Geothlypis trichas
Wilson's Warbler	Wilsonia pusilla
Yellow-breasted Chat	Icteria virens
Scarlet Tanager	Piranga olivacea
Western Tanager	Piranga ludoviciana
Rose-breasted Grosbeak	Pheucticus ludovicianus
Black-headed Grosbeak	Pheucticus melanocephalus
Blue Grosbeak	Guiraca caerulea
Lazuli Bunting	Passerina amoena
Indigo Bunting	Passerina cyanea
Dickissel	Spiza americana
Green-tailed Towhee	Pipilo chlorurus
Rufous-sided Towhee	Pipilo erythrophthalmus
Chipping Sparrow	Spizella passerina
Brewer's Sparrow	Spizella breweri
Vesper Sparrow	Pooecetes gramineus
Lark Sparrow	Chondestes grammacus
Lark Bunting	Calamospiza melanocorys
Savannah Sparrow	Passerculus sandwichensis
Grasshopper Sparrow	Ammodramus savannarum
Song Sparrow	Melospiza melodia
Lincoln's Sparrow	Melospiza lincolnii
White-crowned Sparrow	Zonothrichia leucophrys
Dark-eyed Junco	Junco hyemalis
Bobolink	Dolichonyx oryzivorus
Red-winged Blackbird	Agelaius phoeniceus
Western Meadowlark	Sturnella neglecta
Yellow-headed Blackbird	Xanthocephalus xanthocephalus
Brewer's Blackbird	Euphagus cyanocephalus
Common Grackle	Quiscalus quiscula
Brown-headed Cowbird	Molothrus ater

Table A1. Continued.

FAMILY COMMON NAME	SCIENTIFIC NAME
Northern Oriole	*Icterus galbula*
Fringillidae	
Pine Grosbeak	*Pinicola enucleator*
House Finch	*Carpodacus mexicanus*
Red Crossbill	*Loxia curvirostra*
Pine Siskin	*Carduelis pinus*
Lesser Goldfinch	*Carduelis psaltria*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
Passeridae	
House Sparrow	*Passer domesticus*

APPENDIX B

Raw 1986 data and statistical test results.

Table B1. Raw data printout for species richness of breeding birds sampled in major habitats on City of Boulder Open Space, spring 1986.

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

RIPARIAN SPECIES RICHNESS PLOT DATA

BR1.S86	BR2.S86	BR3.S86	BR4.S86	BR5.S86	BR6.S86	BR7.S86	BR8.S86
6.00	9.00	10.00	12.00	11.00	9.00	9.00	14.00
5.00	9.00	9.00	6.00	11.00	14.00	4.00	9.00
8.00	7.00	9.00	8.00	5.00	9.00	7.00	11.00
9.00	5.00	13.00	11.00	9.00	8.00	8.00	13.00
7.00	6.00	8.00	11.00	9.00	10.00	5.00	9.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

CONIFER SPECIES RICHNESS PLOT DATA

BC1.S86	BC2.S86	BC3.S86	BC4.S86	BC5.S86	BC6.S86	BC7.S86	BC8.S86
6.00	9.00	8.00	5.00	5.00	8.00	6.00	8.00
6.00	11.00	6.00	4.00	3.00	6.00	5.00	3.00
7.00	8.00	4.00	5.00	5.00	4.00	7.00	1.00
5.00	8.00	7.00	2.00	6.00	5.00	5.00	4.00
5.00	9.00	4.00	3.00	4.00	6.00	5.00	4.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

MOUNTAIN SHRUB SPECIES RICHNESS PLOT DATA

BM1.S86	BM2.S86	BM3.S86	BM4.S86	BM5.S86	BM6.S86	BM7.S86	BM8.S86
7.00	4.00	10.00	9.00	7.00	10.00	6.00	5.00
5.00	9.00	8.00	8.00	4.00	5.00	7.00	4.00
7.00	7.00	6.00	4.00	9.00	7.00	5.00	8.00
4.00	5.00	5.00	5.00	7.00	7.00	5.00	7.00
4.00	6.00	6.00	8.00	2.00	4.00	3.00	3.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

GRASSLAND SPECIES RICHNESS PLOT DATA

BG1.S86	BG2.S86	BG3.S86	BG4.S86	BG5.S86	BG6.S86	BG7.S86	BG8.S86
3.00	3.00	3.00	2.00	2.00	4.00	4.00	2.00
5.00	5.00	5.00	3.00	2.00	3.00	1.00	2.00
2.00	1.00	2.00	3.00	3.00	3.00	4.00	3.00
3.00	4.00	2.00	3.00	3.00	2.00	2.00	2.00
1.00	1.00	1.00	2.00	2.00	5.00	1.00	3.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

AGRICULTURAL GRASSLAND SPECIES RICHNESS PLOT DATA

BP1.S86	BP2.S86	BP3.S86	BP4.S86	BP5.S86	BP6.S86	BP7.S86	BP8.S86
6.00	3.00	3.00	2.00	2.00	9.00	2.00	9.00
8.00	4.00	3.00	3.00	4.00	6.00	4.00	7.00
6.00	6.00	4.00	5.00	5.00	6.00	5.00	7.00
6.00	4.00	6.00	3.00	3.00	6.00	6.00	5.00
5.00	8.00	4.00	5.00	4.00	7.00	4.00	7.00

Table B2. Results of two-level nested analysis of variance test examining differences in breeding species richness between and within major Open Space habitats.

06-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

1986 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	772.0005	4	193.0001	23.94765	53.95401 %
AMONG SUBGROUPS	282.0737	35	8.05925	2.762378	12.00028 %
WITHIN GROUPS (ERROR)	466.8008	160	2.917505		34.04571 %
TOTAL	1520.875	199			

NO TRANSFORMATION

Table B3. Species richness means, standard errors, and coefficients of variation of the mean for breeding birds in habitats (group 1 = riparian = R; group 2 = conifer = C; group 3 = mountain shrub = M; group 4 = grassland = G; and group 5 = agricultural grassland = P).

06-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

1986 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	8.8	.3958113	40	4.497856
GROUP 2	5.55	.3241359	40	5.840287
GROUP 3	6.05	.3140921	40	5.191605
GROUP 4	2.675	.1839297	40	6.875876
GROUP 5	5.05	.2929733	40	5.801451

Table B4. 1986 Species richness means, standard errors, and coefficients of variation of the mean for breeding birds in plots.

06-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

1986 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SUBGROUP BREAKDOWNS

FILE	MEAN +/-	SE	n	CVM(%)
BR1.S86	7	.7071068	5	10.10153
BR2.S86	7.2	.7999996	5	11.11111
BR3.S86	9.8	.8602322	5	8.777879
BR4.S86	9.600001	1.122498	5	11.69268
BR5.S86	9	1.095445	5	12.17161
BR6.S86	10	1.048809	5	10.48809
BR7.S86	6.6	.9273618	5	14.05094
BR8.S86	11.2	1.019804	5	9.105389
BC1.S86	5.8	.374166	5	6.451137
BC2.S86	9	.5477226	5	6.085807
BC3.S86	5.8	.8000001	5	13.79311
BC4.S86	3.8	.5830953	5	15.34461
BC5.S86	4.6	.5099018	5	11.08482
BC6.S86	5.8	.6633251	5	11.43664
BC7.S86	5.6	.3999998	5	7.142854
BC8.S86	4	1.140176	5	28.50439
BM1.S86	5.4	.678233	5	12.55987
BM2.S86	6.2	.8602326	5	13.87472
BM3.S86	7	.8944272	5	12.77753
BM4.S86	6.8	.969536	5	14.25788
BM5.S86	5.8	1.240967	5	21.39599
BM6.S86	6.6	1.029563	5	15.59944
BM7.S86	5.2	.6633251	5	12.75625
BM8.S86	5.4	.9273618	5	17.17337
BG1.S86	2.8	.663325	5	23.69018
BG2.S86	2.8	.8	5	28.57143
BG3.S86	2.6	.678233	5	26.08589
BG4.S86	2.6	.2449491	5	9.421118
BG5.S86	2.4	.2449491	5	10.20621
BG6.S86	3.4	.509902	5	14.99712
BG7.S86	2.4	.678233	5	28.25971
BG8.S86	2.4	.2449491	5	10.20621
BP1.S86	6.2	.4898981	5	7.901583
BP2.S86	5	.8944272	5	17.88854
BP3.S86	4	.5477226	5	13.69307
BP4.S86	3.6	.5999999	5	16.66666
BP5.S86	3.6	.5099018	5	14.16394
BP6.S86	6.8	.5830953	5	8.57493
BP7.S86	4.2	.6633251	5	15.79346
BP8.S86	7	.6324555	5	9.035079

Table B5. Student-Newman-Keuls test results for 1986 breeding species richness sampled in grassland (group 1), agricultural grassland (group 2), mountain shrub (group 3), conifer (group 4), and riparian (group 5) habitats.

06-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	2.675	8.8	BR.S86
2	5.05	5.55	BC.S86
3	5.55	6.05	BM.S86
4	6.05	2.675	BG.S86
5	8.8	5.05	BP.S86

CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 13.64545
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = 8.354354
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = 7.240441
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = 6.126526
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 7.518919
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = 2.227828
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = 1.113915
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 6.405005
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 1.113913
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 5.291092

NUMBER OF MEANS COMPARED = 5 ERROR DF = 35

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (5) IS THE COLUMN STARTING POINT.
THE ERROR DF (35) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

06-10-1986

********** LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS **********

1986 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 35
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) 0 ? 2.030,0.05

LSD = 1.288634 t-value = 2.03 α = .05

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y

```
ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 =  35
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05  ) .05 ? 2.030,0.05

LSD =  1.288634              t-value =  2.03              α =  .05


DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? N


ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE
SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.
```

Table B6. Raw data printout for density (n/2ha) of breeding birds sampled in riparian (R), conifer (C), mountain shrub (M), grassland (G), and agricultural grassland (P) plots on City of Boulder Open Space, spring 1986.

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

RIPARIAN PLOT DENSITY DATA

BR1.D86	BR2.D86	BR3.D86	BR4.D86	BR5.D86	BR6.D86	BR7.D86	BR8.D86
11.00	20.00	29.00	17.00	42.00	17.00	12.00	34.00
10.00	23.00	19.00	20.00	29.00	24.00	10.00	19.00
17.00	16.00	23.00	16.00	25.00	16.00	13.00	26.00
13.00	19.00	32.00	19.00	28.00	12.00	11.00	19.00
25.00	17.00	19.00	32.00	27.00	16.00	6.00	13.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

CONIFER PLOT DENSITY DATA

BC1.D86	BC2.D86	BC3.D86	BC4.D86	BC5.D86	BC6.D86	BC7.D86	BC8.D86
13.00	16.00	16.00	7.00	17.00	13.00	8.00	15.00
14.00	22.00	10.00	4.00	5.00	10.00	7.00	3.00
13.00	13.00	5.00	8.00	6.00	4.00	9.00	1.00
7.00	19.00	16.00	3.00	9.00	8.00	6.00	4.00
11.00	16.00	6.00	4.00	9.00	10.00	7.00	7.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

MOUNTAIN SHRUB PLOT DENSITY DATA

BM1.D86	BM2.D86	BM3.D86	BM4.D86	BM5.D86	BM6.D86	BM7.D86	BM8.D86
12.00	10.00	22.00	17.00	12.00	18.00	16.00	11.00
6.00	23.00	15.00	15.00	10.00	8.00	11.00	9.00
10.00	10.00	9.00	5.00	18.00	10.00	7.00	18.00
5.00	9.00	12.00	7.00	15.00	10.00	10.00	16.00
7.00	8.00	15.00	10.00	4.00	9.00	5.00	7.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

GRASSLAND PLOT DENSITY DATA

BG1.D86	BG2.D86	BG3.D86	BG4.D86	BG5.D86	BG6.D86	BG7.D86	BG8.D86
10.00	5.00	3.00	5.00	4.00	10.00	11.00	4.00
9.00	12.00	7.00	5.00	4.00	7.00	4.00	3.00
6.00	1.00	5.00	5.00	4.00	13.00	6.00	6.00
4.00	5.00	5.00	5.00	6.00	5.00	5.00	4.00
2.00	1.00	4.00	6.00	4.00	14.00	4.00	8.00

RAW DATA PRINTOUT 06-10-1986 R.W.THOMPSON

AGRICULTURAL GRASSLAND PLOT DENSITY DATA

BP1.D86	BP2.D86	BP3.D86	BP4.D86	BP5.D86	BP6.D86	BP7.D86	BP8.D86
18.00	3.00	5.00	3.00	2.00	26.00	5.00	31.00
20.00	8.00	10.00	7.00	7.00	35.00	6.00	17.00
20.00	8.00	9.00	25.00	31.00	34.00	12.00	24.00
22.00	6.00	11.00	5.00	6.00	31.00	16.00	32.00
30.00	12.00	5.00	8.00	18.00	21.00	7.00	15.00

Table B7. Results of two-level nested analysis of variance test examining differences in 1986 breeding species density between and within major Open Space habitats.

06-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

1986 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	4717	4	1179.25	9.080548	36.43001 %
AMONG SUBGROUPS	4545.293	35	129.8655	5.245493	29.19108 %
WITHIN GROUPS (ERROR)	3961.207	160	24.75754		34.37892 %
TOTAL	13223.5	199			

NO TRANSFORMATION

Table B8. Means, standard errors, and coefficients of variation of the mean for breeding species density (n/2ha) in 1986 habitats (group 1 = riparian = R; group 2 = conifer = C; group 3 = mountain shrub = m; group 4 = grassland = G; group 5 = agricultural grassland = P).

06-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

1986 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

GROUP BREAKDOWNS

GROUP NO.	MEAN +/-	SE	n	CUM(%)
GROUP 1	19.9	1.214654	40	6.103789
GROUP 2	9.524999	.7877163	40	8.269987
GROUP 3	11.275	.7381435	40	6.546728
GROUP 4	5.775	.4756743	40	8.236783
GROUP 5	15.275	1.608068	40	10.52745

Table B9. Basic statistics for breeding species density in 1986 plots.

06-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

1986 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SUBGROUP BREAKDOWNS

FILE	MEAN +/-	SE	n	CUM(%)
BR1.D86	15.2	2.727637	5	17.94498
BR2.D86	19	1.224745	5	6.446026
BR3.D86	24.4	2.638181	5	10.81222
BR4.D86	20.8	2.887906	5	13.88417
BR5.D86	30.2	3.023242	5	10.01073
BR6.D86	17	1.949359	5	11.46682
BR7.D86	10.4	1.208305	5	11.61832
BR8.D86	22.2	3.597221	5	16.2037
BC1.D86	11.6	1.249	5	10.76724
BC2.D86	17.2	1.529707	5	8.893643
BC3.D86	10.6	2.357965	5	22.24495
BC4.D86	5.2	.969536	5	18.64492
BC5.D86	9.2	2.107131	5	22.90359
BC6.D86	9	1.48324	5	16.48044
BC7.D86	7.4	.5099026	5	6.890575
BC8.D86	6	2.44949	5	40.82483
BM1.D86	8	1.30384	5	16.298
BM2.D86	12	2.774887	5	23.12406
BM3.D86	14.6	2.158703	5	14.78563
BM4.D86	10.8	2.289105	5	21.19541
BM5.D86	11.8	2.374869	5	20.126
BM6.D86	11	1.788854	5	16.26231
BM7.D86	9.8	1.881489	5	19.19886
BM7.D86	9.8	1.881489	5	19.19886
BM8.D86	12.2	2.083267	5	17.07596
BG1.D86	6.2	1.496663	5	24.13973
BG2.D86	4.8	2.009975	5	41.87448
BG3.D86	4.8	.6633251	5	13.81927
BG4.D86	5.2	.2000004	5	3.846161
BG5.D86	4.4	.3999998	5	9.090904
BG6.D86	9.8	1.714643	5	17.49635
BG7.D86	6	1.30384	5	21.73067
BG8.D86	5	.8944272	5	17.88854
BP1.D86	22	2.097618	5	9.534626
BP2.D86	7.4	1.469694	5	19.86073
BP3.D86	8	1.264911	5	15.81139
BP4.D86	9.600001	3.944617	5	41.08976
BP5.D86	12.8	5.266878	5	41.14749
BP6.D86	29.4	2.619162	5	8.908713
BP7.D86	9.2	2.083267	5	22.6442
BP8.D86	23.8	3.484251	5	14.63971

Table B10. Student-Newman-Keuls test results for 1986 breeding species density (n/2ha) in grassland (group 1), mountain shrub (group 2), agricultural grassland (group 3), conifer (group 4), and riparian (group 5) habitats.

06-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	5.775	19.9	BR.D86
2	9.525001	9.525001	BC.D86
3	11.275	11.275	BM.D86
4	15.275	5.775	BG.D86
5	19.9	15.275	BP.D86

CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 7.839189
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = 5.757988
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = 4.786761
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = 2.566813
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 5.272376
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = 3.191174
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = 2.219948
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 3.052428
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .9712265
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 2.081201

NUMBER OF MEANS COMPARED = 5 ERROR DF = 35

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (5) IS THE COLUMN STARTING POINT.
THE ERROR DF (35) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

06-10-1986

********** LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS **********

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 35
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) 0 ? 2.030, 0.05

LSD = 5.172831 t-value = 2.03 α = .05

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y

06-10-1986

********** LEAST SIGNIFICANT DIFFERENCE <LSD> TEST RESULTS **********

ENTER t-value <FROM p. 413-414 of Zar> FOR DF2 = 35
THEN ALPHA <2> LEVEL <e.g., 2.037,0.05 > .1 ? 1.690,0.1

LSD = 4.306446 t-value = 1.69 α = .1

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? <Y/RETURN> ? N

ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.

Table B11. One-way analysis of variance results testing for differences in 1986 breeding species richness between 2 mountain shrub plots on the Ertl parcel (BM2.S86 and BM4.S86) and the 6 other mountain shrub plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

SINGLE FACTOR ANALYSIS OF VARIANCE   ANOVA.   R. W. THOMPSON

1986 SPECIES RICHNESS - ERTL vs NONERTL MOUNTAIN SHRUB

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	17.1001	7	2.442871	.5714321	7.894676 %
WITHIN GROUPS	136.7999	32	4.274998		92.10532 %
TOTAL	153.9	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BM1.S86	MEAN+/-SE(n)=	5.4 +/- .678233 (5)	CUM= 12.55987 %
BM2.S86	MEAN+/-SE(n)=	6.2 +/- .8602326 (5)	CUM= 13.87472 %
BM3.S86	MEAN+/-SE(n)=	7 +/- .8944272 (5)	CUM= 12.77753 %
BM4.S86	MEAN+/-SE(n)=	6.8 +/- .969536 (5)	CUM= 14.25788 %
BM5.S86	MEAN+/-SE(n)=	5.8 +/- 1.240967 (5)	CUM= 21.39599 %
BM6.S86	MEAN+/-SE(n)=	6.6 +/- 1.029563 (5)	CUM= 15.59944 %
BM7.S86	MEAN+/-SE(n)=	5.2 +/- .6633251 (5)	CUM= 12.75625 %
BM8.S86	MEAN+/-SE(n)=	5.4 +/- .9273618 (5)	CUM= 17.17337 %

Table B12. Student-Newman-Keuls and least significant difference test results for 1986 breeding species richness between 2 mountain shrub plots on the Ertl parcel (ranked means 2 and 4; unranked means file names BM2.S86 and BM4.S86) and the 6 other mountain shrub plots on Open Space.

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********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 SPECIES RICHNESS - ERTL vs NONERTL MOUNTAIN SHRUB


          RANKED MEANS          UNRANKED MEANS          FILENAME
          ------------          --------------          ------------

1            5.2                    5.4                  BM1.S86
2            5.4                    6.2                  BM2.S86
3            5.4                    7                    BM3.S86
4            5.8                    6.8                  BM4.S86
5            6.2                    5.8                  BM5.S86
6            6.6                    6.6                  BM6.S86
7            6.8                    5.2                  BM7.S86
8            7                      5.4                  BM8.S86

CALCULATED Q VALUE FOR COMPARISON:    8 vs 1    Q' =  1.946658
CALCULATED Q VALUE FOR COMPARISON:    8 vs 2    Q' =  1.730362
CALCULATED Q VALUE FOR COMPARISON:    8 vs 3    Q' =  1.730362
CALCULATED Q VALUE FOR COMPARISON:    8 vs 4    Q' =  1.297772
CALCULATED Q VALUE FOR COMPARISON:    8 vs 5    Q' =  .8651813
CALCULATED Q VALUE FOR COMPARISON:    8 vs 6    Q' =  .4325907
CALCULATED Q VALUE FOR COMPARISON:    8 vs 7    Q' =  .2162951
CALCULATED Q VALUE FOR COMPARISON:    7 vs 1    Q' =  1.730363
CALCULATED Q VALUE FOR COMPARISON:    7 vs 2    Q' =  1.514067
CALCULATED Q VALUE FOR COMPARISON:    7 vs 3    Q' =  1.514067
CALCULATED Q VALUE FOR COMPARISON:    7 vs 4    Q' =  1.081477
CALCULATED Q VALUE FOR COMPARISON:    7 vs 5    Q' =  .6488863
CALCULATED Q VALUE FOR COMPARISON:    7 vs 6    Q' =  .2162956
CALCULATED Q VALUE FOR COMPARISON:    6 vs 1    Q' =  1.514067
CALCULATED Q VALUE FOR COMPARISON:    6 vs 2    Q' =  1.297772
CALCULATED Q VALUE FOR COMPARISON:    6 vs 3    Q' =  1.297772
CALCULATED Q VALUE FOR COMPARISON:    6 vs 4    Q' =  .8651808

CALCULATED Q VALUE FOR COMPARISON:    6 vs 5    Q' =  .4325907
CALCULATED Q VALUE FOR COMPARISON:    5 vs 1    Q' =  1.081477
CALCULATED Q VALUE FOR COMPARISON:    5 vs 2    Q' =  .8651808
CALCULATED Q VALUE FOR COMPARISON:    5 vs 3    Q' =  .8651808
CALCULATED Q VALUE FOR COMPARISON:    5 vs 4    Q' =  .4325902
CALCULATED Q VALUE FOR COMPARISON:    4 vs 1    Q' =  .6488863
CALCULATED Q VALUE FOR COMPARISON:    4 vs 2    Q' =  .4325907
CALCULATED Q VALUE FOR COMPARISON:    4 vs 3    Q' =  .4325907
CALCULATED Q VALUE FOR COMPARISON:    3 vs 1    Q' =  .2162956
CALCULATED Q VALUE FOR COMPARISON:    3 vs 2    Q' =  0
CALCULATED Q VALUE FOR COMPARISON:    2 vs 1    Q' =  .2162956

NUMBER OF MEANS COMPARED =  8     ERROR DF =  32

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS ( 8 ) IS THE COLUMN STARTING POINT.
THE ERROR DF ( 32 ) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.
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06-10-1986

********** LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS **********

1986 SPECIES RICHNESS - ERTL vs NONERTL MOUNTAIN SHRUB

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) 0 ? 2.037,0.05

LSD = 2.663723   t-value = 2.037   α = .05

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) .05 ? 1.694,0.1

LSD = 2.215192   t-value = 1.694   α = .1

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? N

ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.

Table B13. One-way analysis of variance results testing for differences in 1986 breeding species density between 2 mountain shrub plots on the Ertl parcel (BM2.D86 and BM4.D86) and the 6 other mountain shrub plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

06-10-1986

SINGLE FACTOR ANALYSIS OF VARIANCE   ANOVA.   R. W. THOMPSON

1986 DENSITY - ERTL vs NONERTL MOUNTAIN SHRUB

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	129.5752	7	18.51074	.822243	3.43309 %
WITHIN GROUPS	720.3999	32	22.5125		96.56691 %
TOTAL	849.9751	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BM1.D86	MEAN+/-SE(n)=	8 +/- 1.30384 (5)	CVM= 16.298 %
BM2.D86	MEAN+/-SE(n)=	12 +/- 2.774887 (5)	CVM= 23.12406 %
BM3.D86	MEAN+/-SE(n)=	14.6 +/- 2.158703 (5)	CVM= 14.78563 %
BM4.D86	MEAN+/-SE(n)=	10.8 +/- 2.289105 (5)	CVM= 21.19541 %
BM5.D86	MEAN+/-SE(n)=	11.8 +/- 2.374869 (5)	CVM= 20.126 %
BM6.D86	MEAN+/-SE(n)=	11 +/- 1.788854 (5)	CVM= 16.26231 %
BM7.D86	MEAN+/-SE(n)=	9.8 +/- 1.881489 (5)	CVM= 19.19886 %
BM8.D86	MEAN+/-SE(n)=	12.2 +/- 2.083267 (5)	CVM= 17.07596 %

Table B14. Student-Newman-Keuls and least significant difference test results for 1986 breeding species density (n/2ha) between 2 mountain shrub plots on the Ertl parcel (ranked means 2 and 5; unranked means file names BM2.D86 and BM4.D86) and the 6 other mountain shrub plots on Open Space.

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 DENSITY - ERTL vs NONERTL MOUNTAIN SHRUB

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	8	8	BM1.D86
2	9.8	12	BM2.D86
3	10.8	14.6	BM3.D86
4	11	10.8	BM4.D86
5	11.8	11.8	BM5.D86
6	12	11	BM6.D86
7	12.2	9.8	BM7.D86
8	14.6	12.2	BM8.D86

CALCULATED Q VALUE FOR COMPARISON: 8 vs 1 Q' = 3.110407
CALCULATED Q VALUE FOR COMPARISON: 8 vs 2 Q' = 2.262114
CALCULATED Q VALUE FOR COMPARISON: 8 vs 3 Q' = 1.79084
CALCULATED Q VALUE FOR COMPARISON: 8 vs 4 Q' = 1.696585
CALCULATED Q VALUE FOR COMPARISON: 8 vs 5 Q' = 1.319566
CALCULATED Q VALUE FOR COMPARISON: 8 vs 6 Q' = 1.225312
CALCULATED Q VALUE FOR COMPARISON: 8 vs 7 Q' = 1.131057
CALCULATED Q VALUE FOR COMPARISON: 7 vs 1 Q' = 1.979349
CALCULATED Q VALUE FOR COMPARISON: 7 vs 2 Q' = 1.131057
CALCULATED Q VALUE FOR COMPARISON: 7 vs 3 Q' = .659783
CALCULATED Q VALUE FOR COMPARISON: 7 vs 4 Q' = .5655283
CALCULATED Q VALUE FOR COMPARISON: 7 vs 5 Q' = .1885093
CALCULATED Q VALUE FOR COMPARISON: 7 vs 6 Q' = 9.425464E-02
CALCULATED Q VALUE FOR COMPARISON: 6 vs 1 Q' = 1.885095
CALCULATED Q VALUE FOR COMPARISON: 6 vs 2 Q' = 1.036802
CALCULATED Q VALUE FOR COMPARISON: 6 vs 3 Q' = .5655283
CALCULATED Q VALUE FOR COMPARISON: 6 vs 4 Q' = .4712737
CALCULATED Q VALUE FOR COMPARISON: 6 vs 5 Q' = 9.425464E-02

CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 1.79084
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = .9425473
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = .4712737
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = .377019
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 1.413821
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = .5655283
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = 9.425464E-02
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 1.319566
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .4712737
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = .8482926

NUMBER OF MEANS COMPARED = 8 ERROR DF = 32

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (8) IS THE COLUMN STARTING POINT.
THE ERROR DF (32) IS THE ROW.

COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).
Ok CULATED Q VALUE FOR COMPARISON:
IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

06-10-1986

********** LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS **********

1986 DENSITY - ERTL vs NONERTL MOUNTAIN SHRUB PLOTS

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) 0 ? 2.037,0.05

LSD = 6.112697 t-value = 2.037 α = .05

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) .05 ? 1.694,0.1

LSD = 5.083411 t-value = 1.694 α = .1

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? N

ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE
SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.

Table B15. One-way analysis of variance results testing for differences in 1986 breeding species richness between 2 riparian plots in the Cottonwood Grove (BR2.S86 and BR4.S86) and the 6 other riparian plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

06-10-1986

SINGLE FACTOR ANALYSIS OF VARIANCE   ANOVA.   R. W. THOMPSON

1986 SPECIES RICHNESS - COTTONWOOD GROVE vs OTHER RIPARIAN HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	97.59986	7	13.94284	3.039309	28.9703 %
WITHIN GROUPS	146.8001	32	4.587502		71.0297 %
TOTAL	244.3999	39			

NO TRANSFORMATION

BR1.S86.   MEAN+/-SE(n)= 7 +/- .7071068 (5)   CUM= 10.10153 %

BR2.S86   MEAN+/-SE(n)= 7.2 +/- .7999996 (5)   CUM= 11.11111 %

BR3.S86   MEAN+/-SE(n)= 9.8 +/- .8602322 (5)   CUM= 8.777879 %

BR4.S86   MEAN+/-SE(n)= 9.600001 +/- 1.122498 (5)   CUM=
11.69268 %

BR5.S86   MEAN+/-SE(n)= 9 +/- 1.095445 (5)   CUM= 12.17161 %

BR6.S86   MEAN+/-SE(n)= 10 +/- 1.048809 (5)   CUM= 10.48809 %

BR7.S86   MEAN+/-SE(n)= 6.6 +/- .9273618 (5)   CUM= 14.05094 %

BR8.S86   MEAN+/-SE(n)= 11.2 +/- 1.019804 (5)   CUM= 9.105389 %

Table B16. Student-Newman-Keuls and least significant difference test results for 1986 breeding species richness between 2 riparian plots in the Cottonwood Grove (ranked means 2 and 4; unranked means file names BR2.S86 and BR4.S86) and the 6 other riparian plots on Open Space.

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 SPECIES RICHNESS - COTTONWOOD GROVE vs OTHER RIPARIAN HABITATS

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	6.6	7	BR1.S86
2	7	7.2	BR2.S86
3	7.2	9.8	BR3.S86
4	9	9.600001	BR4.S86
5	9.600001	9	BR5.S86
6	9.8	10	BR6.S86
7	10	6.6	BR7.S86
8	11.2	11.2	BR8.S86

CALCULATED Q VALUE FOR COMPARISON:	8 vs 1	Q' = 4.80236
CALCULATED Q VALUE FOR COMPARISON:	8 vs 2	Q' = 4.384763
CALCULATED Q VALUE FOR COMPARISON:	8 vs 3	Q' = 4.175965
CALCULATED Q VALUE FOR COMPARISON:	8 vs 4	Q' = 2.296781
CALCULATED Q VALUE FOR COMPARISON:	8 vs 5	Q' = 1.670386
CALCULATED Q VALUE FOR COMPARISON:	8 vs 6	Q' = 1.461587
CALCULATED Q VALUE FOR COMPARISON:	8 vs 7	Q' = 1.252789
CALCULATED Q VALUE FOR COMPARISON:	7 vs 1	Q' = 3.549571
CALCULATED Q VALUE FOR COMPARISON:	7 vs 2	Q' = 3.131974
CALCULATED Q VALUE FOR COMPARISON:	7 vs 3	Q' = 2.923176
CALCULATED Q VALUE FOR COMPARISON:	7 vs 4	Q' = 1.043991
CALCULATED Q VALUE FOR COMPARISON:	7 vs 5	Q' = .4175961
CALCULATED Q VALUE FOR COMPARISON:	7 vs 6	Q' = .2087981
CALCULATED Q VALUE FOR COMPARISON:	6 vs 1	Q' = 3.340773
CALCULATED Q VALUE FOR COMPARISON:	6 vs 2	Q' = 2.923176
CALCULATED Q VALUE FOR COMPARISON:	6 vs 3	Q' = 2.714378
CALCULATED Q VALUE FOR COMPARISON:	6 vs 4	Q' = .8351933
CALCULATED Q VALUE FOR COMPARISON:	6 vs 5	Q' = .2087981
CALCULATED Q VALUE FOR COMPARISON:	5 vs 1	Q' = 3.131975
CALCULATED Q VALUE FOR COMPARISON:	5 vs 2	Q' = 2.714378
CALCULATED Q VALUE FOR COMPARISON:	5 vs 3	Q' = 2.50558
CALCULATED Q VALUE FOR COMPARISON:	5 vs 4	Q' = .6263952
CALCULATED Q VALUE FOR COMPARISON:	4 vs 1	Q' = 2.505579
CALCULATED Q VALUE FOR COMPARISON:	4 vs 2	Q' = 2.087983
CALCULATED Q VALUE FOR COMPARISON:	4 vs 3	Q' = 1.879185
CALCULATED Q VALUE FOR COMPARISON:	3 vs 1	Q' = .6263947
CALCULATED Q VALUE FOR COMPARISON:	3 vs 2	Q' = .2087981
CALCULATED Q VALUE FOR COMPARISON:	2 vs 1	Q' = .4175967

NUMBER OF MEANS COMPARED = 8 ERROR DF = 32

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (8) IS THE COLUMN STARTING POINT.
THE ERROR DF (32) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

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06-10-1986

     **********  LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS  **********

1986 SPECIES RICHNESS - COTTONWOOD GROVE vs OTHER RIPARIAN HABITATS


ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 =  32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05   ) 0 ? 2.037,0.05

LSD =  2.759365              t-value =  2.037              α =  .05


DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y


ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 =  32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05   ) .05 ? 1.694,0.1


LSD =  2.29473               t-value =  1.694              α =  .1


DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? N


ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE
SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.
```

Table B17. One-way analysis of variance results testing for differences in 1986 breeding species density between 2 riparian plots in the Cottonwood Grove (BR2.D86 and BR4.D86) and the 6 other riparian plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

06-10-1986

SINGLE FACTOR ANALYSIS OF VARIANCE ANOVA. R. W. THOMPSON

1986 DENSITY - COTTONWOOD GROVE vs OTHER RIPARIAN HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	1270	7	181.4286	5.627876	48.06747 %
WITHIN GROUPS	1031.6	32	32.23749		51.93254 %
TOTAL	2301.6	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BR1.D86	MEAN+/-SE(n)=	15.2 +/- 2.727637 (5)	CUM= 17.94498 %
BR2.D86	MEAN+/-SE(n)=	19 +/- 1.224745 (5)	CUM= 6.446026 %
BR3.D86	MEAN+/-SE(n)=	24.4 +/- 2.638181 (5)	CUM= 10.81222 %
BR4.D86	MEAN+/-SE(n)=	20.8 +/- 2.887906 (5)	CUM= 13.88417 %
BR5.D86	MEAN+/-SE(n)=	30.2 +/- 3.023242 (5)	CUM= 10.01073 %
BR6.D86	MEAN+/-SE(n)=	17 +/- 1.949359 (5)	CUM= 11.46682 %
BR7.D86	MEAN+/-SE(n)=	10.4 +/- 1.208305 (5)	CUM= 11.61832 %
BR8.D86	MEAN+/-SE(n)=	22.2 +/- 3.597221 (5)	CUM= 16.2037 %

Table B18. Student-Newman-Keuls and least significant difference test results for 1986 breeding species density between 2 riparian plots in the Cottonwood Grove (ranked means 2 and 4; unranked means file names BR2.D86 and BR4.D86) and the 6 other riparian plots on Open Space.

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********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 DENSITY - COTTONWOOD GROVE vs OTHER RIPARIAN HABITATS

            RANKED MEANS      UNRANKED MEANS      FILENAME
            ------------      --------------      ------------

1           10.4              15.2                BR1.D86
2           15.2              19                  BR2.D86
3           17                24.4                BR3.D86
4           19                20.8                BR4.D86
5           20.8              30.2                BR5.D86
6           22.2              17                  BR6.D86
7           24.4              10.4                BR7.D86
8           30.2              22.2                BR8.D86

CALCULATED Q VALUE FOR COMPARISON:   8 vs 1   Q' =  7.797756
CALCULATED Q VALUE FOR COMPARISON:   8 vs 2   Q' =  5.907391
CALCULATED Q VALUE FOR COMPARISON:   8 vs 3   Q' =  5.198504
CALCULATED Q VALUE FOR COMPARISON:   8 vs 4   Q' =  4.410852
CALCULATED Q VALUE FOR COMPARISON:   8 vs 5   Q' =  3.701965
CALCULATED Q VALUE FOR COMPARISON:   8 vs 6   Q' =  3.150608
CALCULATED Q VALUE FOR COMPARISON:   8 vs 7   Q' =  2.284191
CALCULATED Q VALUE FOR COMPARISON:   7 vs 1   Q' =  5.513565
CALCULATED Q VALUE FOR COMPARISON:   7 vs 2   Q' =  3.6232
CALCULATED Q VALUE FOR COMPARISON:   7 vs 3   Q' =  2.914313
CALCULATED Q VALUE FOR COMPARISON:   7 vs 4   Q' =  2.12666
CALCULATED Q VALUE FOR COMPARISON:   7 vs 5   Q' =  1.417774
CALCULATED Q VALUE FOR COMPARISON:   7 vs 6   Q' =  .8664168
CALCULATED Q VALUE FOR COMPARISON:   6 vs 1   Q' =  4.647148
CALCULATED Q VALUE FOR COMPARISON:   6 vs 2   Q' =  2.756783
CALCULATED Q VALUE FOR COMPARISON:   6 vs 3   Q' =  2.047896
CALCULATED Q VALUE FOR COMPARISON:   6 vs 4   Q' =  1.260244
CALCULATED Q VALUE FOR COMPARISON:   6 vs 5   Q' =  .551357
CALCULATED Q VALUE FOR COMPARISON:   5 vs 1   Q' =  4.095791
CALCULATED Q VALUE FOR COMPARISON:   5 vs 2   Q' =  2.205426
CALCULATED Q VALUE FOR COMPARISON:   5 vs 3   Q' =  1.496539
CALCULATED Q VALUE FOR COMPARISON:   5 vs 4   Q' =  .7088866
CALCULATED Q VALUE FOR COMPARISON:   4 vs 1   Q' =  3.386904
CALCULATED Q VALUE FOR COMPARISON:   4 vs 2   Q' =  1.496539
CALCULATED Q VALUE FOR COMPARISON:   4 vs 3   Q' =  .7876521
CALCULATED Q VALUE FOR COMPARISON:   3 vs 1   Q' =  2.599252
CALCULATED Q VALUE FOR COMPARISON:   3 vs 2   Q' =  .708887
CALCULATED Q VALUE FOR COMPARISON:   2 vs 1   Q' =  1.890365

NUMBER OF MEANS COMPARED =  8      ERROR DF =  32

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS ( 8 ) IS THE COLUMN STARTING POINT.
THE ERROR DF ( 32 ) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.
```

06-10-1986

********** LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS **********

1986 DENSITY - COTTONWOOD GROVE vs OTHER RIPARIAN HABITATS

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) 0 ? 2.037,0.05

LSD = 7.314787 t-value = 2.037 α = .05

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) .05 ? 1.694,0.1

LSD = 6.083087 t-value = 1.694 α = .1

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? N

ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.

Table B19. One-way analysis of variance results testing for differences in breeding species richness between 4 irrigated (BP1.S 86, BP5.S 86, BP6.S 86 and BP8.S 86) and 4 nonirrigated agricultural grassland plots. Means, standard errors, and coefficients of variation of the mean are provided below test results.

07-10-1986

SINGLE FACTOR ANALYSIS OF VARIANCE   ANOVA.   R. W. THOMPSON

1986 SPECIES RICHNESS - IRRIGATED vs NONIRRIGATED AGRICULTURAL GRASSLAND

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	71.09998	7	10.15714	5.175609	45.5077 %
WITHIN GROUPS	62.80005	32	1.962502		54.4923 %
TOTAL	133.9	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BP1.S86	MEAN+/-SE(n)=	6.2 +/- .4898981 (5)	CVM= 7.901583 %
BP2.S86	MEAN+/-SE(n)=	5 +/- .8944272 (5)	CVM= 17.88854 %
BP3.S86	MEAN+/-SE(n)=	4 +/- .5477226 (5)	CVM= 13.69307 %
BP4.S86	MEAN+/-SE(n)=	3.6 +/- .5999999 (5)	CVM= 16.66666 %
BP5.S86	MEAN+/-SE(n)=	3.6 +/- .5099018 (5)	CVM= 14.16394 %
BP6.S86	MEAN+/-SE(n)=	6.8 +/- .5830953 (5)	CVM= 8.57493 %
BP7.S86	MEAN+/-SE(n)=	4.2 +/- .6633251 (5)	CVM= 15.79346 %
BP8.S86	MEAN+/-SE(n)=	7 +/- .6324555 (5)	CVM= 9.035079 %

Table B20. Student-Newman-Keuls and least significant difference test results for 1986 breeding species richness between 4 irrigated (ranked means 2,6,7 and 8) and 4 nonirrigated agricultural grassland plots.

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 SPECIES RICHNESS - IRRIGATED vs NONIRRIGATED AGRICULTURAL GRASSLAND

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	3.6	6.2	BP1.S86
2	3.6	5	BP2.S86
3	4	4	BP3.S86
4	4.2	3.6	BP4.S86
5	5	3.6	BP5.S86
6	6.2	6.8	BP6.S86
7	6.8	4.2	BP7.S86
8	7	7	BP8.S86

CALCULATED Q VALUE FOR COMPARISON:	8 vs 1	Q' = 5.426989
CALCULATED Q VALUE FOR COMPARISON:	8 vs 2	Q' = 5.426989
CALCULATED Q VALUE FOR COMPARISON:	8 vs 3	Q' = 4.78852
CALCULATED Q VALUE FOR COMPARISON:	8 vs 4	Q' = 4.469285
CALCULATED Q VALUE FOR COMPARISON:	8 vs 5	Q' = 3.192346
CALCULATED Q VALUE FOR COMPARISON:	8 vs 6	Q' = 1.276939
CALCULATED Q VALUE FOR COMPARISON:	8 vs 7	Q' = .3192343
CALCULATED Q VALUE FOR COMPARISON:	7 vs 1	Q' = 5.107754
CALCULATED Q VALUE FOR COMPARISON:	7 vs 2	Q' = 5.107754
CALCULATED Q VALUE FOR COMPARISON:	7 vs 3	Q' = 4.469285
CALCULATED Q VALUE FOR COMPARISON:	7 vs 4	Q' = 4.150051
CALCULATED Q VALUE FOR COMPARISON:	7 vs 5	Q' = 2.873112
CALCULATED Q VALUE FOR COMPARISON:	7 vs 6	Q' = .9577045
CALCULATED Q VALUE FOR COMPARISON:	6 vs 1	Q' = 4.15005
CALCULATED Q VALUE FOR COMPARISON:	6 vs 2	Q' = 4.15005
CALCULATED Q VALUE FOR COMPARISON:	6 vs 3	Q' = 3.511581
CALCULATED Q VALUE FOR COMPARISON:	6 vs 4	Q' = 3.192346
CALCULATED Q VALUE FOR COMPARISON:	6 vs 5	Q' = 1.915407
CALCULATED Q VALUE FOR COMPARISON:	5 vs 1	Q' = 2.234643
CALCULATED Q VALUE FOR COMPARISON:	5 vs 2	Q' = 2.234643
CALCULATED Q VALUE FOR COMPARISON:	5 vs 3	Q' = 1.596173
CALCULATED Q VALUE FOR COMPARISON:	5 vs 4	Q' = 1.276939
CALCULATED Q VALUE FOR COMPARISON:	4 vs 1	Q' = .9577037
CALCULATED Q VALUE FOR COMPARISON:	4 vs 2	Q' = .9577037
CALCULATED Q VALUE FOR COMPARISON:	4 vs 3	Q' = .3192343
CALCULATED Q VALUE FOR COMPARISON:	3 vs 1	Q' = .6384694
CALCULATED Q VALUE FOR COMPARISON:	3 vs 2	Q' = .6384694
CALCULATED Q VALUE FOR COMPARISON:	2 vs 1	Q' = 0

NUMBER OF MEANS COMPARED = 8 ERROR DF = 32

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (8) IS THE COLUMN STARTING POINT.
THE ERROR DF (32) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

07-10-1986

********** LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS **********

1986 SPECIES RICHNESS - IRRIGATED vs NONIRRIGATED AGRICULTURAL GRASSLAND

```
ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 =  32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05   ) 0 ? 2.037,0.05

LSD =  1.804787              t-value =  2.037              α =  .05


DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y


ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 =  32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05   ) .05 ? 1.694,0.1


LSD =  1.500889              t-value =  1.694              α =  .1


DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? N
```

ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.

Table B21. One-way analysis of variance results testing for differences in breeding species density between 4 irrigated (BP1.D86, BP5.D86, BP6.D86 and BP8.D86) and 4 nonirrigated agricultural grassland plots. Means, standard errors, and coefficients of variation of the mean are provided below test results.

07-10-1986

SINGLE FACTOR ANALYSIS OF VARIANCE ANOVA. R. W. THOMPSON

1986 DENSITY - IRRIGATED vs NONIRRIGATED AGRICULTURAL GRASSLAND

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	2537.975	7	362.5678	7.755461	57.46658 %
WITHIN GROUPS	1496 .	32	46.75		42.53342 %
TOTAL	4033.975	39			

NO TRANSFORMATION

BP1.D86	MEAN+/-SE(n)=	22 +/- 2.097618 (5)	CUM= 9.534626 %
BP2.D86	MEAN+/-SE(n)=	7.4 +/- 1.469694 (5)	CUM= 19.86073 %
BP3.D86	MEAN+/-SE(n)=	8 +/- 1.264911 (5)	CUM= 15.81139 %
BP4.D86	MEAN+/-SE(n)=	9.600001 +/- 3.944617 (5)	CUM= 41.08976 %
BP5.D86	MEAN+/-SE(n)=	12.8 +/- 5.266878 (5)	CUM= 41.14749 %
BP6.D86	MEAN+/-SE(n)=	29.4 +/- 2.619162 (5)	CUM= 8.908713 %
BP7.D86	MEAN+/-SE(n)=	9.2 +/- 2.083267 (5)	CUM= 22.6442 %
BP8.D86	MEAN+/-SE(n)=	23.8 +/- 3.484251 (5)	CUM= 14.63971 %

Table B22. Student-Newman-Keuls and least significant difference test results for 1986 breeding species density between 4 irrigated (ranked means 5,6,7 and 8) and 4 nonirrigated agricultural grassland plots.

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

1986 DENSITY - IRRIGATED vs NONIRRIGATED AGRICULTURAL GRASSLAND

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	7.4	22	BP1.D86
2	8	7.4	BP2.D86
3	9.2	8	BP3.D86
4	9.600001	9.600001	BP4.D86
5	12.8	12.8	BP5.D86
6	22	29.4	BP6.D86
7	23.8	9.2	BP7.D86
8	29.4	23.8	BP8.D86

CALCULATED Q VALUE FOR COMPARISON:	8 vs 1	Q' =	7.19477
CALCULATED Q VALUE FOR COMPARISON:	8 vs 2	Q' =	6.998549
CALCULATED Q VALUE FOR COMPARISON:	8 vs 3	Q' =	6.606107
CALCULATED Q VALUE FOR COMPARISON:	8 vs 4	Q' =	6.475292
CALCULATED Q VALUE FOR COMPARISON:	8 vs 5	Q' =	5.42878
CALCULATED Q VALUE FOR COMPARISON:	8 vs 6	Q' =	2.420059
CALCULATED Q VALUE FOR COMPARISON:	8 vs 7	Q' =	1.831396
CALCULATED Q VALUE FOR COMPARISON:	7 vs 1	Q' =	5.363374
CALCULATED Q VALUE FOR COMPARISON:	7 vs 2	Q' =	5.167153
CALCULATED Q VALUE FOR COMPARISON:	7 vs 3	Q' =	4.774711
CALCULATED Q VALUE FOR COMPARISON:	7 vs 4	Q' =	4.643896
CALCULATED Q VALUE FOR COMPARISON:	7 vs 5	Q' =	3.597385
CALCULATED Q VALUE FOR COMPARISON:	7 vs 6	Q' =	.5886627
CALCULATED Q VALUE FOR COMPARISON:	6 vs 1	Q' =	4.774711
CALCULATED Q VALUE FOR COMPARISON:	6 vs 2	Q' =	4.57849
CALCULATED Q VALUE FOR COMPARISON:	6 vs 3	Q' =	4.186048
CALCULATED Q VALUE FOR COMPARISON:	6 vs 4	Q' =	4.055234
CALCULATED Q VALUE FOR COMPARISON:	6 vs 5	Q' =	3.008722
CALCULATED Q VALUE FOR COMPARISON:	5 vs 1	Q' =	1.765989
CALCULATED Q VALUE FOR COMPARISON:	5 vs 2	Q' =	1.569768
CALCULATED Q VALUE FOR COMPARISON:	5 vs 3	Q' =	1.177326
CALCULATED Q VALUE FOR COMPARISON:	5 vs 4	Q' =	1.046512
CALCULATED Q VALUE FOR COMPARISON:	4 vs 1	Q' =	.7194771
CALCULATED Q VALUE FOR COMPARISON:	4 vs 2	Q' =	.5232561
CALCULATED Q VALUE FOR COMPARISON:	4 vs 3	Q' =	.1308142
CALCULATED Q VALUE FOR COMPARISON:	3 vs 1	Q' =	.5886629
CALCULATED Q VALUE FOR COMPARISON:	3 vs 2	Q' =	.3924419
CALCULATED Q VALUE FOR COMPARISON:	2 vs 1	Q' =	.196221

NUMBER OF MEANS COMPARED = 8   ERROR DF = 32

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (8) IS THE COLUMN STARTING POINT.
THE ERROR DF (32) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

07-10-1986

********** LEAST SIGNIFICANT DIFFERENCE (LSD) TEST RESULTS **********

1986 DENSITY - IRRIGATED vs NONIRRIGATED AGRICULTURAL GRASSLAND

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) 9 ? 2.037,0.05

LSD = 8.808701 t-value = 2.037 α = .05

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? Y

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) .05 ? 1.694,0.1

LSD = 7.325449 t-value = 1.694 α = .1

DO YOU WANT AN LSD VALUE AT A DIFFERENT ALPHA-LEVEL? (Y/RETURN) ? N

ANY PAIR OF MEANS DIFFERING FROM EACH OTHER BY MORE THAN THE LSD VALUE ARE SIGNIFICANTLY DIFFERENT AT THE GIVEN ALPHA-LEVEL.

Table B23. Raw species richness data for breeding birds on 1984-86 riparian plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 RIPARIAN SPECIES RICHNESS PLOT DATA

BR1.S84	BR2.S84	BR3.S84	BR4.S84	BR5.S84	BR6.S84	BR7.S84	BR8.S84
5.00	9.00	15.00	7.00	6.00	6.00	5.00	14.00
9.00	7.00	11.00	8.00	11.00	11.00	6.00	11.00
5.00	8.00	13.00	8.00	9.00	12.00	8.00	11.00
9.00	10.00	13.00	7.00	8.00	10.00	9.00	9.00
11.00	7.00	8.00	5.00	9.00	6.00	6.00	14.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 RIPARIAN SPECIES RICHNESS PLOT DATA

BR1.S85	BR2.S85	BR3.S85	BR4.S85	BR5.S85	BR6.S85	BR7.S85	BR8.S85
5.00	6.00	8.00	8.00	7.00	11.00	8.00	14.00
10.00	10.00	16.00	13.00	13.00	15.00	5.00	10.00
12.00	7.00	10.00	9.00	10.00	13.00	9.00	13.00
7.00	7.00	13.00	7.00	8.00	12.00	7.00	12.00
9.00	5.00	12.00	7.00	8.00	10.00	5.00	7.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 RIPARIAN SPECIES RICHNESS PLOT DATA

BR1.S86	BR2.S86	BR3.S86	BR4.S86	BR5.S86	BR6.S86	BR7.S86	BR8.S86
6.00	9.00	10.00	12.00	11.00	9.00	9.00	14.00
5.00	9.00	9.00	6.00	11.00	14.00	4.00	9.00
8.00	7.00	9.00	8.00	5.00	9.00	7.00	11.00
9.00	5.00	13.00	11.00	9.00	8.00	8.00	13.00
7.00	6.00	8.00	11.00	9.00	10.00	5.00	9.00

Table B24. NANOVA results for species richness on 1984-86 riparian plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

RIPARIAN BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	9.799805	2	4.899903	.2647219	4.243057 %
AMONG SUBGROUPS	388.7022	21	18.50963	3.72366	33.76759 %
WITHIN GROUPS (ERROR)	477.1983	96	4.970815		61.98936 %
TOTAL	875.7002	119			

NO TRANSFORMATION

Table B25. Basic statistics for 1984-86 riparian species richness. Groups 1-3 represent years 1984-86, respectively.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

RIPARIAN BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN +/-	SE	n	CUM(%)
GROUP 1	8.899999	.4263742	40	4.790721
GROUP 2	9.45	.4654058	40	4.924928
GROUP 3	8.8	.3958113	40	4.497856

Table B26. Means, standard errors, and coefficients of variation of the mean for breeding species richness in 1984-86 riparian plots.

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

RIPARIAN BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CUM(%)
BR1.S84	7.8	1.2	5	15.38461
BR2.S84	8.2	.5830947	5	7.110911
BR3.S84	12	1.183216	5	9.860132
BR4.S84	7	.5477226	5	7.824608
BR5.S84	8.600001	.8124042	5	9.446561
BR6.S84	9	1.264911	5	14.05457
BR7.S84	6.8	.734847	5	10.80657
BR8.S84	11.8	.9695356	5	8.216403
BR1.S85	8.600001	1.208305	5	14.05006
BR2.S85	7	.83666	5	11.95229
BR3.S85	11.8	1.356466	5	11.49547
BR4.S85	8.8	1.113553	5	12.65401
BR5.S85	9.2	1.067708	5	11.60552
BR6.S85	12.2	.8602322	5	7.051084
BR7.S85	6.8	.8000001	5	11.76471
BR8.S85	11.2	1.240967	5	11.08006
BR1.S86	7	.7071068	5	10.10153
BR2.S86	7.2	.7999996	5	11.11111
BR3.S86	9.8	.8602322	5	8.777879
BR4.S86	9.600001	1.122498	5	11.69268
BR5.S86	9	1.095445	5	12.17161
BR6.S86	10	1.048809	5	10.48809
BR7.S86	6.6	.9273618	5	14.05094
BR8.S86	11.2	1.019804	5	9.105389

Table B27. SNK test results comparing riparian species richness between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

RIPARIAN BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	8.8	8.900001	BR.S84
2	8.900001	9.45	BR.S85
3	9.45	8.8	BR.S86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = .9555326
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .808527
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = .1470057

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (3) IS THE COLUMN STARTING POINT.
THE ERROR DF (21) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

Table B28. Raw species density data for breeding birds on 1984-86 riparian plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 RIPARIAN PLOT DENSITY DATA

BR1.D84	BR2.D84	BR3.D84	BR4.D84	BR5.D84	BR6.D84	BR7.D84	BR8.D84
10.00	13.00	32.00	19.00	28.00	7.00	7.00	27.00
11.00	18.00	42.00	19.00	30.00	15.00	7.00	33.00
12.00	20.00	33.00	17.00	36.00	17.00	16.00	19.00
14.00	21.00	27.00	16.00	27.00	18.00	12.00	46.00
24.00	19.00	19.00	30.00	23.00	11.00	8.00	28.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 RIPARIAN PLOT DENSITY DATA

BR1.D85	BR2.D85	BR3.D85	BR4.D85	BR5.D85	BR6.D85	BR7.D85	BR8.D85
21.00	18.00	15.00	16.00	28.00	20.00	14.00	27.00
20.00	20.00	25.00	27.00	43.00	25.00	5.00	27.00
21.00	14.00	19.00	19.00	31.00	28.00	13.00	36.00
8.00	19.00	27.00	18.00	26.00	20.00	9.00	20.00
15.00	11.00	21.00	11.00	28.00	19.00	17.00	19.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 RIPARIAN PLOT DENSITY DATA

BR1.D86	BR2.D86	BR3.D86	BR4.D86	BR5.D86	BR6.D86	BR7.D86	BR8.D86
11.00	20.00	29.00	17.00	42.00	17.00	12.00	34.00
10.00	23.00	19.00	20.00	29.00	24.00	10.00	19.00
17.00	16.00	23.00	16.00	25.00	16.00	13.00	26.00
13.00	19.00	32.00	19.00	28.00	12.00	11.00	19.00
25.00	17.00	19.00	32.00	27.00	16.00	6.00	13.00

Table B29. NANOVA results for species density on 1984-86 riparian plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE   NANOVA2.   R.W.THOMPSON

RIPARIAN BREEDING DENSITY - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	16.01172	2	8.00586	3.397128E-02	7.178257 %
AMONG SUBGROUPS	4948.977	21	235.6656	7.124286	51.10144 %
WITHIN GROUPS (ERROR)	3175.602	96	33.07918		41.72032 %
TOTAL	8140.59	119			

NO TRANSFORMATION

Table B30. Basic statistics for 1984-86 riparian species density. Groups 1-3 represent years 1984-86, respectively.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE   NANOVA2.   R.W.THOMPSON

RIPARIAN BREEDING DENSITY - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	20.775	1.516781	40	7.300992
GROUP 2	20.5	1.196683	40	5.83748
GROUP 3	19.9	1.214654	40	6.103789

Table B31. Means, standard errors, and coefficients of variation of the mean for breeding bird density in 1984-86 riparian plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

RIPARIAN BREEDING DENSITY - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CUM(%)
BR1.D84	14.2	2.537716	5	17.87124
BR2.D84	18.2	1.39284	5	7.652965
BR3.D84	30.6	3.776243	5	12.34066
BR4.D84	20.2	2.517936	5	12.46503
BR5.D84	28.8	2.130726	5	7.398352
BR6.D84	13.6	2.039608	5	14.99712
BR7.D84	10	1.760682	5	17.60682
BR8.D84	30.6	4.456457	5	14.56359
BR1.D85	17	2.50998	5	14.76459
BR2.D85	16.4	1.691153	5	10.31191
BR3.D85	21.4	2.135415	5	9.978575
BR4.D85	18.2	2.596151	5	14.26457
BR5.D85	31.2	3.05614	5	9.795319
BR6.D85	22.4	1.749285	5	7.809307
BR7.D85	11.6	2.088061	5	18.00053
BR8.D85	25.8	3.056142	5	11.84551
BR1.D86	15.2	2.727637	5	17.94498
BR2.D86	19	1.224745	5	6.446026
BR3.D86	24.4	2.638181	5	10.81222
BR4.D86	20.8	2.887906	5	13.88417
BR5.D86	30.2	3.023242	5	10.01073
BR6.D86	17	1.949359	5	11.46682
BR7.D86	10.4	1.208305	5	11.61832
BR8.D86	22.2	3.597221	5	16.2037

Table B32. SNK test results comparing riparian species density between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

RIPARIAN BREEDING DENSITY - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	19.9	20.775	BR.D84
2	20.5	20.5	BR.D85
3	20.775	19.9	BR.D86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = .360489
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .1132967
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = .2471923

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (3) IS THE COLUMN STARTING POINT.
THE ERROR DF (21) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

Table B33. Raw species richness data for breeding birds on 1984-86 conifer plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 CONIFER SPECIES RICHNESS PLOT DATA

BC1.S84	BC2.S84	BC3.S84	BC4.S84	BC5.S84	BC6.S84	BC7.S84	BC8.S84
6.00	8.00	4.00	4.00	5.00	8.00	7.00	5.00
6.00	7.00	10.00	6.00	4.00	7.00	7.00	6.00
7.00	6.00	7.00	5.00	5.00	8.00	7.00	8.00
8.00	8.00	8.00	6.00	4.00	10.00	5.00	8.00
7.00	10.00	10.00	4.00	6.00	10.00	6.00	12.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 CONIFER SPECIES RICHNESS PLOT DATA

BC1.S85	BC2.S85	BC3.S85	BC4.S85	BC5.S85	BC6.S85	BC7.S85	BC8.S85
4.00	4.00	4.00	5.00	6.00	6.00	5.00	9.00
7.00	8.00	6.00	4.00	6.00	9.00	8.00	8.00
9.00	11.00	8.00	6.00	5.00	9.00	9.00	8.00
8.00	10.00	6.00	4.00	11.00	8.00	9.00	7.00
7.00	10.00	4.00	4.00	4.00	4.00	6.00	8.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 CONIFER SPECIES RICHNESS PLOT DATA

BC1.S86	BC2.S86	BC3.S86	BC4.S86	BC5.S86	BC6.S86	BC7.S86	BC8.S86
6.00	9.00	8.00	5.00	5.00	8.00	6.00	8.00
6.00	11.00	6.00	4.00	3.00	6.00	5.00	3.00
7.00	8.00	4.00	5.00	5.00	4.00	7.00	1.00
5.00	8.00	7.00	2.00	6.00	5.00	5.00	4.00
5.00	9.00	4.00	3.00	4.00	6.00	5.00	4.00

Table B34. NANOVA results for species richness on 1984-86 conifer plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

CONIFER BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	45.9502	2	22.9751	2.207374	6.680887 %
AMONG SUBGROUPS WITHIN GROUPS	218.5752	21	10.40834	3.609832	32.00429 %
(ERROR)	276.7998	96	2.883331		61.31484 %
TOTAL	541.3252	119			

NO TRANSFORMATION

Table B35. Basic statistics for 1984-86 conifer species richness. Groups 1-3 represent years 1984-86, respectively.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

CONIFER BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN +/- SE		n	CUM(%)
GROUP 1	6.875	.3104742	40	4.515988
GROUP 2	6.85	.3407194	40	4.974007
GROUP 3	5.55	.3241359	40	5.840287

Table B36. Means, standard errors, and coefficients of variation of the mean for breeding species richness in 1984-86 conifer plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

CONIFER BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN +/-	SE	n	CUM(%)
BC1.S84	6.8	.374166	5	5.502441
BC2.S84	7.8	.6633245	5	8.50416
BC3.S84	7.8	1.113553	5	14.27632
BC4.S84	5	.4472136	5	8.944271
BC5.S84	4.8	.374166	5	7.795124
BC6.S84	8.600001	.6000005	5	6.97675
BC7.S84	6.4	.3999998	5	6.249997
BC8.S84	7.8	1.2	5	15.38461
BC1.S85	7	.83666	5	11.95229
BC2.S85	8.600001	1.249	5	14.52325
BC3.S85	5.6	.7483314	5	13.36306
BC4.S85	4.6	.3999998	5	8.695648
BC5.S85	6.4	1.208305	5	18.87976
BC6.S85	7.2	.9695356	5	13.46577
BC7.S85	7.4	.8124042	5	10.97844
BC8.S85	8	.3162278	5	3.952847
BC1.S86	5.8	.374166	5	6.451137
BC2.S86	9	.5477226	5	6.085807
BC3.S86	5.8	.8000001	5	13.79311
BC4.S86	3.8	.5830953	5	15.34461
BC5.S86	4.6	.5099018	5	11.08482
BC6.S86	5.8	.6633251	5	11.43664
BC7.S86	5.6	.3999998	5	7.142854
BC8.S86	4	1.140176	5	28.50439

Table B37. SNK test results comparing conifer species richness between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

CONIFER BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	5.55	6.875001	bc.s84
2	6.850001	6.850001	BC.S85
3	6.875001	5.55	BC.S86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 2.597499
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 4.900958E-02
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 2.54849

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (3) IS THE COLUMN STARTING POINT.
THE ERROR DF (21) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

Table B38. Raw species density data for breeding birds on 1984-86 conifer plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 CONIFER PLOT DENSITY DATA

BC1.D84	BC2.D84	BC3.D84	BC4.D84	BC5.D84	BC6.D84	BC7.D84	BC8.D84
13.00	18.00	7.00	11.00	10.00	14.00	9.00	8.00
7.00	25.00	29.00	12.00	9.00	10.00	11.00	10.00
8.00	17.00	13.00	7.00	7.00	12.00	9.00	11.00
14.00	15.00	14.00	12.00	11.00	19.00	10.00	17.00
18.00	21.00	20.00	6.00	13.00	16.00	8.00	21.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 CONIFER PLOT DENSITY DATA

BC1.D85	BC2-C.D85	BC3.D85	BC4.D85	BC5.D85	BC6.D85	BC7.D85	BC8.D8 5
14.00	32.00	6.00	9.00	7.00	11.00	7.00	40.00
16.00	19.00	36.00	16.00	15.00	36.00	13.00	13.00
15.00	17.00	18.00	17.00	27.00	19.00	11.00	18.00
16.00	23.00	21.00	9.00	17.00	13.00	15.00	11.00
13.00	21.00	9.00	6.00	7.00	8.00	9.00	9.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 CONIFER PLOT DENSITY DATA

BC1.D86	BC2.D86	BC3.D86	BC4.D86	BC5.D86	BC6.D86	BC7.D86	BC8.D86
13.00	16.00	16.00	7.00	17.00	13.00	8.00	15.00
14.00	22.00	10.00	4.00	5.00	10.00	7.00	3.00
13.00	13.00	5.00	8.00	6.00	4.00	9.00	1.00
7.00	19.00	16.00	3.00	9.00	8.00	6.00	4.00
11.00	16.00	6.00	4.00	9.00	10.00	7.00	7.00

Table B39. NANOVA results for species density on 1984-86 conifer plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

CONIFER BREEDING DENSITY - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	834.4512	2	417.2256	6.059088	17.26714 %
AMONG SUBGROUPS	1446.049	21	68.85947	1.970462	13.44772 %
WITHIN GROUPS (ERROR)	3354.801	96	34.94584		69.28513 %
TOTAL	5635.301	119			

NO TRANSFORMATION

Table B40. Basic statistics for 1984-86 conifer species density. Groups 1-3 represent years 1984-86, respectively.

CONIFER BREEDING DENSITY - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	13.05	.8327819	40	6.38147
GROUP 2	15.975	1.327948	40	8.312662
GROUP 3	9.524999	.7877163	40	8.269987

Table B41. Means, standard errors, and coefficients of variation of the mean for breeding bird density in 1984-86 conifer plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

CONIFER BREEDING DENSITY - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN +/-	SE	n	CUM(%)
BC1.D84	12	2.024846	5	16.87372
BC2.D84	19.2	1.74356	5	9.081043
BC3.D84	16.6	3.722902	5	22.42712
BC4.D84	9.600001	1.28841	5	13.42094
BC5.D84	10	1	5	10
BC6.D84	14.2	1.56205	5	11.00035
BC7.D84	9.399999	.5099026	5	5.424495
BC8.D84	13.4	2.420744	5	18.06525
BC1.D85	14.8	.5830973	5	3.939847
BC2-C.D85	22.4	2.6	5	11.60714
BC3.D85	18	5.282046	5	29.3447
BC4.D85	11.4	2.158704	5	18.936
BC5.D85	14.6	3.709447	5	25.40717
BC6.D85	17.4	4.98598	5	28.65506
BC7.D85	11	1.414214	5	12.85649
BC8.D85	18.2	5.651549	5	31.05246
BC1.D86	11.6	1.249	5	10.76724
BC2.D86	17.2	1.529707	5	8.893643
BC3.D86	10.6	2.357965	5	22.24495
BC4.D86	5.2	.969536	5	18.64492
BC5.D86	9.2	2.107131	5	22.90359
BC6.D86	9	1.48324	5	16.48044
BC7.D86	7.4	.5099026	5	6.890575
BC8.D86	6	2.44949	5	40.82483

Table B42. SNK test results comparing conifer species density between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

CONIFER BREEDING DENSITY - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	9.525001	13.05	BC.D84
2	13.05	15.975	BC-C.D85
3	15.975	9.525001	BC.D86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 4.915958
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 2.229329
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 2.686628

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (3) IS THE COLUMN STARTING POINT.
THE ERROR DF (21) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

Table B43. Raw species richness data for breeding birds on 1984-86 mountain shrub plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 MOUNTAIN SHRUB SPECIES RICHNESS PLOT DATA

BM1.S84	BM2.S84	BM3.S84	BM4.S84	BM5.S84	BM6.S84	BM7.S84	BM8.S84
7.00	2.00	7.00	5.00	5.00	6.00	4.00	6.00
9.00	7.00	7.00	7.00	5.00	6.00	6.00	7.00
8.00	4.00	8.00	4.00	8.00	7.00	6.00	8.00
8.00	8.00	5.00	6.00	5.00	3.00	6.00	7.00
7.00	3.00	7.00	8.00	6.00	6.00	6.00	5.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 MOUNTAIN SHRUB SPECIES RICHNESS PLOT DATA

BM1.S85	BM2.S85	BM3.S85	BM4.S85	BM5.S85	BM6.S85	BM7.S85	BM8.S85
6.00	7.00	7.00	6.00	9.00	7.00	10.00	7.00
7.00	13.00	3.00	9.00	5.00	10.00	9.00	6.00
7.00	5.00	5.00	4.00	8.00	5.00	9.00	9.00
6.00	9.00	6.00	7.00	7.00	5.00	8.00	3.00
7.00	5.00	5.00	7.00	4.00	6.00	5.00	7.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 MOUNTAIN SHRUB SPECIES RICHNESS PLOT DATA

BM1.S86	BM2.S86	BM3.S86	BM4.S86	BM5.S86	BM6.S86	BM7.S86	BM8.S86
7.00	4.00	10.00	9.00	7.00	10.00	6.00	5.00
5.00	9.00	8.00	8.00	4.00	5.00	7.00	4.00
7.00	7.00	6.00	4.00	9.00	7.00	5.00	8.00
4.00	5.00	5.00	5.00	7.00	7.00	5.00	7.00
4.00	6.00	6.00	8.00	2.00	4.00	3.00	3.00

Table B44. NANOVA results for species richness on 1984-86 mountain shrub plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

MOUNTAIN SHRUB BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	11.8169	2	5.908448	1.637447	1.584467 %
AMONG SUBGROUPS	75.7749	21	3.608329	1.012864	.2525569 %
WITHIN GROUPS (ERROR)	342	96	3.5625		98.16297 %
TOTAL	429.5918	119			

NO TRANSFORMATION

Table B45. Basic statistics for 1984-86 mountain shrub species richness. Groups 1-3 represent years 1984-86, respectively.

MOUNTAIN SHRUB BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	6.125	.2511193	40	4.099907
GROUP 2	6.75	.3257142	40	4.825396
GROUP 3	6.05	.3140921	40	5.191605

ERASE THIS LINE, PRINT THE GROUP BREAKDOWNS, THEN HIT THE `F5' KEY TO CONTINUE

Table B46. Means, standard errors, and coefficients of variation of the mean for breeding species richness in 1984-86 mountain shrub plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

MOUNTAIN SHRUB BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CUM(%)
BM1.S84	7.8	.3741649	5	4.796986
BM2.S84	4.8	1.157584	5	24.11633
BM3.S84	6.8	.4898981	5	7.204384
BM4.S84	6	.7071068	5	11.78511
BM5.S84	5.8	.5830953	5	10.05337
BM6.S84	5.6	.678233	5	12.1113
BM7.S84	5.6	.3999998	5	7.142854
BM8.S84	6.6	.5099018	5	7.725785
BM1.S85	6.6	.2449487	5	3.711343
BM2.S85	7.8	1.496663	5	19.18799
BM3.S85	5.2	.6633251	5	12.75625
BM4.S85	6.6	.8124038	5	12.30915
BM5.S85	6.6	.9273618	5	14.05094
BM6.S85	6.6	.9273618	5	14.05094
BM7.S85	8.2	.8602322	5	10.49064
BM8.S85	6.4	.9797958	5	15.30931
BM1.S86	5.4	.678233	5	12.55987
BM2.S86	6.2	.8602326	5	13.87472
BM3.S86	7	.8944272	5	12.77753
BM4.S86	6.8	.969536	5	14.25788
BM5.S86	5.8	1.240967	5	21.39599
BM6.S86	6.6	1.029563	5	15.59944
BM7.S86	5.2	.6633251	5	12.75625
BM8.S86	5.4	.9273618	5	17.17337

Table B47. Raw species density data for breeding birds on 1984-86 mountain shrub plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 MOUNTAIN SHRUB PLOT DENSITY DATA

BM1.D84	BM2.D84	BM3.D84	BM4.D84	BM5.D84	BM6.D84	BM7.D84	BM8.D84
12.00	3.00	13.00	10.00	19.00	11.00	20.00	24.00
20.00	13.00	13.00	13.00	12.00	10.00	13.00	20.00
12.00	9.00	15.00	4.00	12.00	10.00	10.00	16.00
17.00	14.00	11.00	16.00	9.00	4.00	12.00	19.00
11.00	9.00	15.00	18.00	14.00	12.00	10.00	15.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 MOUNTAIN SHRUB PLOT DENSITY DATA

BM1.D85	BM2.D85	BM3.D85	BM4.D85	BM5.D85	BM6.D85	BM7.D85	BM8.D85
17.00	13.00	11.00	10.00	17.00	14.00	23.00	22.00
13.00	23.00	7.00	17.00	10.00	18.00	12.00	11.00
11.00	9.00	13.00	5.00	20.00	14.00	23.00	20.00
10.00	14.00	11.00	12.00	11.00	8.00	11.00	7.00
12.00	9.00	8.00	11.00	13.00	9.00	8.00	16.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 MOUNTAIN SHRUB PLOT DENSITY DATA

BM1.D86	BM2.D86	BM3.D86	BM4.D86	BM5.D86	BM6.D86	BM7.D86	BM8.D86
12.00	10.00	22.00	17.00	12.00	18.00	16.00	11.00
6.00	23.00	15.00	15.00	10.00	8.00	11.00	9.00
10.00	10.00	9.00	5.00	18.00	10.00	7.00	18.00
5.00	9.00	12.00	7.00	15.00	10.00	10.00	16.00
7.00	8.00	15.00	10.00	4.00	9.00	5.00	7.00

Table B48. NANOVA results for species density on 1984-86 mountain shrub plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

MOUNTAIN SHRUB BREEDING DENSITY - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	82.94922	2	41.47461	1.547708	1.66712 %
AMONG SUBGROUPS	562.7461	21	26.79744	1.316555	5.854875 %
WITHIN GROUPS (ERROR)	1954.004	96	20.35421		92.47801 %
TOTAL	2599.699	119			

Table B49. Basic statistics for 1984-86 mountain shrub species density. Groups 1-3 represent years 1984-86, respectively.

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

MOUNTAIN SHRUB BREEDING DENSITY - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	13	.7098213	40	5.460163
GROUP 2	13.075	.7513982	40	5.746832
GROUP 3	11.275	.7381435	40	6.546728

Table B50. Means, standard errors, and coefficients of variation of the mean for breeding bird density in 1984-86 mountain shrub plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

MOUNTAIN SHRUB BREEDING DENSITY - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN +/-	SE	n	CUM(%)
BM1.D84	14.4	1.749285	5	12.14781
BM2.D84	9.600001	1.939072	5	20.19867
BM3.D84	13.4	.7483319	5	5.584567
BM4.D84	12.2	2.457641	5	20.1446
BM5.D84	13.2	1.655294	5	12.54011
BM6.D84	9.399999	1.4	5	14.89362
BM7.D84	13	1.843909	5	14.18391
BM8.D84	18.8	1.593738	5	8.477332
BM1.D85	12.6	1.208305	5	9.589722
BM2.D85	13.6	2.56125	5	18.83272
BM3.D85	10	1.095445	5	10.95445
BM4.D85	11	1.923539	5	17.48671
BM5.D85	14.2	1.881489	5	13.24992
BM6.D85	12.6	1.83303	5	14.54786
BM7.D85	15.4	3.17175	5	20.59578
BM8.D85	15.2	2.782086	5	18.3032
BM1.D86	8	1.30384	5	16.298
BM2.D86	12	2.774887	5	23.12406
BM3.D86	14.6	2.158703	5	14.78563
BM4.D86	10.8	2.289105	5	21.19541
BM5.D86	11.8	2.374869	5	20.126
BM6.D86	11	1.788854	5	16.26231
BM7.D86	9.8	1.881489	5	19.19886
BM8.D86	12.2	2.083267	5	17.07596

Table B51. Raw species richness data for breeding birds on 1984-86 grassland plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 GRASSLAND SPECIES RICHNESS PLOT DATA

BG1.S84	BG2.S84	BG3.S84	BG4.S84	BG5.S84	BG6.S84	BG7.S84	BG8.S84
3.00	4.00	1.00	1.00	2.00	2.00	1.00	2.00
3.00	1.00	1.00	1.00	3.00	2.00	1.00	1.00
2.00	2.00	2.00	3.00	4.00	2.00	1.00	1.00
7.00	2.00	2.00	2.00	7.00	4.00	2.00	3.00
5.00	1.00	2.00	1.00	3.00	2.00	2.00	2.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 GRASSLAND SPECIES RICHNESS PLOT DATA

BG1.S85	BG2.S85	BG3.S85	BG4.S85	BG5.S85	BG6.S85	BG7.S85	BG8.S85
2.00	3.00	1.00	3.00	3.00	4.00	3.00	3.00
4.00	1.00	2.00	4.00	2.00	3.00	1.00	3.00
6.00	2.00	2.00	1.00	3.00	4.00	2.00	3.00
6.00	2.00	2.00	2.00	3.00	3.00	3.00	5.00
5.00	2.00	1.00	1.00	3.00	3.00	5.00	4.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 GRASSLAND SPECIES RICHNESS PLOT DATA

BG1.S86	BG2.S86	BG3.S86	BG4.S86	BG5.S86	BG6.S86	BG7.S86	BG8.S86
3.00	3.00	3.00	2.00	2.00	4.00	4.00	2.00
5.00	5.00	5.00	3.00	2.00	3.00	1.00	2.00
2.00	1.00	2.00	3.00	3.00	3.00	4.00	3.00
3.00	4.00	2.00	3.00	3.00	2.00	2.00	2.00
1.00	1.00	1.00	2.00	2.00	5.00	1.00	3.00

Table B52. NANOVA results for species richness on 1984-86 grassland plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs. 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	6.199951	2	3.099976	.8854058	.553065 %
AMONG SUBGROUPS	73.52503	21	3.501192	2.538628	23.40121 %
WITHIN GROUPS (ERROR)	132.4	96	1.379167		76.04573 %
TOTAL	212.125	119			

NO TRANSFORMATION

Table B53. Basic statistics for 1984-86 grassland species richness. Groups 1-3 represent years 1984-86, respectively.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	2.325	.2331157	40	10.02649
GROUP 2	2.875	.2093565	40	7.281964
GROUP 3	2.675	.1839297	40	6.875876

Table B54. Means, standard errors, and coefficients of variation of the mean for breeding species richness in 1984-86 grassland plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE   NANOVA2.   R.W.THOMPSON

GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CUM(%)
BG1.S84	4	.8944272	5	22.36068
BG2.S84	2	.5477226	5	27.38613
BG3.S84	1.6	.244949	5	15.30931
BG4.S84	1.6	.4	5	25
BG5.S84	3.8	.8602326	5	22.6377
BG6.S84	2.4	.4	5	16.66667
BG7.S84	1.4	.244949	5	17.49635
BG8.S84	1.8	.3741657	5	20.78698
BG1.S85	4.6	.7483314	5	16.26807
BG2.S85	2	.3162278	5	15.81139
BG3.S85	1.6	.244949	5	15.30931
BG4.S85	2.2	.5830951	5	26.50432
BG5.S85	2.8	.1999999	5	7.142854
BG6.S85	3.4	.2449491	5	7.204384
BG7.S85	2.8	.663325	5	23.69018
BG8.S85	3.6	.3999998	5	11.11111
BG1.S86	2.8	.663325	5	23.69018
BG2.S86	2.8	.8	5	28.57143
BG3.S86	2.6	.678233	5	26.08589
BG4.S86	2.6	.2449491	5	9.421118
BG5.S86	2.4	.2449491	5	10.20621
BG6.S86	3.4	.509902	5	14.99712
BG7.S86	2.4	.678233	5	28.25971
BG8.S86	2.4	.2449491	5	10.20621

Table B55. SNK test results comparing grassland species richness between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS <SNK> TEST RESULTS **********

GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	2.325	2.325	BG.S84
2	2.675	2.875	BG.S85
3	2.875	2.675	BG.S86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 1.859024
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .6760095
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 1.183014

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS < 3 > IS THE COLUMN STARTING POINT.
THE ERROR DF < 21 > IS THE ROW.
COMPARE EACH OF THE ABOVE Q's <TOP DOWN> WITH ZAR's TABLE <RIGHT-LEFT>.

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

Table B56. Raw species density data for breeding birds on 1984-86 grassland plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 GRASSLAND PLOT DENSITY DATA

BG1.D84	BG2.D84	BG3.D84	BG4.D84	BG5.D84	BG6.D84	BG7.D84	BG8.D84
6.00	5.00	5.00	2.00	6.00	7.00	1.00	5.00
5.00	1.00	3.00	1.00	6.00	5.00	4.00	2.00
3.00	3.00	3.00	5.00	6.00	6.00	1.00	3.00
13.00	4.00	4.00	4.00	9.00	9.00	2.00	14.00
7.00	2.00	7.00	2.00	7.00	8.00	4.00	6.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 GRASSLAND PLOT DENSITY DATA

BG1.D85	BG2.D85	BG3.D85	BG4.D85	BG5.D85	BG6.D85	BG7.D85	BG8.D85
3.00	4.00	5.00	8.00	5.00	12.00	5.00	7.00
8.00	1.00	5.00	5.00	4.00	9.00	3.00	9.00
8.00	3.00	4.00	2.00	8.00	9.00	54.00	6.00
10.00	3.00	4.00	3.00	8.00	9.00	19.00	12.00
26.00	2.00	3.00	2.00	5.00	7.00	14.00	10.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 GRASSLAND PLOT DENSITY DATA

BG1.D86	BG2.D86	BG3.D86	BG4.D86	BG5.D86	BG6.D86	BG7.D86	BG8.D86
10.00	5.00	3.00	5.00	4.00	10.00	11.00	4.00
9.00	12.00	7.00	5.00	4.00	7.00	4.00	3.00
6.00	1.00	5.00	5.00	4.00	13.00	6.00	6.00
4.00	5.00	5.00	5.00	6.00	5.00	5.00	4.00
2.00	1.00	4.00	6.00	4.00	14.00	4.00	8.00

Table B57. NANOVA results for species density on 1984-86 grassland plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	218.8164	2	109.4082	1.882367	3.757733 %
AMONG SUBGROUPS	1220.576	21	58.12268	2.191931	18.52639 %
WITHIN GROUPS (ERROR)	2545.599	96	26.51666		77.71588 %
TOTAL	3984.992	119			

NO TRANSFORMATION

Table B58. Basic statistics for 1984-86 grassland species density. Groups 1-3 represent years 1984-86, respectively.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN +/- SE		n	CUM(%)
GROUP 1	4.9	.467947	40	9.549938
GROUP 2	8.100001	1.403202	40	17.32348
GROUP 3	5.775	.4756743	40	8.236783

Table B59. Means, standard errors, and coefficients of variation of the mean for breeding bird density in 1984-86 grassland plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CUM(%)
BG1.D84	6.8	1.68523	5	24.78279
BG2.D84	3	.7071068	5	23.57023
BG3.D84	4.4	.7483314	5	17.00753
BG4.D84	2.8	.7348469	5	26.24453
BG5.D84	6.8	.5830953	5	8.57493
BG6.D84	7	.7071068	5	10.10153
BG7.D84	2.4	.678233	5	28.25971
BG8.D84	6	2.12132	5	35.35534
BG1.D85	11	3.924283	5	35.6753
BG2.D85	2.6	.509902	5	19.61161
BG3.D85	4.2	.374166	5	8.908713
BG4.D85	4	1.140176	5	28.50439
BG5.D85	6	.83666	5	13.94433
BG6.D85	9.2	.7999996	5	8.695648
BG7.D85	19	9.224966	5	48.55245
BG8.D85	8.8	1.067708	5	12.13304
BG1.D86	6.2	1.496663	5	24.13973
BG2.D86	4.8	2.009975	5	41.87448
BG3.D86	4.8	.6633251	5	13.81927
BG4.D86	5.2	.2000004	5	3.846161
BG5.D86	4.4	.3999998	5	9.090904
BG6.D86	9.8	1.714643	5	17.49635
BG7.D86	6	1.30384	5	21.73067
BG8.D86	5	.8944272	5	17.88854

Table B60. SNK test results comparing grassland species density between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	4.9	4.9	BG.D84
2	5.775	8.100001	BG.D85
3	8.100001	5.775	BG.D86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 2.654652
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 1.92877
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = .7258812

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (3) IS THE COLUMN STARTING POINT.
THE ERROR DF (21) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

Table B61. Raw species richness data for breeding birds on 1984-86 agricultural grassland plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 AGRICULTURAL GRASSLAND SPECIES RICHNESS PLOT DATA

BP1.S84	BP2.S84	BP3.S84	BP4.S84	BP5.S84	BP6.S84	BP7.S84	BP8.S84
9.00	2.00	1.00	2.00	1.00	3.00	4.00	4.00
6.00	1.00	2.00	5.00	4.00	6.00	4.00	6.00
5.00	7.00	4.00	5.00	4.00	7.00	2.00	5.00
6.00	3.00	4.00	5.00	4.00	6.00	5.00	9.00
6.00	2.00	4.00	3.00	5.00	5.00	3.00	7.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 AGRICULTURAL GRASSLAND SPECIES RICHNESS PLOT DATA

BP1.S85	BP2.S85	BP3.S85	BP4.S85	BP5.S85	BP6.S85	BP7.S85	BP8.S85
3.00	4.00	6.00	2.00	5.00	6.00	2.00	6.00
7.00	6.00	5.00	5.00	6.00	9.00	4.00	8.00
6.00	6.00	5.00	3.00	4.00	11.00	4.00	3.00
8.00	9.00	6.00	4.00	6.00	8.00	4.00	7.00
6.00	5.00	4.00	3.00	5.00	6.00	2.00	6.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 AGRICULTURAL GRASSLAND SPECIES RICHNESS PLOT DATA

BP1.S86	BP2.S86	BP3.S86	BP4.S86	BP5.S86	BP6.S86	BP7.S86	BP8.S86
6.00	3.00	3.00	2.00	2.00	9.00	2.00	9.00
8.00	4.00	3.00	3.00	4.00	6.00	4.00	7.00
6.00	6.00	4.00	5.00	5.00	6.00	5.00	7.00
6.00	4.00	6.00	3.00	3.00	6.00	6.00	5.00
5.00	8.00	4.00	5.00	4.00	7.00	4.00	7.00

Table B62. NANOVA results for species richness on 1984-86 agricultural grassland plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

AGRICULTURAL GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	19.71655	2	9.858276	.9288796	.4707948 %
AMONG SUBGROUPS	222.8748	21	10.61308	4.54846	41.3145 %
WITHIN GROUPS (ERROR)	224.0003	96	2.333336		58.2147 %
TOTAL	466.5916	119			

NO TRANSFORMATION

Table B63. Basic statistics for 1984-86 agricultural grassland species richness. Groups 1-3 represent years 1984-86, respectively.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

AGRICULTURAL GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	4.4	.3137858	40	7.131496
GROUP 2	5.375	.3196302	40	5.946608
GROUP 3	5.05	.2929733	40	5.801451

Table B64. Means, standard errors, and coefficients of variation of the mean for breeding species richness in 1984-86 agricultural grassland plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

AGRICULTURAL GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CUM(%)
BP1.S84	6.4	.678233	5	10.59739
BP2.S84	3	1.048809	5	34.96029
BP3.S84	3	.6324555	5	21.08185
BP4.S84	4	.6324555	5	15.81139
BP5.S84	3.6	.678233	5	18.8398
BP6.S84	5.4	.678233	5	12.55987
BP7.S84	3.6	.5099018	5	14.16394
BP8.S84	6.2	.8602326	5	13.87472
BP1.S85	6	.83666	5	13.94433
BP2.S85	6	.83666	5	13.94433
BP3.S85	5.2	.374166	5	7.1955
BP4.S85	3.4	.509902	5	14.99712
BP5.S85	5.2	.374166	5	7.1955
BP6.S85	8	.9486832	5	11.85854
BP7.S85	3.2	.4898979	5	15.30931
BP8.S85	6	.83666	5	13.94433
BP1.S86	6.2	.4898981	5	7.901583
BP2.S86	5	.8944272	5	17.88854
BP3.S86	4	.5477226	5	13.69307
BP4.S86	3.6	.5999999	5	16.66666
BP5.S86	3.6	.5099018	5	14.16394
BP6.S86	6.8	.5830953	5	8.57493
BP7.S86	4.2	.6633251	5	15.79346
BP8.S86	7	.6324555	5	9.035079

Table B65. SNK test results comparing agricultural grassland species richness between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

AGRICULTURAL GRASSLAND BREEDING SPECIES RICHNESS - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	4.4	4.4	BP.S84
2	5.05	5.375	BP.S85
3	5.375	5.05	BP.S86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 1.892839
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .6309462
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 1.261893

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (3) IS THE COLUMN STARTING POINT.
THE ERROR DF (21) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

Table B66. Raw species density data for breeding birds on 1984-86 agricultural grassland plots.

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1984 AGRICULTURAL GRASSLAND PLOT DENSITY DATA

BP1.D84	BP2.D84	BP3.D84	BP4.D84	BP5.D84	BP6.D84	BP7.D84	BP8.D84
15.00	2.00	3.00	3.00	2.00	13.00	7.00	7.00
20.00	2.00	4.00	8.00	6.00	26.00	12.00	18.00
20.00	9.00	8.00	6.00	5.00	23.00	3.00	16.00
20.00	5.00	7.00	12.00	10.00	29.00	11.00	23.00
19.00	4.00	7.00	6.00	11.00	33.00	6.00	19.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1985 AGRICULTURAL GRASSLAND PLOT DENSITY DATA

BP1.D85	BP2.D85	BP3.D85	BP4.D85	BP5.D85	BP6.D85	BP7.D85	BP8.D85
17.00	4.00	11.00	4.00	12.00	29.00	6.00	30.00
24.00	11.00	11.00	8.00	10.00	33.00	5.00	20.00
25.00	16.00	8.00	5.00	13.00	37.00	7.00	10.00
24.00	22.00	14.00	10.00	13.00	25.00	7.00	28.00
37.00	13.00	8.00	7.00	11.00	22.00	5.00	26.00

RAW DATA PRINTOUT 07-10-1986 R.W.THOMPSON

1986 AGRICULTURAL GRASSLAND PLOT DENSITY DATA

BP1.D86	BP2.D86	BP3.D86	BP4.D86	BP5.D86	BP6.D86	BP7.D86	BP8.D86
18.00	3.00	5.00	3.00	2.00	26.00	5.00	31.00
20.00	8.00	10.00	7.00	7.00	35.00	6.00	17.00
20.00	8.00	9.00	25.00	31.00	34.00	12.00	24.00
22.00	6.00	11.00	5.00	6.00	31.00	16.00	32.00
30.00	12.00	5.00	8.00	18.00	21.00	7.00	15.00

Table B67. NANOVA results for species density on 1984-86 agricultural grassland plots.

B
07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

AGRICULTURAL GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	427.6172	2	213.8086	.6183205	3.403409 %
AMONG SUBGROUPS	7261.574	21	345.7893	11.29569	65.02016 %
WITHIN GROUPS (ERROR)	2938.801	96	30.61251		31.57642 %
TOTAL	10627.99	119			

NO TRANSFORMATION

Table B68. Basic statistics for 1984-86 agricultural grassland species density. Groups 1-3 represent years 1984-86, respectively.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

AGRICULTURAL GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	11.5	1.283525	40	11.16108
GROUP 2	15.7	1.518349	40	9.671015
GROUP 3	15.275	1.608068	40	10.52745

Table B69. Means, standard errors, and coefficients of variation of the mean for breeding bird density in 1984-86 agricultural grassland plots.

07-10-1986

TWO-LEVEL NESTED ANALYSIS OF VARIANCE NANOVA2. R.W.THOMPSON

AGRICULTURAL GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CUM(%)
BP1.D84	18.8	.9695372	5	5.157113
BP2.D84	4.4	1.28841	5	29.28204
BP3.D84	5.8	.969536	5	16.71614
BP4.D84	7	1.48324	5	21.18914
BP5.D84	6.8	1.655295	5	24.34257
BP6.D84	24.8	3.382307	5	13.63834
BP7.D84	7.8	1.655294	5	21.22172
BP8.D84	16.6	2.657066	5	16.00642
BP1.D85	25.4	3.234192	5	12.73304
BP2.D85	13.2	2.956349	5	22.39658
BP3.D85	10.4	1.122498	5	10.79325
BP4.D85	6.8	1.067708	5	15.70159
BP5.D85	11.8	.5830947	5	4.94148
BP6.D85	29.2	2.690723	5	9.214804
BP7.D85	6	.4472136	5	7.45356
BP8.D85	22.8	3.611095	5	15.83814
BP1.D86	22	2.097618	5	9.534626
BP2.D86	7.4	1.469694	5	19.86073
BP3.D86	8	1.264911	5	15.81139
BP4.D86	9.600001	3.944617	5	41.08976
BP5.D86	12.8	5.266878	5	41.14749
BP6.D86	29.4	2.619162	5	8.908713
BP7.D86	9.2	2.083267	5	22.6442
BP8.D86	23.8	3.484251	5	14.63971

Table B70. SNK test results comparing agricultural grassland species density between 1984-86.

07-10-1986

********** STUDENT-NEUMAN-KEULS (SNK) TEST RESULTS **********

AGRICULTURAL GRASSLAND BREEDING DENSITY - 1984 vs 1985 vs 1986

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	11.55	11.55	BP.D84
2	15.275	15.7	BP.D85
3	15.7	15.275	BP.D86

CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 1.406263
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .1440153
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 1.262248

NUMBER OF MEANS COMPARED = 3 ERROR DF = 21

SEE ZAR'S CRITICAL Q DISTRIBUTION, p.457.
NUMBER OF MEANS (3) IS THE COLUMN STARTING POINT.
THE ERROR DF (21) IS THE ROW.
COMPARE EACH OF THE ABOVE Q's (TOP DOWN) WITH ZAR's TABLE (RIGHT-LEFT).

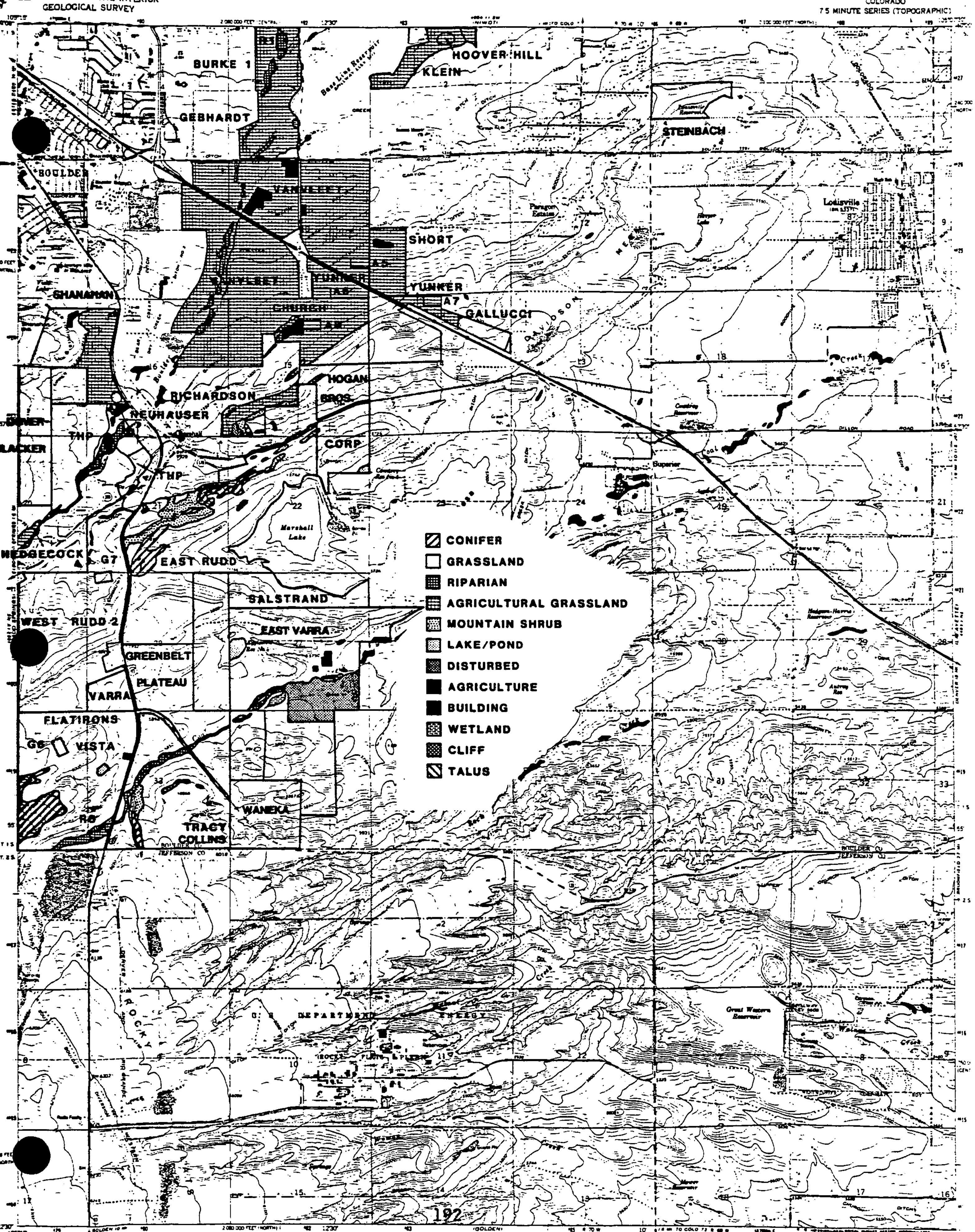
IF Q ABOVE IS > CRITICAL Q, REJECT Ho.

APPENDIX C

Habitat maps and locations of study plots on Open Space.

DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

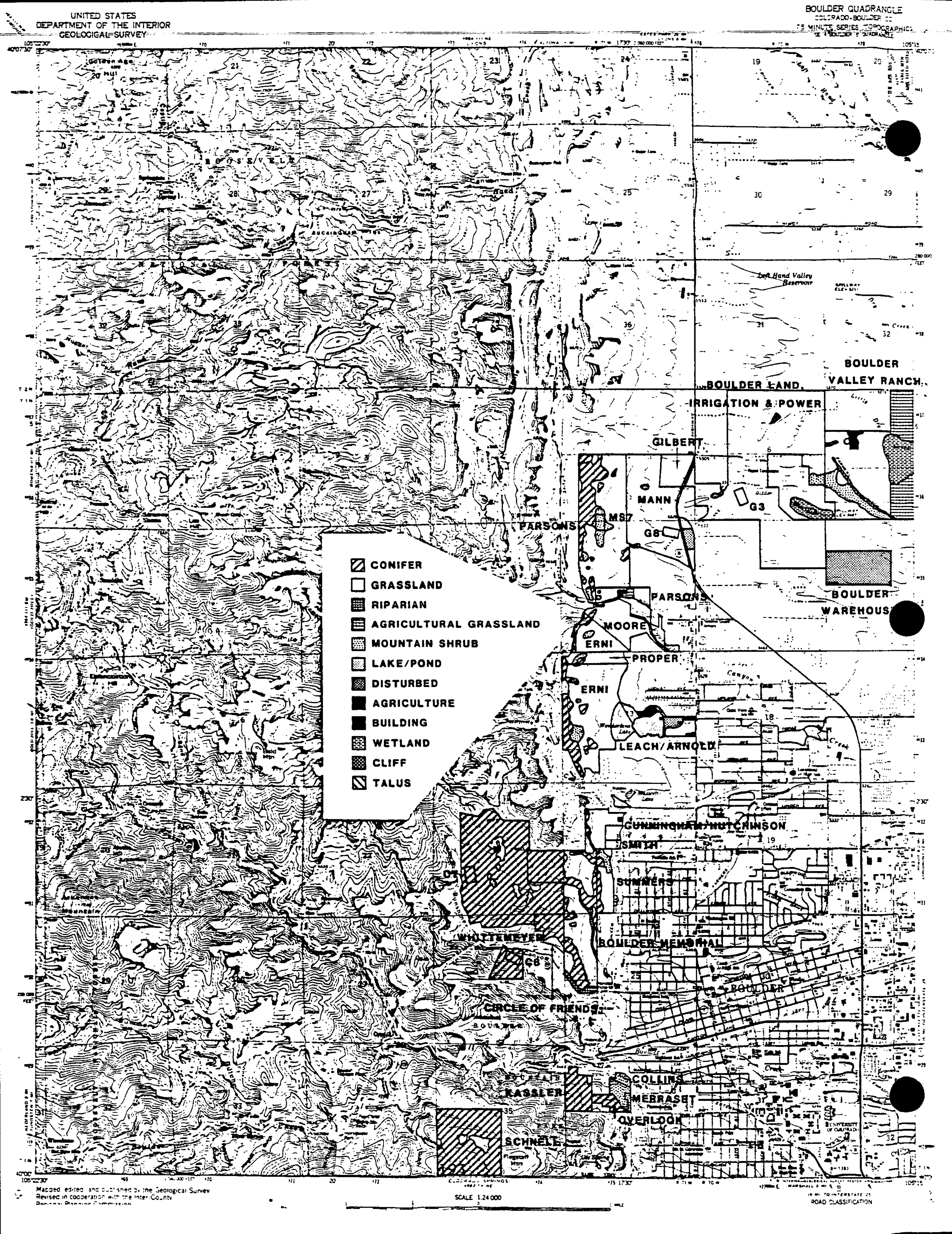
LOUISVILLE QUADRANGLE
COLORADO
7.5 MINUTE SERIES (TOPOGRAPHIC)



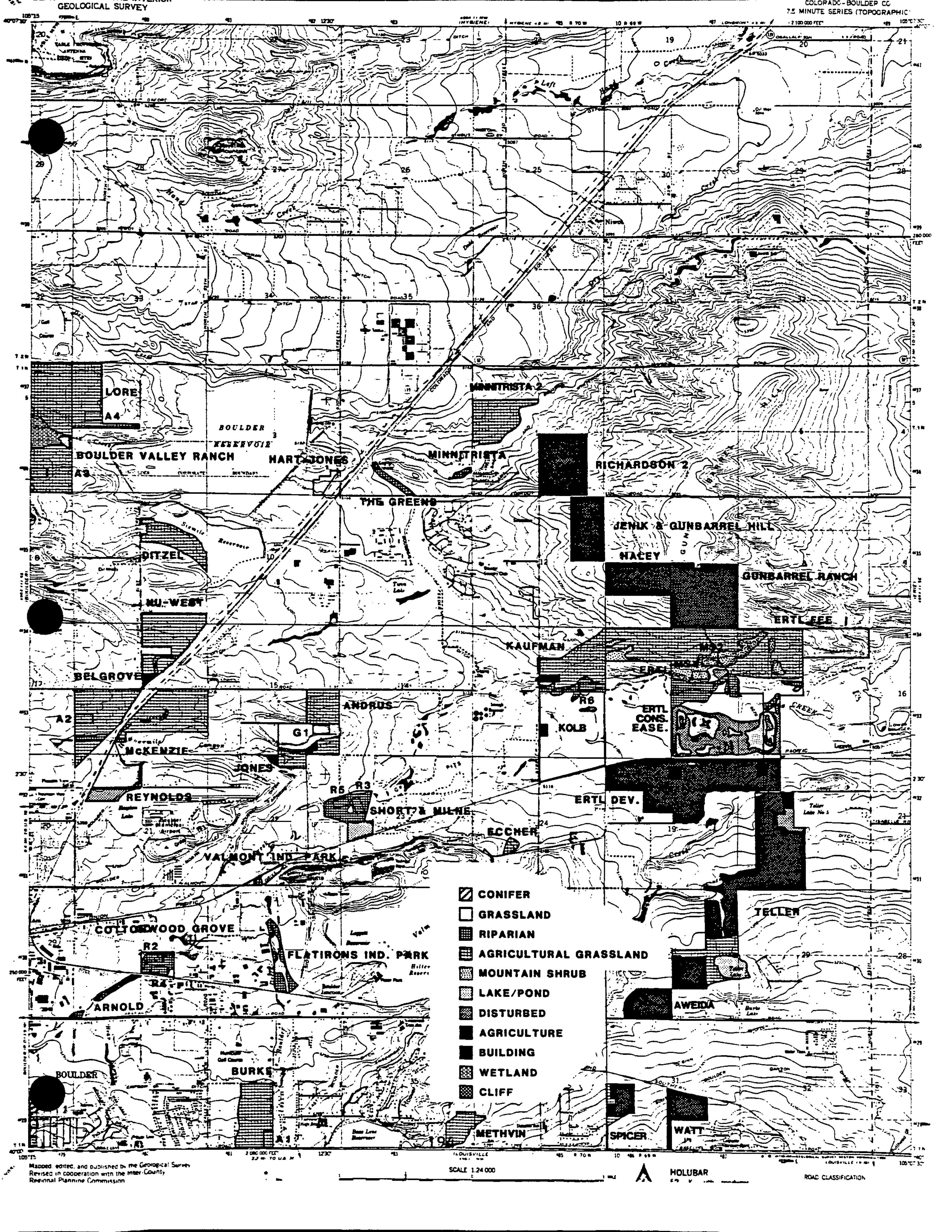
Mapped, edited, and published by the Geological Survey
Control by USGS and NOS/NOAA

SCALE 1:24 000

ROAD CLASSIFICATION
Heavy-duty
Light-duty



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BOULDER QUADRANGLE
COLORADO-BOULDER CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
BOULDER VALLEY RANCH
BOULDER LAND, IRRIGATION & POWER
GILBERT
MANN
G3
MS7
PARSONS
G8
PARSONS
BOULDER WAREHOUSE
MOORE
ERNI
PROPER
ERNI
LEACH/ARNOLD
CONIFER
GRASSLAND
RIPARIAN
AGRICULTURAL GRASSLAND
MOUNTAIN SHRUB
LAKE/POND
DISTURBED
AGRICULTURE
BUILDING
WETLAND
CLIFF
TALUS
CUNNINGHAM/HUTCHINSON
SMITH
SUMMERS
BOULDER MEMORIAL
WHITTEMEYER
G8
CIRCLE OF FRIENDS
BOULDER
KASSLER
COLLINS
MERRASET
OVERLOOK
SCHNELL
Left Hand Valley Reservoir
Flagstaff Mtn
Mapped, edited, and published by the Geological Survey
Revised in cooperation with the Inter-County
SCALE 1:24 000
ROAD CLASSIFICATION


GEOLOGICAL SURVEY
COLORADO-BOULDER CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
LORE
A4
BOULDER RESERVOIR
BOULDER VALLEY RANCH
A3
HART-JONES
MINNITRISTA
MINNITRISTA 2
RICHARDSON 2
THE GREENS
JENIK & GUNBARREL HILL
HACEY
GUNBARREL RANCH
DITZEL
NU-WEST
ERTL FEE
KAUFMAN
BELGROVE
ANDRUS
R6
ERTL CONS. EASE.
KOLB
A2
G1
McKENZIE
JONES
REYNOLDS
R5
R3
SHORT & MILNE
ERTL DEV.
ECCHER
VALMONT IND. PARK
CONIFER
GRASSLAND
RIPARIAN
AGRICULTURAL GRASSLAND
MOUNTAIN SHRUB
LAKE/POND
DISTURBED
AGRICULTURE
BUILDING
WETLAND
CLIFF
COTTONWOOD GROVE
R2
FLATIRONS IND. PARK
R4
ARNOLD
AWEIDA
TELLER
BOULDER
BURKE
METHVIN
SPICER
WATT
Mapped, edited, and published by the Geological Survey
Revised in cooperation with the Inter-County
Regional Planning Commission
SCALE 1:24 000
HOLUBAR
ROAD CLASSIFICATION


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
INTER-COUNTY REGIONAL PLANNING COMMISSION
ELDORADO SPRINGS QUADRANGLE
COLORADO
7.5 MINUTE SERIES (TOPOGRAPHIC)
CONIFER
GRASSLAND
RIPARIAN
AGRICULTURAL GRASSLAND
MOUNTAIN SHRUB
LAKE/POND
DISTURBED
AGRICULTURE
BUILDING
WETLAND
CLIFF
TALUS
BOULDER
TIPPET
ABBEY
G2
McSTAIN
WELLS
BOULDER GREENS VENTURE
BRAMMIER
STENGEL
FARMS
G4
MS3
DUNN 1
G5
MS1
MS6
HEDGECOCK
BARUTE
MS5
MS8
R7
DUNN 2
McCANN
STENGEL 2
C2
GROSS RESERVOIR
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
SCALE 1:24 000
ROAD CLASSIFICATION

BOBOLINKS

INTRODUCTION

Boblinks (Dolichonyx oryzivorus) occur in the West in small, scattered populations usually associated with naturally occuring moist areas. Bobolinks require tall grass for nesting and select irrigated hayfields in the Boulder area. Young do not leave the nest until July and haying before they are able to fly is fatal to them.

Bobolinks were observed on 2 City of Boulder Open Space parcels, Burke 2 and Church during the 1984 fieldwork. Low numbers of both sexes (less than 12) were found on the Burke 2 parcel and we were certain that breeding occurred. Local birdwatchers indicate Bobolinks have been found in this field for several years. Several male Bobolinks were observed on the Church parcel between 21 and 27 June 1984, and this was the first report of this species in this field. The Burke 2 parcel is the only area where Bobolinks have been regularly observed in the Boulder area.

A potential problem is that haying before young Bobolinks have fledged could result in the loss of all young and a possible reduction in the number of Bobolinks nesting in the area in subsequent years (although no special temporal haying considerations have been given to Bobolinks in the past they are still present). Knowledge of the dates Bobolink young fledge is required to understand the effect of haying operations on the productivity of this population.

The City supported additional Bobolink fieldwork in 1985-86 to collect the data required for management. Specific objectives were to: (1) delineate Bobolink distribution on Open Space; (2) determine Bobolink numbers, breeding pairs, and territories on Open Space; (3) locate nests and follow nesting chronology to determine fledging dates; and (4) band adults and juveniles to assess annual site fidelity. Results of the 1986 fieldwork are presented herein. See Thompson and Strauch (1986) for the 1985 Bobolink Study results.

BACKGROUND

Bobolinks are found throughout the northern United States and southern Canada and usually breed on grassy meadows intermixed with sedges and numerous forbs. Eastern populations were once quite extensive but have been drastically reduced since the beginning of the century because of changes in land use and haying methods (Bent 1958). It is widely claimed that western populations arose as the species followed cultivation across the continent. However, Hamilton (1962) found no evidence for such an expansion of the species range and stated that the discovery of the small, isolated western populations coincided with ornithological exploration of the west. Western populations are localized on naturally occuring moist areas and do not center their breeding activities on nearby recently irrigated land (Hamilton 1962). Hamilton (1962) thinks western populations are relics from a period when the west was wetter. On the other hand, Wittenberg (1978) reports that the largest known western breeding population (Malheur National Wildlife Refuge, Oregon) has developed since changes in land management around 1874. He points out, however, that the Malheur population has shown no propensity to expand into other apparently suitable habitat in Oregon. Wittenberg (1978) suggests that the apparent lack of differentiation between western and eastern Bobolink populations indicates a recent range expansion or high gene flow between populations. Western birds apparently join eastern birds in migration (Wittenberg 1978). Regardless of their historical source, western populations tend to be small, isolated, and inbred (Avery and Oring 1977).

In Colorado, Boblinks are irregular summer residents found on both sides of the Continental Divide (Bailey and Niedrach 1965). Bobolinks were first found in Boulder County in 1904 (Betts 1913). They apparently have never been numerous. Henderson (1909) reported a dozen or more using "a big meadow just east of Boulder" each summer. Reports after Henderson's (Betts 1913, Alexander 1937, Bailey and Niedrach 1965) mention only a few birds in any given sighting. Bobolinks were first found breeding in "a meadow 2 mi. southeast of Boulder" in 1929 (Niedrach and Rockwell 1939). The Boulder Audubon Society Wildlife Inventory lists several sightings each year since 1979 in a strip from southeast of Boulder to Lyons.

Bobolinks are characteristically found breeding on hayfields or other areas with tall dense vegetation (Bent 1958, Avery and Oring 1977, Wittenberg 1978). On Malheur National Wildlife Refuge, they prefer to breed in mesic meadows rather that wet or dry ones (Wittenberg 1978, 1980). The earliest arriving males set up territories in mesic habitat with low sedge cover and high forb cover. Late arriving males settled in wet habitats with high sedge and forb cover in preference to flooded or dry areas with low forb cover and high or low sedge cover. Flooded areas and dry areas not near standing water were avoided. Wittenberg's study area was mowed for hay in late summer and grazed in autumn, winter, and early spring. Wittenberg (1978) claimed that Bobolinks depend on new growth of vegetation and that the presence of old vegetation in spring may reduce habitat quality. If old vegetation is left standing, burning improves Bobolink habitat (Wittenberg 1978). The mean territory size on the preferred habitat was 0.74 ha; that on other areas was 1.45 ha.

Several authors (Hamilton 1962, Martin 1973, Wittenberg 1978) emphasize the fidelity of individual birds to traditional nesting areas. Avery and Oring (1977) on the other hand, claimed that population shifts with changes in vegetation was characteristic of the species. They reported one field in which the birds did not return in the year following summer cutting. They did not, however, give any history of the conditions on the field nor a description of the vegetation other than that it was shorter in the spring after cutting. Wittenberg (1980) found that site fidelity was much lower in areas where moisture conditions changed greatly between years.

Females arrive on the breeding grounds 4-8 days after the males (Bent 1958, Wittenberg 1978). Pairing takes place almost immediately and the first eggs are laid about a week after pairing but may be delayed by poor conditions (Wittenberg 1978). For both sexes, older birds arrive first and claim the best habitats. Incubation takes 10-12 days (Bent 1958, Wittenberg 1978) and the young leave the nest when about 10 days old (Bent 1958). Wittenberg (1978) recommends banding young 7 days after hatching to prevent premature fledging. The young leave the nest before they can fly and wander on the ground for several days (Bent 1958). The length of the period from leaving the nest to being able to fly does not seem to be well established. Once young are flying, Bobolinks usually leave the nesting area and seek secluded areas for their molt (Bent 1958).

METHODS

On 25 April 1986 a 100m grid system was established on the Burke 2 parcel to facilitate the identification and relocation of Bobolink observations and nest sites. The south and east fencelines were used as the X and Y axes. One-hundred meter intervals and points along the west and north parcel boundaries intersected by grid lines were marked with 0.91m (3 foot) wood lath identified with the point's coordinates and flagging. The system of shallow irrigation ditches and natural swales which direct and retain water was concomitantly mapped.

Systematic surveys for Bobolinks were made on all potentially suitable Open Space parcels from early May through mid-June 1986. Parcels covered were Burke 2, Burke 1, Gebhardt, East Boulder Community Park (EBCP), Van Vleet, Yunker (N,S, and E), and Church. The Methvin, Nu-West, Ditzel, and Belgrove parcels were surveyed once or twice during this interval. Perch sites and the periphery of display areas were marked with numbered pin flags and surveyor's flagging as males and females arrived. Accumulation of flags, some repositioned after subsequent observations, facilitated identification of individual males as territories were established. After 31 May, surveys to identify distributions were discontinued until 17 June to minimize disturbance during courtship, nest building, and early incubation. Bobolink nests were located by observing males and females bringing food to the nest and/or removing fecal sacs and triangulating in on the site. Nest sites and nest areas were marked with adjacent pinflags and flagging.

Vegetative associations on the Burke 2 parcel were described and mapped by Dr. David Cooper on 31 May 1986 to document the distribution of plant communities when Bobolinks were selecting nest sites. Associations were delineated on a 1 in.= 100 ft. aerial photograph taken 4 May 1979. Dr. Cooper resurveyed the parcel on 7 July and described the vegetative composition in the $4m^2$ surrounding Bobolink nests (n=3) and in the $9m^2$ surrounding the focus of nest areas (i.e., unlocated Bobolinks nest sites, as evidenced by adults bringing food consistantly to the same point and removing fecal sacs.) (n=3).

The grid system was overlain on the vegetation map and 1985-86 nest sites and nest areas were located within plant communities. Acreage of plant associations was determined using a digital electronic planimeter. Evaluation of Bobolink nest site selection relative to the availability of Burke 2 vegetative communities employed a Chi-square goodness of fit test with Yates correction for continuity (Yates 1934, Zar 1974). 1985 and 1986 nest sites were pooled, although nest site selection may not be independent between years. Some plant associations were combined into community or habitat types for statistical considerations (Hayes and Winkler 1970, Nue et. al. 1974, Zar 1974).

Throughout the 1986 field season, contact was maintained with Ralph Burke, leasee of the Burke 2 parcel, to identify when specific sections of the parcel would be hayed. When Bobolink nests or nest areas were within a section to be cut, the area within a 10-25m radius of the nest site was flagged off and Mr. Burke would cut around it. When chicks from such a nest could fly, the flags were removed and the area was cut.

A Mann-Whitney test for ordinal data (Zar 1974) was used to examine the relationship between Bobolink nest success and the mowing sequence in the parcel. Nests were considered unsuccessful (for the purpose of this test) if hay cutting destroyed the nest before all young had fledged or if cutting avoided a flagged nest area before chicks had fledged. This unsuccessful category is conservative since chicks which may have left the nest, but were unable to fly, and, therefore, vulnerable to cutting (e.g., 1986 nest A, see Table 1), were not included.

Mist netting and banding adults and juveniles were conducted in early to mid-July. Three 5m, 1.5 in. nylon mesh nets were suspended between 3.05m (10 ft.) poles. Nets were arranged in a "V" or closed triangle shape with the nest located inside and near a closed point. Nets were checked every 15 min. to minimize stress of captured birds. Numbered, U.S. Fish and Wildlife Service aluminum bands were fitted to the left leg of adults and broods in 1985. Females received size 1B bands while males and young received 1A bands. In 1986, a banding system was established to facilitate field identification of specific individuals. The right leg of adults was banded with a proximal, aluminum band and a distal, red plastic band. Hatching year birds (1986 chicks) were banded with a proximal, red plastic band and a distal, aluminum band on their right leg. This combination established the year and age of birds banded in 1986. Birds marked in subsequent years will follow this system with differently colored plastic bands. The left leg of all birds, regardless of age, was banded with a unique combination of 3 colored (red, white, and blue) plastic bands for individual recognition. Nest checks during July determined fledging dates in relation to the haying sequence.

RESULTS

BURKE 2 VEGETATION ANALYSIS

Dr. Cooper's vegetation report composes Appendix A. This section summarizes his conclusions.

The 27.53 ha (68 acre) Burke 2 hayfield is composed of 5 vegetative communities and stands where 2 or more communities intergrade. Vegetation types are illustrated in Figure 1. In late May, The orchard-grass/meadow fescue (Dactylis glomerata /Festuca pratensis) community occupied 18.82 acres (27.7%) of the most well-drained sites on the parcel. This community is most abundant in the parcel's northeast quarter. Smaller islands of this type occur throughout the parcel but are least common in depressed central and westerly areas along the swale that meanders northwesterly through the property. By early July, timothy (Phleum pratense) and redtop (Agrostis gigantea) replaced the former species as the dominants. An important characteristic of this community is that its ground surface is dry or free of standing water in late May-early June when Bobolinks are initiating nesting.

The sedge/buttercup community (Carex lanuginosa, C. nebraskensis, C. stipata, and C. brunnescens/Ranunculus acriformis), the most widespread vegetation type (42.46 acres, 62.4%), dominates the low-lying southern, central, and northwestern sections of the site. This community commonly intergrades with the orchard-grass/meadow fescue and Juncus/spike-rush types. Standing water occurs in most portions of this community in May through mid-June.

In areas topographically and hydrologically between the distinct orchard-grass/meadow fescue and sedge/buttercup communities, transitional areas with moist soil conditions, but not free standing water in May or June, support mixtures of these two communities. Superficially, these areas appear to be a distinct orchard-grass/meadow fescue type because their canopies are dominated in May by these species, and later by timothy and redtop. However, these stands support a

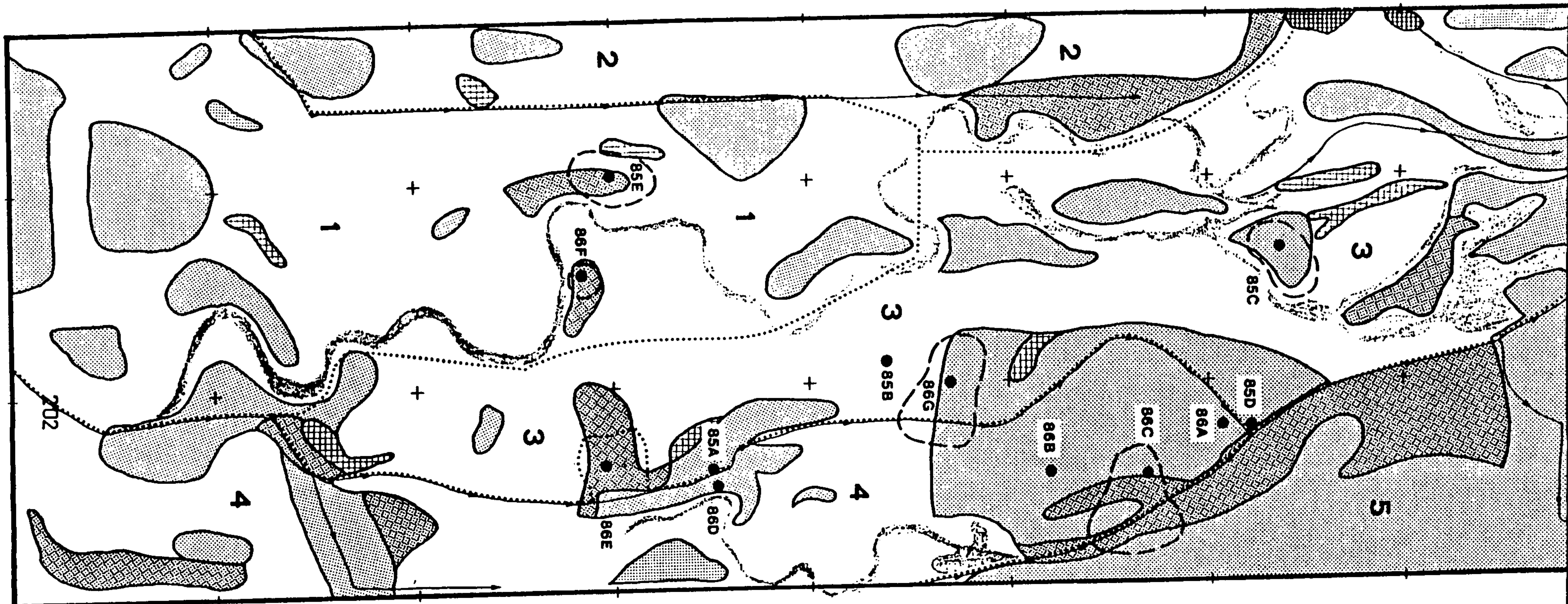


Figure 1. Vegetation types, locations of 1985 and 1986 Bobolink nests (dots) and nest areas (dashed lines), and traditional haying sequence of sections (1-5) on the Burke 2 parcel.

low to moderately dense herbaceous understory commonly dominated by buttercups. This subtype covers 8.5% (5.78 acres) of the parcel and is considered an association within the orchard-grass community.

The juncus/spike-rush (Juncus articus/Eleocharis macrostachya) community occupies only 1.1% (0.78 acres) of the parcel as distinct stands. More commonly, it intergrades in mesic portions of the sedge/buttercup community, where it is considered a subtype. These distinct stands occur in standing water in May and June.

Prairie cordgrass (Spartina pectinata) communities occur in narrow bands of standing water along irrigation ditches. These stands were so narrow that they could not be mapped.

Two broad-leaved cattail (Typha latifolia) stands occur on the northwestern periphery of the parcel. They compose only 0.13 acres (0.2%) and support standing water into July.

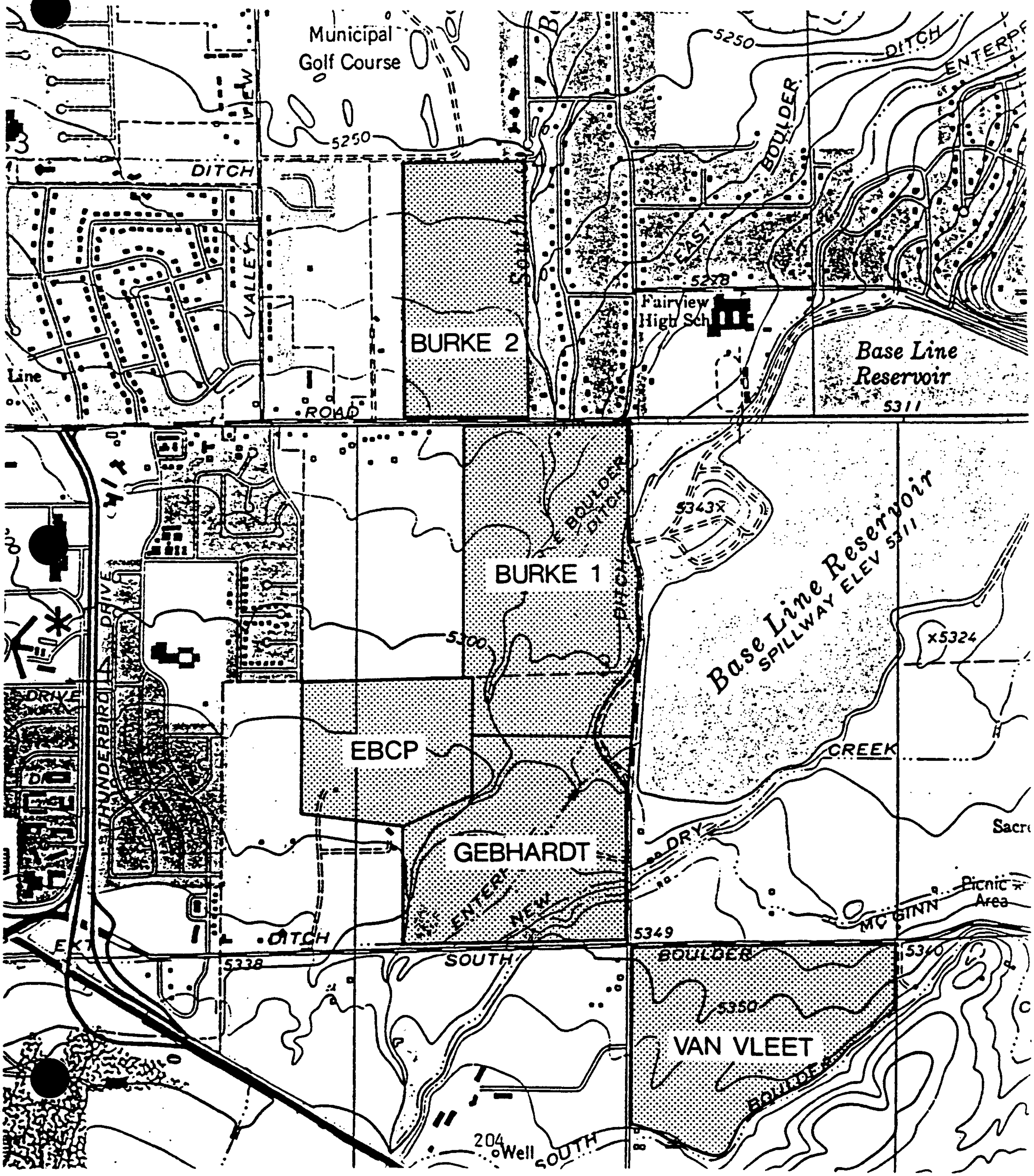
BOBOLINK NESTING

Bobolinks were observed in the Burke 2, Burke 1, Van Vleet, EBCP, Gebhardt, Southeast Yunker, and Church parcels during 1986. Breeding occurred in the 3 former parcels and was suspected in Gebhardt (Fig. 2). One probable first-year male was observed displaying in the Church parcel on 17 July and 2 other males were displaying throughout the South Yunker parcel on 17 June.

Burke 2

On 9 May, a single male Bobolink was observed in the parcel's northeast quarter in what became nest areas A, B, and C (Fig. 1). Up to 7 males were displaying on 12 May and at least 8 males were present on 15 May. Twelve males were present on 19 May when the first female was observed at what became nest area B. Both sexes continued to arrive. By 30 May, approximately 20 males (the 1986 high) and 5 females were present and at least 8 females (the 1986 high) were present on 17 June.

Figure 2. Location of Open Space and East Boulder Community Park (EBCP) parcels where intensive 1986 Bobolink study occurred.



Early-arriving males established territories in the parcel's northeastern quarter. Later-arriving males established territories further and further south until the central two-thirds and eastern two-thirds of the field were occupied. Males arriving after this point defended territories in the parcel's southern quarter and western periphery, however after mid-June, all these males abandoned their territories and either joined an established pair of nesting Bobolinks or, presumeably, left the field. All known 1986 nest areas occured in the east-central portion of the field (Fig. 1) where initial males established territories.

Seven Bobolink nest areas were located on the Burke 2 parcel in 1986 (Fig. 1), all in orchard-grass/meadow fescue communities. When 1985-86 nest site data were pooled, 11 of 12 Bobolink nest sites occurred in the orchard-grass type, while only 36.2% of the parcel was composed of this type. Chi-square test results ($P(X_c^2=47.23) < 0.001$) support the hypothesis that Bobolinks are selecting orchard-grass/meadow fescue communities for nesting more than what this type's availability would dictate. Indeed, nesting Bobolinks have selected islands of orchard grass as small as 0.147 acres (see 1986 nest F as well as 1985 nests C and E, Fig. 1).

The most apparent reason why orchard-grass communities are selected for nest sites is that these areas are the only portions of the Burke 2 parcel that a ground-nesting passeriform can keep its nest dry (and eggs warm) in May and June. However, cover, predator-avoidance, and food availability are important considerations that may also ultimately influence nest site selection.

While orchard-grass communities are most extensive in the northeast portion of the Burke 2 parcel, and the majority of 1985 and 1986 Bobolink nests corresponded to this vegetative distribution, this same portion of hayfield is annually the last to be cut in the traditional haying regime. Mann-Whitney test results ($P(U \geqq 25) = 0.05$, $n=11$) indicate that Bobolinks which nest in southwest sections of the parcel mowed early in the haying regime are less likely to successfully fledge offspring than those birds which nest in Sections 4 or 5. Whether this correlation between haying sequence, orchard-grass distribution, and Bobolink nest site selection is casual or adaptively evolved, a larger sample size is needed for the multivariate analysis required to evaluate this apparent relationship.

Table 1 summarizes the 1986 Burke 2 nesting data. Seven females nested and fledged at least 20-21 young. Nest G apparently failed after eggs had hatched. The female from this nest was observed bringing food to nest A on 2 July, 9 days after she and her mate were feeding young at her nest. On 25 June, several dogs had been running loose in the Burke 2 parcel and their tracks crisscrossed nest area G.

Mowing began on 1 July (three days earlier than the traditional 4 July start) and was completed on 11 July. Fledging dates (when young left the nest) ranged from 29 June to 17 July; the mean fledging date was 5 July (Table 1). Nest F was destroyed by hay cutting just as young were fledging on 1 July. On 4 July, a young bird that had only been flying for 2-4 days was observed 60m east of nest F. This bird was presumed to be an early fledgling from nest F, because similarly aged fledglings from nest C were remaining in their nest area (Fig. 1). Initial searches for nest F were unsuccessful, although the focus of food delivery had been identified and flagged. The nest area was not flagged off to delay cutting because the area was east of the major swale that Mr. Burke has traditionally used as the boundary between sections 1 and 3. Unfortunately, nest F was cut on 1 July as part of Section 1, rather than on 7 and 8 July as part of Section3. Nest E successfully fledged young only because the nest area was flagged and not cut. The 5 young from nest E fledged between 13 and 17 July, 5 to 9 days after that portion of section 3 had been cut. Young from the 6 1986 nests (A-F) fledged an average of 3.5 days before their section of field was cut (range -7 to 11 days). This is similar to the 1985 mean (n=4) of 3.25 days (range -3 to 7.5 days). Considering that it takes another 2-3 days after fledging until young can fly and are no longer susceptible to haying mortality, Bobolink production in this hayfield is quite precarious.

Three adult Bobolinks and 13 fledged young were banded in 1986 using a system permitting individual binocular recognition (Table 2). One or more adult males banded in the Burke 2 parcel in 1985 was observed in 1986. One banded male was the apparent mate of the nest D female. We were unable to capture and identify this male. Our new banding system will allow such determination without capture in the future. Males banded in 1985 were also observed at nests A and E. The banded male at nest A brought in food. How many different, banded 1985 males these observations represent is uncertain; they could all be of one bird. Early nesting Bobolinks that have finished feeding fledglings and/or unsuccessful adults

Table 1. Summary of 1985-86 Bobolink nesting in the Burke 2 parcel.

Nest	Observed/Estimated Dates			Section	Fledging -	Outcome
	Egg Laying[a](n)	Hatching[a](n)	Fledging[b](n)	Cut(#)	Cutting(days)	
1985						
A	16-19 Jun(5)	28-29 Jun(5)	8-9 Jul(5)	12 Jul(3)	3-4	Successful
B	24-27 Jun(4)	6-7 Jul(4)	14-16 Jul (4)	12 Jul(3)	-2-4[c]	Successful[c]; cut around nest
C[d]	Unk	Unk	4-10 Jul(3)[e]	12 Jul(3)	2-8	Successful
D[d]	Unk	Unk	3-4 Jul(3-4)[e]	12 Jul(3)	8-9	Successful
E[d]	Unk	Nest Destroyed	Nest Destroyed	5 Jul(1)		Unsuccessful; Nest destroyed by cutting
1986						
A	15-18 Jun(4)	27-28 Jun(3)	7-10 Jul(3)	11 Jul(4)	1-4	Successful
B	12-16 Jun(5)	24-26 Jun(5)	3-5 Jul(5)	11 Jul(4)	6-8	Successful
C[d]	8-11 Jun(U)	20-21 Jun(U)	30 Jun-1 Jul(3-4)	11 Jul(4)	10-12	Successful
D[d]	11-16 Jun(U)	23-26 Jun(U)	3-6 Jul(3)[e]	11 Jul(4)	5-8	Successful
E	23-27 Jun(6)	5-7 Jul(5)	13-17 Jul(5)	8 Jul(3)	-5-9	Successful[c]; cut around nest
F[d]	7-11 Jun (U)	19-21 Jun(U)	29 Jun-1 Jul(1)[e]	1 Jul(1)	0-2	Unsuccessful[f]; section cut as young were leaving nest
G[d]	Unk	Unk	Failure[f]	8 Jul(3)		Unsuccessful; Nest Failure[g]

a Date based on estimated age of nestlings and/or observed fledging dates. Assumptions include an incubation period of 10-12 days (Bent 1958, Wittenberg 1978) and young leave the nest when 10 days old (Bent 1958).

b Date at which young left the nest. Young can fly in another 2-3 days.

c Nest and young would have been destroyed by cutting had the nest area not been flagged and avoided.

d Nest not located. Fledging dates based on when adults were last observed removing fecal sacs, when feeding of young shifted away from the presumed nest site, and/or the estimate age of recently fledged young.

e Minimum number.

f Unsuccessful because nest was destroyed before all nestlings had fledged.

g Cause of failure unknown, but unrelated to haying.

Table 2. Summary of 1985-86 Bobolink banding data for the Burke 2 parcel.

Date	Band No.	Age[b]	Sex[c]	Nest	Band Combination[a] Right	Left
1985						
4 July	102-173456	AHY	F	E		A1
6 July	102-173457	AHY	F	A		A1
6 July	63-168449	HY	U	D		A1
6 July	63-168450	HY	U	D		A1
6 July	63-168451	HY	U	A		A1
6 July	63-168452	HY	U	A		A1
6 July	63-168453	HY	U	A		A1
6 July	63-168454	HY	U	A		A1
6 July	63-168455	HY	U	A		A1
6 July	63-168456	AHY	M	A		A1
13 July	63-168457	HY	U	B		A1
13 July	63-168458	HY	U	B		A1
13 July	63-168459	HY	U	B		A1
13 July	63-168460	HY	U	B		A1
13 July	63-168461	AHY	M	B		A1
13 July	102-173458	AHY	F	B		A1
1986						
4 July	102-173460	AHY	F	A	A1/R	R/R/R
4 July	63-168462	HY	U	B	R/A1	R/R/R
4 July	63-168463	HY	U	B	R/A1	R/R/W
4 July	63-168464	HY	U	B	R/A1	R/R/B
4 July	63-168465	HY	U	B	R/A1	R/W/R
6 July	63-168466	HY	U	C	R/A1	R/W/W
6 July	63-168467	HY	U	A	R/A1	R/W/B
6 July	63-168468	HY	U	A	R/A1	R/B/R
6 July	63-168469	HY	U	A	R/A1	R/B/W
11 July	63-168470	AHY	M	E	R/A1	R/R/W
11 July	102-173461	AHY	F	E	A1/R	R/R/B
13 July	63-168471	HY	U	E	R/A1	R/B/B

Table 2. Continued.

Date	Band No.	Age[b]	Sex[c]	Nest	Band Combination[a] Right	Left
1986						
13 July	63-168472	HY	U	E	R/Al	W/W/W
13 July	63-168473	HY	U	E	R/Al	W/W/R
13 July	63-168474	HY	U	E	R/Al	W/R/R
13 July	63-168475	HY	U	E	R/Al	W/R/W

a Band combinations are read proximally to distally. Codes are Al=Aluminum, R=Red, B=Blue, W=White.

b Birds were either hatching year (HY, young) or after hatching year (AHY, adults).

c M=Male, F=Female, U=Unknown (for young).

of both sexes congregate at nests where relatively old chicks are still present and assist feeding young. At least 8 different males and 4 different females were observed around nest A and at least 3 different males and 3 different females were feeding the nest A nestlings.

Burke 1

Vegetative composition of the Burke 1 parcel differs east and west of South Boulder Creek. West of the creek, vegetation is qualitatively similar to that of Burke 2 in composition, density, and height. Irrigation regimes are also similar and this section is hayed annually. East of the creek, southerly low-lying areas are dominated by Juncus arcticus and other mesic graminoids. These areas are flooded by irrigation into early July. North of these low-lying areas are nonirrigated, dry upland grasslands that are annually hayed, but which support marginal Bobolink habitat.

In 1986, male Bobolinks were observed throughout the western half of the parcel and on an elevated area surrounded by standing water on the boundary of the Gebhardt parcel. At least one territory was established in the west-central portion of the parcel and defended against males that flew in from Burke 2, EBCP, the east half of Burke 1/Gebhardt, and from the private cattle/horse pasture west of Burke 1. On 30 May, a Bobolink nest with 5 eggs was located in an orchard-grass stand, approximatley 300m south and 50m east of Burke 1's northwest corner. We assumed nesting phenology was similar to that in the Burke 2 parcel and that the eggs had only recently been laid. We returned to the nest on 17 June and found it empty with no shell fragments or feces. It is possible that the birds may have fledged (at least 13 days before the earliest known fledging date (n=10) for the Burke 2 parcel), however predation cannot be ruled out.

A pair of Bobolinks were observed on the boundary of Burke 1 and Gebhardt on 8 July. Prior to this observation, surveys through this area had revealed only 1 or 2 males in the vicinity since 12 May. Over 3 hours were spent observing this pair on 8 and 9 July, however no feeding, fecal sac removal, or fidelity to any specific area was detected. Nevertheless, it is possible this pair had a nest in the area.

East Boulder Community Park

The delayed 1986 irrigation regime and the presence of cattle grazing in the parcel's eastern third, retarded vegetative growth and precluded Bobolink nesting. the EBCP parcel has been traditionally flooded early in the growing season similar to the regime in the Burke 2 parcel. In 1985, vegetative development and composition were similar to that on the Burke 2 and Gebhardt parcels and at least 3 pair of Bobolinks produced young. In contast, vegetative development during the 1986 nesting season was so sparse that moderate numbers of Western Meadowlarks, which uncommonly nest in local irrigated hayfields, were nesting. By 1 July, mean vegetative height in the EBCP parcel was estimated at 4-5 in. The field had recently been flooded, but this irrigation was too late to produce the vegetative development required by nesting Bobolinks. Indeed, had any Bobolinks been nesting, irrigation at this time would have flooded nests, adversely affecting nestling survival. The western two-thirds (portion without cattle) contained even sparser vegetation. Mean vegetative height was estimated at 2-3 in. and bare ground was visible over 60% of the field. The tallest sedge clumps were 16 in., but sparse and confined to local, low-lying areas. Vegetation was largely dead over hundreds of square meters in the east-central portion of the field's western half. Regardless of the cause, these dead areas were not present in 1985.

Until 8 July, 2-5 males were regularly seen throughout the parcel, although none displayed fidelity to any particular area. These males moved around in groups between the Gebhardt, Burke 1, and the private cattle/horse pastures to the north. On 8 July, 7 males were sitting on the south fenceline with 2 females and one well-flying young, and foraging in a weed field to the south. It is unlikely that Bobolinks sucessfully nested in the EBCP parcel in 1986.

Gebhardt

With the exception of the Bobolink pair observed on the border of the Gebhardt and Burke 1 parcels, no females were observed in the Gebhardt parcel in 1986. Irrigation and haying dates followed traditional patterns and vegetation was suitable for Bobolink nesting. Up to 3 males were commonly observed displaying around the parcel and one male appeared to have established a territory in the west central portion of the field.

Van Vleet

Bobolinks nested in the Van Vleet parcel south of South Boulder Road and east of Cherryvale Road in 1986. Three nest areas were observed on 9 and 11 July. Four males and 3 females were present; individuals of both sexes were bringing in food. No nests could be located. One pair was feeding at least 4 fledged young. Haying began in this field the following week.

NESTING SUMMARY

Bobolinks nested on the Burke 2 (7 pairs), Burke 1 (1), and Van Vleet (3) parcels in 1986, and breeding was suspected in the Gebhardt parcel (1). Bobolinks were also observed on EBCP, Church, and southeast Yunker parcels. Assuming no interchange between our observations, at least 38 males and 13 females were present on the above parcels. At least 25-26 young successfully fledged. The majority of Boulder's 1986 Bobolink population (at least 20 males, 8 females) and most recruitment from that population (20-21 fledglings) inhabit the Burke 2 parcel. Three adults and 13 fledglings from the Burke 2 parcel were banded in 1986 with color combinations permitting recognition of individuals. A total of 32 Bobolinks have been banded in 1985-86. At least 1 male, banded on the Burke 2 parcel in 1985, was observed on the parcel in 1986.

DISCUSSION

Our observations of arriving males and females agree with the phenology observed in other areas (Bent 1958, Wittenberg 1978). The earliest arriving males in the Burke 2 parcel established territories which subsequently produced all of the known young. These territories were in the central and northeast part of the parcel. Late arriving males settled more toward the south and west ends of the field, but appeared to remain unmated.

The northeast part of the Burke 2 parcel is drier and supports the more xeric orchard-grass/meadow fescue communities. Bobolinks are selecting this vegetation type for nesting. This indicates that habitat selection by Bobolinks on Burke 2 corresponds to that reported by Wittenberg (1978) in Oregon.

Vegetation composing this flat, irrigated hayfield is a former native grassland that is harrowed, fertilized, mowed, and grazed, each winter by cattle. Haying of the field traditionally starts in the southwestern part of the field with the northeastern part being cut last. This pattern has been followed for decades (Ralph Burke, pers. commun.) because the southwestern corner is easier to access and because the low-lying wet area which crosses the field from the southeast to northwest has to be dry enough to be crossed by a tractor before the northeast corner can be cut.

The spatial nesting pattern and mowing regime function to ensure that the earliest nesting birds usually have sufficient time to fledge broods before their area of the field is cut. In contrast, later breeding birds nest in areas which are cut earlier and, thus, have a higher risk that their nests will be destroyed by mowing before their young fledge. Chicks in nest 1985 B and 1986 E, (Fig. 2) were too young to fledge when their section of the field was mowed. If we had not flagged-off the areas around these nests, which were left uncut until after the young fledged, these young, like those at Nest E 1985 and part of the brood at nest 1986 F, would have been killed.

MANAGEMENT RECOMMENDATIONS

It appears likely that Bobolinks have nested in or near the Burke 2 parcel for decades. The early reports of Bobolinks nesting in a meadow to the east or southeast of Boulder (Henderson 1909, Niedrach and Rockwell 1939) must have come from sites near, if not identical to, the Burke 2 parcel. There is no evidence of the former population size outside of Henderson's (1909) report of a dozen birds. It may be that the Burke 2 birds are members of a larger population breeding in the Boulder Valley. Our discovery of Bobolinks nesting on the Burke 1, Gebhardt, EBCP, and, in 1986, Van Vleet parcels indicates that the immediate population is larger than just the birds on Burke 2. However, development of the EBCP parcel will reduce available Bobolink nesting habitat. BASWI records suggest that there are probably several small groups of breeding Bobolinks between Boulder and Lyons, but there is no proof of breeding or estimates of the number of birds involved.

There is little information on the population dynamics of Bobolinks inhabiting Open Space. The survivorship, breeding area fidelity, and natal philopatry of these birds are unknown. Previous Bobolink studies (Martin 1973, Wittenberg 1978) indicate that adult survivorship is high for this small song bird and that adults usually return to areas in which they previously bred. However, only small numbers of young return to their natal area, either because of low survival or dispersal. The small size of the Burke 2 population suggests that few young return to the field. Since Bobolinks have persisted on the field for many years adult survivorship must be high enough that the few young that do return sustain the population, or that birds raised elsewhere enter the population. The only way to determine the actual situation is to establish an individually marked population and to follow it through several breeding seasons. If this is done, local bird watchers should be encouraged to report sightings of marked birds found in other areas.

If it is found that the Burke 2 Bobolinks represent a closed population (little or no immigration or emigration), its small size would indicate it was at high risk of extinction. In that case a management program to increase the number of birds would be highly recommended. If, on the other hand, the population is open and other birds enter the breeding population as space is available, the population will probably be maintained as long as conditions do not change much from present ones.

Current management practices (hay mowing starting on 4 July and winter grazing) appear to be tenuously compatible with the small breeding population on the Burke 2 parcel. Changes in these practices could easily eliminate the birds or increase their numbers. Earlier mowing will destroy a larger fraction, and perhaps all nests before the young can fledge. In the past 2 years, 3 of 11 nests were destroyed, or would have been without our interference, by the normal haying sequence, which began on 4 July in 1985 and 1 July in 1986. Mowing one week earlier in 1985 and 1986 would have killed or adversely affected young in 10 of the 11 nests. Mowing later might increase the breeding population by maximizing the number of young that fledge before mowing. There is however, no definative evidence on which to base an estimate of how the population might ultimately respond to any given delay of mowing.

If Wittenberg's (1978) claim that Bobolinks depend on new vegetative growth is true, then the elimination of mowing and grazing on Burke 2 might make the area unusable for Bobolinks.

Another approach which would benefit Bobolinks on Open Space would be to adjust the irrigation or seeding practices on other mowed fields so that patches of habitat suitable for breeding would develop. Our impression is that much of the Gebhardt parcel and the southeast Burke 1 parcel are too wet for nesting Bobolinks. Reduction in the amount of water delivered to portions of that parcel might increase the number of breeding Bobolinks. Modification of the irrigation regime might also increase the quality of the hay produced if it decreased sedge abundance. Results of the 1986 irrigation delay on the EBCP parcel provide a salient example of how altered irrigation regimes can adversely affect formerly suitable Bobolink nesting habitat.

The preservation of the Boulder Valley breeding population probably depends on forces beyond the control of the Open Space Office. Practices on Open Space can, however, encourage the species and perhaps offset habitat losses in other areas.

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APPENDIX A

REPORT ON THE VEGETATION OF THE BURKE 2 PROPERTY AND THE RELATIONSHIP OF NESTING BOBOLINKS TO THE VEGETATION

David J. Cooper

A rapid ecological survey was undertaken on 31 May 1986 to prepare a vegetation map for the Burke 2 property. The purpose of this survey was to document the distribution of plant communities on the property as they occurred in late May when bobolinks were choosing nesting sites. The location of successful bobolink nests discovered during June 1986 was then plotted this vegetation map by Rick Thompson and Joe Strauch. I revisited the property on 7 July to survey the vegetation surrounding the nest sites discovered by Thompson and Strauch. That data is attached to this report as Appendix 1. The vegetation types presented below are generalized and abstracted from the field work done on May 31. The composition of some community types changed between the initial visit (May 31) and the later visit (July 7). These differences are noted in the description of each community.

The community of greatest interest is the Orchard-grass-Meadow Fescue (Dactylis glomerata-Festuca pratensis) community (number 1 in red on the vegetation map) which occupies the most well-drained sites on the property. The vegetation structure in this community is tall and dense enough to provide appropriate nesting habitat for bobolinks. This community is most abundant in the northeastern section of the property. Smaller islands of this community type occur throughout the property but cover the least area in the central and western portions. The composition of this community changed significantly between the two visits. During the first visit Orchard Grass and Meadow Fescue were the dominant species. During the latter visit Timothy (*Phleum pratense*), and Redtop (*Agrostis gigantea*) were the dominants. Other plant species common in this community type are: *Poa pratensis, Trifolium pratense, Plantago lanceolata, Lotis tenuis* and *Taraxacum officinale*. All the dominant species in this community type are non-native species common in reseeded or overgrazed pastures. It is most likely that either the landowners seeded their field with these species, or they purchased hay to feed cattle that was composed of these species. This hay being the seed source for the species that eventually came to dominate the pasture. *Briza media* (Quaking Grass) occurs in this community type and this apparently is the first collection of this species in Colorado. This species is native to Europe. An important characteristic of stands of these communities is that the ground surface is dry or at least does not have standing water in May-June.

The most abundant community on the property is the sedge-buttercup community (*Carex* spp.-*Ranunculus acriformis* community) (number 4 on the vegetation map). A number of sedges are common including; *Carex lanuginosa, C. nebraskensis, C. stipata,* and *C. brunnescens*. In addition Fowl Manna-Grass (*Glyceria striata*) and American Manna-Grass (*Glyceria maxima* ssp. *grandis*) are locally common. *Scirpus microcarpus* occurs in the wettest areas. This community dominates the central portion of the property and is also widespread in the southern and western portions as well.

This community intergrades with most of the other communities found on the property, especially communities numbers 1 and 2. Standing water occur throughout almost every portion of all stands of this community type in May-June.

Community number 2 is dominated by a mixture of Juncus arcticus and Eleocharis macrostachya. It rarely occurs in pure stands but intergrades freely with community 4 and in some places with community 1. Standing water occurs throughout almost every portion of all stands of this community type in May-June.

Community 3 is dominated by Prairie Cordgrass (Spartina pectinata). It is not common, but occurs along irrigation ditches. This species was more common in July than what I had been led to believe by my investigation on 31 May. Standing water occurs in all stands of this community type.

Community 5 is dominated by Broad-leaved Cattail (Typha latifolia). It occurs only in the northwestern portion of the property in deep water sloughs.

During 1985 most successful bobolinks nests were in the northeastern portion of the property. Coincidental is the fact that mowing of the property commences on approximately 1 July each summer in the southwestern portion of the property and works in a northwesterly direction over a period of weeks. Rick Thompson has hypothesized that the early July mowing eliminates bobolink nests in the southwestern portion of the property. Successful nests in the northeast produce young that may return to that same portion of the field to nest in following years. An alternate hypothesis is that the bobolinks are choosing the Orchard Grass-Meadow Fescue community for nesting and most of this community type occurs in the northeastern portion of the property, thus most birds would normally nest in that area.

The vegetation map supports the second hypothesis, but do not disprove the first hypothesis. All successful nests in 1986 were located in stands of Orchard Grass-Meadow Fescue, or in mixed stands of Orchard Grass-Meadow Fescue and other community types. The underlying point is that the presence of grasses indicates that the ground surface never has standing water although the water table may be high allowing the survival of sedges, rushes and other obligate wetland plant species within the grass-dominated stands. It is clear on the vegetation may that most of the Orchard-Grass-Meadow Fescue community occurs in the northeast and thus most potential nest sites are in that area.

All six nest sites located in the Burke 2 property in 1986 occurred in the Orchard Grass-Meadow Fescue stands or stands with a high coverage by the grass species that dominate that community type. Since 100 % of the nest sites occur within a single vegetation type that occupies less than approximately 40 % of the property it indicates that the birds are choosing this community type as the best nest sites.

My feeling is that two factors are important in nest site selection. These are (1) that there be no standing water in May-June; (2) the vegeation be tall and dense enough to provide coverage for the nest. Both of these requirements are filled only in stands with high coverage of the following four grass species; Orchard Grass, Meadow Fescue, Redtop and Timothy. These are the dominant species of the Orchard Grass-Meadow Fescue community type. If it was desirable to increase the acreage or add locations with suitable bobolink nesting habitat, I feel this could be done by paying attention to the two principles stated above.

Sample # A Photo # Date 7 July 86
Location: Burke 2
Habitat description & notes:
located rest site – sample size $4 m^2$

Elevation /Aspect /Slope /Parent Rock
pH humus /pH subsoil
Soil description & notes:

Total cover / shrubs / vascs / lichens / bryos /
Moisture= / Temperature= / Snow Duration= / Stability=
1-10,wet-dry / 1-10,cold-hot / 1-10, long-short / 1-10, stable-unstable

Taxon	% Cover	Taxon	% Cover
Phleum pratense	15		
Dactylis glomerata	35		
Festuca pratense	10		
Agrostis gigantea	25		
Lotis tenuis	10		
Achillea lanulosa	+		
Plantago lanceolata	+		
Rosa	5		

D.C.

Sample # B　　Photo #　　Date 7 July 1986
Location: Burke 2
Habitat description & notes: nest located
sample area 4 m^2

Elevation　/Aspect　/Slope　/Parent Rock
pH humus　/pH subsoil
Soil description & notes:

Total cover　/ shrubs　/ vascs　/ lichens　/ bryos　/
Moisture=　/ Temperature=　/ Snow Duration=　/ Stability=
1-10,wet-dry　/ 1-10,cold-hot　/ 1-10, long-short　/ 1-10, stable-unstable

Taxon	% Cover	Taxon	% Cover
Phleum pratense	10		
Festuca pratensis	10		
Agrostis gigantea	60		
Lotis tenuis	35		
Tragopogon porrifolius	+		
Asclepias speciosa	2		
Dactylis glomerata	15		
Plantago lanceolata	+		
~~Eq~~ Hippochaete hyemalis	+		

D.C.

Sample # C   Photo #   Date July 7, 1986
Location: Burke 2
Habitat description & notes: - close to nest area, but nest not located
sample area 9m²

Elevation   /Aspect   /Slope   /Parent Rock
pH humus   /pH subsoil
Soil description & notes:

Total cover   / shrubs   / vascs   / lichens   / bryos   /
Moisture=   / Temperature=   / Snow Duration=   / Stability=
1-10,wet-dry   / 1-10,cold-hot   / 1-10, long-short   / 1-10, stable-unstable

Taxon	% Cover	Taxon	% Cover
Phleum pratense	35		
Festuca pratensis	15		
Agrostis gigantea	60		
Dactylis glomerata	5		
Lotis tenuis	25		
Trifolium pratense	1		
Plantago lanceolata	+		
Rumex salicifolius	+		
Asclepias speciosa	1		
Taraxacum officionale	+		
Trifolium repens	+		

Sample # D Photo # Date 7 July 1986
Location: Burke 2
Habitat description & notes: nest not located – sample area 9m²

Elevation /Aspect /Slope /Parent Rock
pH humus /pH subsoil
Soil description & notes:

Total cover / shrubs / vascs / lichens / bryos /
Moisture= / Temperature= / Snow Duration= / Stability=
1-10,wet-dry / 1-10,cold-hot / 1-10, long-short / 1-10, stable-unstable

Taxon	% Cover	Taxon	% Cover
Phleum pratense	35		
Dactylis glomerata	10		
Festuca pratensis	5		
Agrostis gigantea	75		
Lotus tenuis	15		
Rumex salicifolius	+		
Ranunculus acriformis	~~8~~5		
Plantago lanceolata	+		
Juncus tracyi	+		

Sample # E Photo # Date 7 July 86
Location: Burke 2
Habitat description & notes: nest located - sample size 4m²

Elevation /Aspect /Slope /Parent Rock
pH humus /pH subsoil
Soil description & notes:

Total cover / shrubs / vascs / lichens / bryos /
Moisture= / Temperature= / Snow Duration= / Stability=
1-10,wet-dry / 1-10,cold-hot / 1-10, long-short / 1-10, stable-unstable

Taxon	% Cover	Taxon	% Cover
Phleum pratense	25		
Briza media	15		
Lotus tenuis	15		
Ranunculus acriformis	10		
Dactylis glomerata	10		
Agrostis gigantea	15		
Carex lanuginosa	30		
Juncus arcticus	+		
Festuca pratensis	15		
Hippochaeta hyemalis	1		
Agropyron sp.	+		

Sample # F Photo # Date 7 July 86
Location: Burke 2
Habitat description & notes:
Grassdom community - already cut when surveyed
Elevation /Aspect /Slope /Parent Rock
pH humus /pH subsoil
Soil description & notes:

Total cover / shrubs / vascs / lichens / bryos /
Moisture= / Temperature= / Snow Duration= / Stability=
1-10,wet-dry / 1-10,cold-hot / 1-10, long-short / 1-10, stable-unstable

Taxon	% Cover	Taxon	% Cover
Grass (Orchard, Fescue, Redtop)	75		
Juncus tracyi	7		
Forbs	2		
Rosa	1		

GRASSHOPPER SPARROWS

INTRODUCTION

Records of Grasshopper Sparrows (Ammodramus savannarum) for Boulder County are few. Until 1909 the only record was a bird collected near Haystack Butte in the 1903 nesting season (Henderson 1909). Betts (1913) considered the species an infrequent summer resident on the plains, reporting several seen in June-August 1910 and 1911. He observed an adult feeding nonflying young on 12 June (year?). Alexander (1937) considered Grasshopper Sparrows rare or infrequent summer residents on the plains, but gave no further details. Bailey and Niedrach (1965) state that the species is an irregularly common local resident on the eastern plains of Colorado. In addition to the records cited above they list 1 bird seen in Boulder County on 13 May 1959.

Chase et al. (1982) indicate that the Grasshopper Sparrow is a migrant or unrecorded from the latilong blocks covering Boulder County. Holitza and Kreig (1981) list the species as rare in Boulder County. The Boulder Audubon Society Wildlife Inventory records list 1 bird seen in July 1978, 3 on 7 August 1978, 26 in July 1983, and 4 in July 1985.

During a study of birds breeding on City of Boulder Open Space in 1984, Thompson and Strauch (1985) found Grasshopper Sparrows on agricultural and grassland habitats and estimated a total City of Boulder Open Space population of about 40 birds based on plot counts. The species became evident only toward the end of the breeding bird census period and appeared to be most common on areas not covered by their regular census plots. They concluded their estimate was probably much lower than the actual population size.

On 15 and 16 July 1985, Thompson and Strauch (1986) surveyed Grasshopper Sparrows using variable-line transects (Eberhardt 1978) when birds were near the peak of their singing period and thought to be in late incubation or early brood rearing. The objective of this impromptu study was to obtain a rough estimate of sparrow numbers. This survey was not designed to rigorous statistical standards from which accurate population estimates could be obtained. Nevertheless, 111 different Grasshopper Sparrows were observed from 28,004m of line transects for an average of 3.97 sparrows/1000m. A Kelker (1945) index produced a mean Grasshopper Sparrow density of 0.312 birds/ha. Based on line transects, the population was estimated at approximately 269 sparrows. Grassland plot counts from 1985, which were not oriented toward Grasshopper Sparrow colonies, produced a population estimate of 117 $\pm$ 145 (n $\pm$ 90% CI) birds.

METHODS

In 1985, surveys were conducted on all grassland and nonirrigated agricultural grassland parcels known to, or suspected of supporting Grasshopper Sparrows. Transects totalled over 28 km (17.5 miles) and required 18 man-hours on 2 consecutive mornings to survey each of the 13 transects just once.

Sampling was modified in 1986 to (1) establish a more rigorous experimental design that would provide a higher degree of statistical confidence in data obtained and to (2) establish permanent transects that could be annually surveyed to identify trends in Grasshopper Sparrow numbers. Five parcels were selected which had the highest numbers of sparrows observed along transects in 1985, Boulder Valley Ranch, VanVleet/Church, Dover/Blacker/THP, West Rudd, and Greenbelt Plateau/East Rudd.

Transect orientation was roughed-out on maps to cover local colony distribution and modified slightly during field establishment to incorporate prominant physiographic features (trees, watertowers, fencecorners, etc.), which observers could orient by, or to provide compass bearings on 5 of 10 degree intervals. Transects did not parallel fencelines closer than 100m to avoid concentrating perched or singing birds at fixed distances from transects. Ends of transects and transect legs were marked with 1.22m (4 foot) rebar posts marked with surveyor's flagging. Vegetation along transects was flagged at 100m intervals.

Observers walked at a constant rate along the linear transect and recorded the right angle distance from the transect line where sparrows flushed or were initially observed. Censuses were conducted during fair weather between 0.5 hours of sunrise and 0930 hours to minimize variation in bird conspicuousness (Conner and Dickson 1980).

A histogram of cumulative right angle sighting distances was constructed from survey results. The histogram indicated that the point at which bird detectability fell off, as a result of increasing distance from the line transect, occurred at 60m. Observations beyond this distance were excluded from density estimates (Kelker 1945). Data were analyzed using the Kelker (1945) estimator. F-tests and t-tests were used to test equality among variances, means, and 95% confidence intervals (Sokal and Rohlf 1969).

RESULTS

Sixty-five different Grasshopper Sparrows were observed along the 5 transects, totalling 11,640m (7.28 miles), based on the maximum 1-day count and assuming no interchange occurred between parcels with transects. Sparrows detected ranged from 0.707 birds/1000m on the Greenbelt Plateau/East Rudd parcel to 8.055 birds/1000m on the Dover/Blacker/THP parcel. (Table 1). Grasshopper Sparrows averaged 4.15 ± 2.86 birds/1000m on all 5 transects (Table 1). Variation in the number of birds detected/transect between the 3 replications was relatively minor, except on the Dover/Blacker/THP parcel (Table 1). No explanation is available for the comparatively low numbers detected on 18 and 20 July.

All sparrows were assumed to have been seen out to 60m, although the peak between 20m and 40m in Figure 1 suggests sparrows were moving away from the transect as observers approached, a commonly occuring phenomenon. The Kelker (1945) index (mean density = n/2LW, where n = mean number of birds observed out to the fall-off distance, W = fall-off distance, and L = total length of transects) produced a mean Grasshopper Sparrow density of 0.235 ± 0.177 birds/ha (mean ±SD), ranging from 0.017 birds/ha on the Greenbelt Plateau/East Rudd parcel to 0.463 birds/ha on the Dover/Blacker/THP parcel (Table 1).

Grasshopper Sparrow abundance, as measured by number of birds/1000m of transect of density, was highest on the Dover/Blacker/THP parcel (as in 1985), followed by the West Rudd, Boulder Valley Ranch, VanVleet/Church, and Greenbelt Plateau/East Rudd parcels (Table 1).

Although the 1986 transects did not conform to the 1985 orientations, they did sample the same areas, albeit at different intensities. Results of a statistical

Table 1. Grasshopper Sparrows detected from line transects on selected Boulder Open Space parcels 16-20 July 1986.

Parcel	Transect Length(m)	Sparrows Observed: July[a] 16	July[a] 18	July[a] 20	Mean $\pm$ SE	Mean/1000m of Transect	Out to 60m[b]	Density(n/ha)[c]
Dover/Blacker/THP	1,738	28[d]	5	9	14.00 $\pm$ 7.09	8.055	29	0.463
West Rudd	2,900	19[d]	19[d]	12	16.67 $\pm$ 2.33	5.747	35	0.335
Boulder Valley Ranch	1,663	7[d]	6	6	6.33 $\pm$ 0.33	3.808	15	0.251
VanVleet/Church	2,039	2	8[b]	5	5.00 $\pm$ 1.73	2.452	8	0.109
Greenbelt Plateau/ East Rudd	3,300	3[d]	1	3[d]	2.33 $\pm$ 0.67	0.707	2	0.017
TOTAL	11,640	59	39	35	44.33 $\pm$ 7.42		89	
MEAN $\pm$ SD						4.14 $\pm$ 2.84		0.235 $\pm$ 0.177

[a] 3 replicated counts.

[b] Number of sparrows observed out to 60m from transect line during 3 reps.

[c] Based on the mean number of sparrows observed out to 60m from transect.

[d] Highest 1-day count.

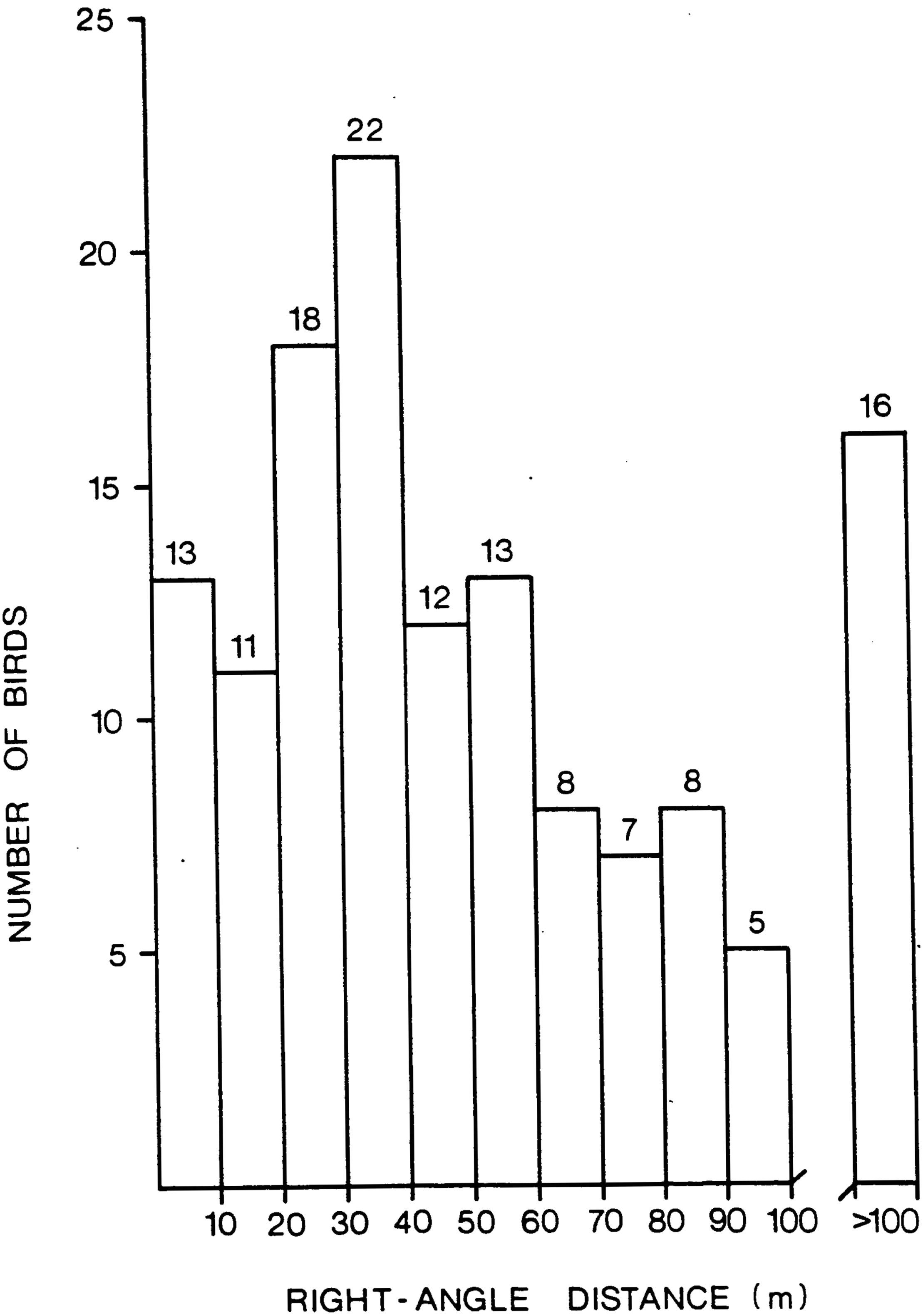

Figure 1. Histogram of cumulative right-angle sighting distances from a variable-line transect (Eberhardt 1978) to Grasshopper Sparrows observed during 3 replicated counts on selected Boulder Open Space grasslands, 16, 18, and 20 July 1986.

comparison between 1985 and 1986 abundance data may be invalidated because 1985 figures were derived from a single count, and may therefore be nonrepresentative, while 1986 numbers represented a mean of 3 replicated counts. (Compare the total number of sparrows observed on 16, 18, and 20 July 1986 to see how much any 1 count can deviate from the mean). Nevertheless, such a comparison, tempered by the above consideration, would be interesting for a species about which limited, local, qualitative data are available and whose numbers are thought to fluctuate widely. Grasshopper Sparrow abundance on the 5 1986 transects was lower than on the 5 comparable 1985 transects, however differences between transect means and 95% confidence intervals were not statistically significant. Grasshopper Sparrows/1000m of transect averaged 6.87 $\pm$ 2.08 (mean $\pm$SD) in 1985 vs. 4.14 $\pm$ 2.84 in 1986 (t_s = 1.715, P>0.1; L_1 = -6.361, L_2 = 0.935). Grasshopper Sparrow density on the 5 comparable transects averaged 0.476 $\pm$ 0.106 birds/ha in 1985 vs. 0.235 $\pm$ 0.177 birds/ha in 1986 (t_s = 1.821, P>0.1; L_1 = -0.064, L_2 = 0.547).

Grasshopper Sparrow densities on the 1985 and 1986 permanent plots suggested that 1986 sparrow numbers may have been down. In 1985, Grasshopper Sparrows were only recorded on grassland plots G6 (Flatirons Vista) and G7 (West Rudd) during plot counts. Density and population estimates for 1985 grassland habitats were 0.50 $\pm$0.77 sparrows/10 ha (mean $\pm$ 95% CI) and 117 $\pm$ 181 sparrows, respectively. In 1986, sparrows were only recorded on agricultural grassland plots A3 (Boulder Valley Ranch) and A4 (Lore) during plot counts. Density and population estimates for this habitat were 0.50 $\pm$ 0.77 sparrows/10 ha and 58 $\pm$ 89 sparrows, respectively. However, results of plot surveys are probably invalid indicators of Grasshopper Sparrow numbers and habitat use because this sampling methodology is suboptimal for enumerating uncommon species with small, spotty distributions.

DISCUSSION

The distribution of the western race (perpallidus) of the Grasshopper Sparrow is spotty (Smith 1968). The species tends to breed in small colonies, and local populations fluctuate considerably from year to year in spite of the apparent availability of suitable habitat (Wiens 1969).

Our results indicated that in 1985 the species bred in good numbers in Boulder County. Grasshopper Sparrows appeared to be less common in 1986.

The contrast of our findings with previous records of Grasshopper Sparrows in Boulder County may be due to a recent increase of the species in the Boulder area, but we find this unlikely. More likely fluctuations in population size and the unattractiveness of the species' local breeding habitat (i.e., unattractive to birdwatchers) have contributed to the paucity of observations. The presence of the species does not become evident near Boulder until males start singing in late June or early July. At that time (and at most other times of the year) the hot, dry grasslands are less attractive for bird watching and are typically ignored. Our findings probably do not represent an atypical situation; the species probably is a regular breeder in Boulder County. We have no evidence to indicate the range of local population fluctuations or whether the 1985-86 populations were unusually high or low.

MANAGEMENT CONSIDERATIONS

The Grasshopper Sparrows prefer open, treeless grasslands with a fairly thick cover of grasses and a variety of taller forbs (Wiens 1969). Such conditions are usually found on dry, well-drained, upland sites. In a survey of different range habitats, Wiens and Dyer (1975) found that Grasshopper Sparrows occur at relatively high frequencies in tallgrass prairie (0.80) and in various agricultural habitats (e.g., pastures, fallow fields, or hayfields) (0.73), but also in shrub, mixed-grass, shortgrass, and Palouse habitats. They normally inhabit open grasslands where bunchgrasses rather than sod types predominate (Whitmore 1981, James 1983). Nest placement is associated with bunches of grasses and forbs are important for singing perches (Smith 1968, Wiens 1969). James (1983) found that only bunchgrass habitat containing a large, shrub-like lupine (Lupinus leucophilus) was used for nesting in Oregon. The average forb height on Grasshopper Sparrow territories in Wiens (1969) study site was higher than that found on Western Meadowlark (Sturnella neglecta) and Vesper Sparrow (Pooecetes gramineus) territories.

From a study of West Virginia reclaimed surface-mined land in different successional stages, Whitmore (1979) found optimal values for Grasshopper Sparrow nesting to be 73% litter cover, 24% bare ground, and 28% grass cover.

Grasshopper Sparrows require denser vegetation for nesting than Savannah (Passerculus sandwichensis) and Vesper sparrows (Whitmore 1979). Wiens and Dyer (1975) found that their occurrence on western rangelands was negatively associated with Horned Larks (Eremophila alpestris), Lark Buntings (Calamospiza melanocorys), and Western Meadowlarks.

Whitmore (1981) recommended that grasslands be maintained in an early successional stage with low vegetation density, litter depth and cover, and shrub coverage to encourage Grasshopper Sparrows. His 3 specific management recommendations were:

1. Burning. Grasslands that have encroaching shrubs should be burned during the winter.

2. Deferred grazing. Timing of grazing should be delayed until nesting is completed.

3. Vegetative reclamation. Disturbed sites should be replanted with bunch grasses to encourage Grasshopper Sparrows. Shrub and tree planting should be avoided.

In comparing the effects of different grazing intensities on western grasslands Wiens and Dyer (1975) found:

> Where grazing regimes affected vegetational composition only slightly, the bird species composition of the treatment plots seemed unaffected. On the other hand, where grazing produced marked changes in vegetation, there were accompanying major shifts in avian community composition, generally toward closer resemblance to avian communities in more xeric locations.

Whitmore's (1979) measures of optimal habitat were for the eastern race of Grasshopper Sparrow and for conditions different from those found in City of Boulder Open Space. There are no data to indicate whether his values apply to Boulder County. Results of our surveys (Thompson and Strauch 1985, 1986) show that Vesper Sparrows and Western Meadowlarks are considerably more abundant on Open Space than are Savannah or Grasshopper Sparrows. This indicates that most of the area is too xeric for Grasshopper Sparrows, but not so xeric that it supports large numbers of Horned Larks. We have noted moderate numbers of Horned Larks and Vesper Sparrows on areas adjacent to sites used by Grasshopper Sparrows on Marshall Mesa. This may indicate that increased grazing in this area might reduce Grasshopper Sparrow habitat.

Before a sound management plan can be developed for this species, fluctuations in the local population need to be documented, the physical characteristics of the habitat used may need to be determined, and the possible effects of grazing on vegetation structure and sparrow populations may need to be investigated.

Annual surveys of the 5 permanent transects established in this study will provide a cost-effective index for monitoring local fluctuations. Transect establishment was conducted in 1 day by 2 people and required 19.5 man-hours. Surveys in subsequent years would only require reflagging transects and replacing lost posts. Total survey time for the 3 replications was 20.0 man-hours and averaged 6.7 man-hours for 2 people to survey all 5 transects for each replication. Given the variability observed between 1986 replications, we recommend additional replications to increase accuracy and precision. If surveys will be conducted by more than 1 observer, we recommend presampling to reduce observer bias and/or measuring perpendicular distance between birds and the transect.

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