HABITAT USE BY BREEDING BIRDS I
OSMP Studies 3139
Study
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HABITAT USE BY BREEDING BIRDS ON CITY OF BOULDER OPEN SPACE, 1985

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.

20 March 1986

Western Ecosystems, Inc.
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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.

STUDY AREA

Open Space parcels were located in a 120 mi^2 area ($40^o5'$ to $39^o55'$N and $105^o19'$ to $105^o8'$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). 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 and 1985 field seasons, 13 parcels were added to the Open Space system amounting to an additional 763.8 ha (1,886.4 acres). Quality and areal extent of habitats present on these parcels significantly contributed to avifauna habitats and the species now observed on Open Space. Perhaps the most significant addition was the Ertl Conservation Easement which doubled the area of Open Space lakes and ponds. This parcel of reclaimed, flooded gravel pits is expected to develop into habitats similar to that found around Sawhill and Walden Ponds.

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, (2) mountain shrub, (3) coniferous (ponderosa pine) forest, (4) "native" grassland (undisturbed or lightly grazed), (5) agricultural grasslands (irrigated hayfields and/or heavily grazed pastures), and (6) lakes and ponds. 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.,

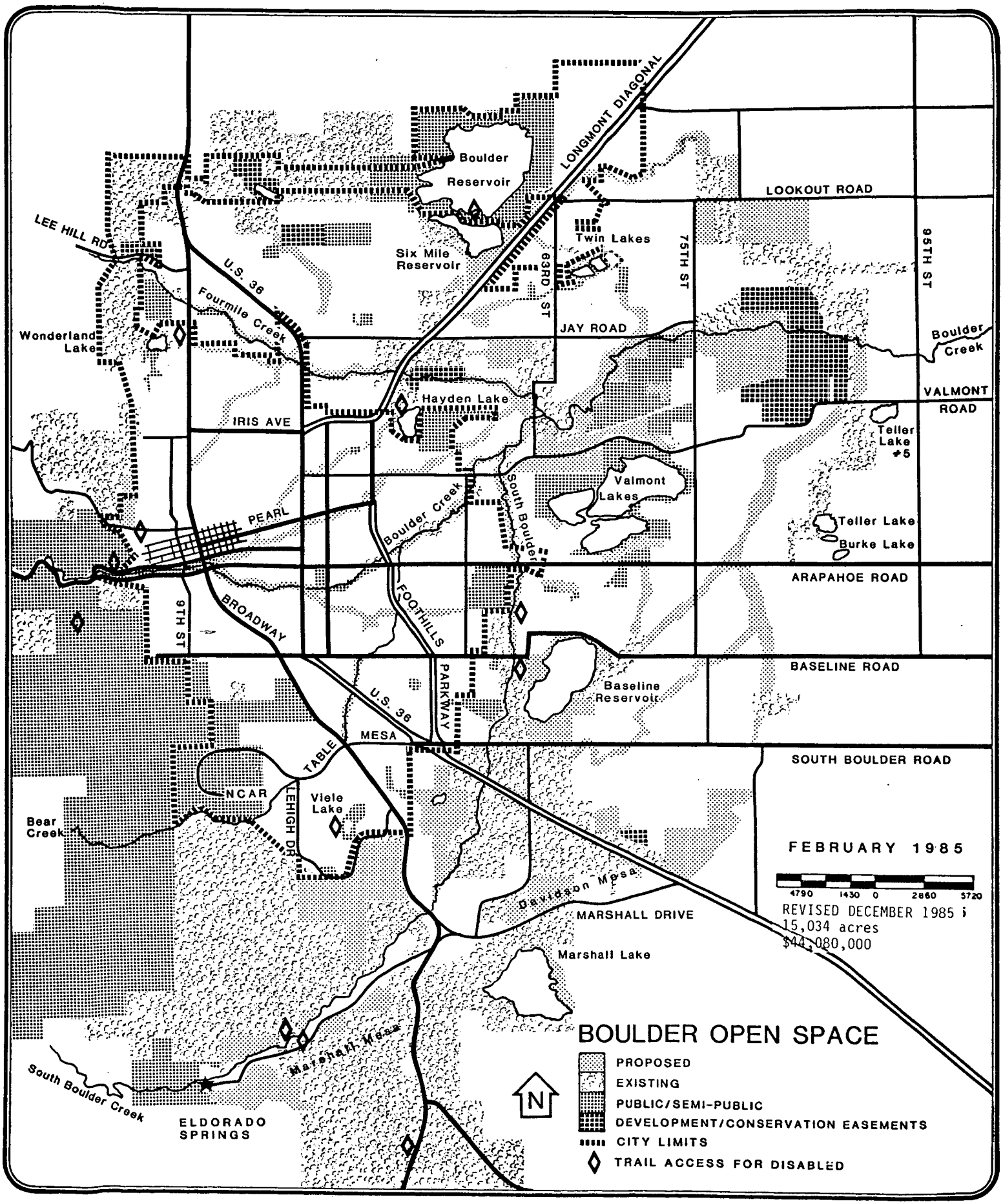

BOULDER OPEN SPACE
PROPOSED
EXISTING
PUBLIC/SEMI-PUBLIC
DEVELOPMENT/CONSERVATION EASEMENTS
CITY LIMITS
TRAIL ACCESS FOR DISABLED
N
FEBRUARY 1985
4790 1430 0 2860 5720
REVISED DECEMBER 1985
15,034 acres
$44,080,000
LONGMONT DIAGONAL
LOOKOUT ROAD
LEE HILL RD
U.S. 36
Fourmile Creek
Boulder Reservoir
Six Mile Reservoir
Twin Lakes
63RD ST
75TH ST
95TH ST
JAY ROAD
Wonderland Lake
Boulder Creek
Hayden Lake
VALMONT ROAD
IRIS AVE
Teller Lake #5
Valmont Lakes
South Boulder
PEARL
Boulder Creek
Teller Lake
Burke Lake
ARAPAHOE ROAD
9TH ST
BROADWAY
FOOTHILLS
PARKWAY
BASELINE ROAD
Baseline Reservoir
U.S. 36
MESA
TABLE
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 1985.

PARCEL	ACREAGE	ACREAGE OF HABITAT TYPES[a]											
		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.
ACREAGE OF HABITAT TYPES[a]

PARCEL	ACREAGE	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.
ACREAGE OF HABITAT TYPES[a]

PARCEL	ACREAGE	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.
ACREAGE OF HABITAT TYPES[a]

PARCEL	ACREAGE	G	C	A/G	MS	AG	R	D	W	B	L&P	CL	T
TOTALS[d]													
ACRES	13,361.15	5,768.5	2,471.1	2,639.0	571.6	910.9	372.7	223.4	109.0	113.3	135.8	15.1	1.0
HECTARES	5,409.4	2,335.4	1,000.4	1,068.4	231.4	368.8	150.9	90.4	44.1	45.9	55.0	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 The sum of habitat type areas does not equal total Open Space area due to rounding and measurement errors. Combined acreage errors account for 0.22% (29.75 acres) of total Open space acreage.

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. 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 plots (8 plots per habitat type x 5 types) was sampled 5 times between 10 May and 17 June (Rep. 1: 10-12 May; Rep. 2: 19-21 May; Rep. 3: 28-30 May; Rep. 4: 6-8 June; Rep. 5: 15-17 June), the peak of the 1985 breeding season. Observers (Thompson and Strauch) 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 ameliorated 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 transect boundaries during surveys and which demonstrated an affinity to the transect area were included in quantitative measurements. (e.g., a gull flying high over a grassland plot was not included). Young-of-the-year were noted, but not included in quantitative measurements.

Birds demonstrating an affinity towards a plot were considered breeders or transients. Breeders were those birds using habitats in the Boulder area while breeding. However, this should not imply that breeders utilizing a particular habitat were necessarily breeding in that habitat, only that they were using that habitat (e.g., for display purposes, maintainance activities, foraging for young, etc.) while breeding in that or a different habitat nearby. For example, a robin (scientific names are listed in Appendix A) observed foraging on a grassland plot was considered a breeder even though it nested in an adjacent riparian habitat. Transients were late migrants.

Species richness (S)(number of species present on a plot during each replication) and density (number of birds present on a 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 = $\bar{\bar{X}}_{i=1} = \sum_{i=1}^{5} n/5$ and habitat mean = $\sum_{i=1}^{8} \bar{X}/8$.

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 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 between 26 June and 21 July 1985 when most young would have left the nest, but before they could fly and leave the area. On 26 June we surveyed the following wetlands: Boulder Valley Ranch Reservoir, Mesa Reservoir, Wonderland Lake, the pond on the Burke 1 property, Teller Lake, all ponds in the Ertl Conservation Easement, the Short-Milne ponds, the wetland on the Gebhart property, the farm pond on the Church property just north of the Hogan's house (hereafter called Hogan Pond), the pond near the south boundary of the Church property (hereafter called Church Pond), the pond near the Open Space Ranger Headquarters (hereafter called Ranger Pond), a small pond on the Dunn 2 property, Flatirons Vista Reservoir, Marshall Lake (only along the north and west shores where Open Space extends to the water's edge), and Cowdrey Reservoir No. 2 (the entire reservoir, not just the area on Open Space). As in 1984, 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 use them indiscriminately. We were unable to obtain access and, therefore, survey the Valmont Lakes.

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 Gebhart property, and the pond on the Dunn 2 property. The remaining wetlands were surveyed on 26/28 June, 2/3, 8, 14 and 20/21 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 1985. 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 produced 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), Student-Newman-Keuls (SNK) multiple range tests and 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 tested between 1984 and 1985 using a mixed, two-way analysis of variance (2xN ANOVA) model. 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

Thirteen parcels representing 763.8 ha (1,886.4 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 now inhabit Open Space. As a result, comparison of 1984 and 1985 population estimates, waterfowl productivity, and total species richness are somewhat confused by bird use on these additional parcels and are, therefore, not necessarily comparable. However, breeding species richness and density estimates, obtained from the 40 permanent plots, are unaffected by additions to the system. Annual comparisons of these estimates are still valid indicators of population fluctuations.

BIRDS PRESENT ON OPEN SPACE

One-hundred-twenty breeding species and 133 breeders and transients were observed in the 6 major Open Space habitats during the 1985 breeding season (Table 2). This is the same number of breeders that was observed in 1984 (references to 1984 data are from Thompson and Strauch 1985). The greatest number of breeding species occurred in riparian habitats (68) followed by mountain shrub stands (57), agricultural grasslands (53), conifer habitats (43), grasslands (40), and lakes and ponds (29). This order is similar to that found in 1984 with the exception that conifer habitats and agricultural grassland switched positions. Also, with the exception of conifer habitats, more breeding species were observed in all habitats during 1985 than in 1984. 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). Nine (24%) of the 38 species observed on lakes and ponds were transients, the highest percentage of transients in any habitat. Combined numbers of breeding and transient species using habitats was similar to the relation for breeding species (Table 2).

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

BREEDING BIRD DENSITIES AND POPULATION ESTIMATES.

Thirty-five breeding species were observed in conifer habitats during the plot counts. Red Crossbills, Chipping Sparrows, Western Wood Pewees, Mourning

Table 2. Species of birds observed on Boulder Open Space, 9 April - 25 July 1985. Phylogenetic order and common names follow AOU (1983).

SPECIES	Habitat Type[a]					
	AG	G	R	MS	C	L&P
Pied-billed Grebe						B[b]
Eared Grebe						T
Western Grebe						B
American Bittern						B
Great Blue Heron			B			B
Great Egret						B
Snowy Egret						B
Green-backed Heron						B
Black-crowned Night-Heron	B		B			B
White-faced Ibis						T
Canada Goose	B		B		B	B
Wood Duck			B			
Mallard	B	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 Widgeon						T
Redhead						T
[c]Ring-necked Duck						T
[c]Common Merganser						B
Ruddy Duck						B
Turkey Vulture	B	B				
Osprey						T
Northern Harrier	B	B	B	B		
[c]Sharp-shinned Hawk	B					
Red-tailed Hawk	B	B	B	B	B	
[c]Golden Eagle		B		B	B	
American Kestrel	B	B	B	B		

Table 2. Continued.

SPECIES	Habitat Type[a]					
	AG	G	R	MS	C	L&P
Ring-necked Pheasant	B	B	B	B		
[c]Blue Grouse					B	
Virginia Rail	B					
American Coot						B
American Avocet						B
Killdeer	B	B	B			B
Greater Yellowlegs						T
Lesser Yellowlegs						T
Spotted Sandpiper			B			B
Common Snipe	B		B			
Wilson's Phalarope	B					B
Ring-billed Gull	T					
California Gull	T					
Forster's Tern						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		
Northern Pygmy-Owl					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		B
Downy Woodpecker			B		B	
Hairy Woodpecker					B	
Northern Flicker	B	B	B	B	B	
Western Wood Pewee			B	B	B	
Willow Flycatcher		B				
Hammond's Flycatcher			B	B		
[c]Say's Phoebe		B				

Table 2. Continued.

SPECIES	Habitat Type[a]					
	AG	G	R	MS	C	L&P
Western Kingbird	B	B	B			
Eastern Kingbird	B		B	B		
Horned Lark	B	B				
Tree Swallow		B	B			B
Violet-green Swallow	B	B	B	B	B	B
Northern Rough-winged Swallow			B			
Bank Swallow		B	B			
Cliff Swallow	B	B	B	B		B
Barn Swallow	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	
Common Raven	B	B		B	B	
Black-capped Chickadee			B			
Mountain Chickadee				B	B	
Red-breasted Nuthatch					B	
Pygmy Nuthatch					B	
Rock Wren		B		B		
House Wren			B	B		
American Dipper			B			
Townsend's Solitaire					B	
Swainson's Thrush			T			
American Robin	B		B	B	B	
Gray Catbird			B	B		
Sage Thrasher		T		T		
Loggerhead Shrike	B					
European Starling	B	B	B	B	B	
Solitary Vireo					B	
Red-eyed Vireo			B			
Virginia's Warbler				B	B	

Table 2. Continued.

SPECIES	Habitat Type[a]					
	AG	G	R	MS	C	L&P
Yellow Warbler	B		B	B	B	
Yellow-rumped Warbler			B	B	B	
McGillivray's Warbler				B		
Common Yellowthroat	B	B	B	B		
Wilson's Warbler			B	B		
Yellow-breasted Chat			B	B		
Western Tanager					B	
Black-headed Grosbeak			B	B	B	
Blue Grosbeak		B	B	B		
Lazuli Bunting			B	B		
Indigo Bunting				B		
Dickcissel		B				
Green-tailed Towhee				B	B	
Rufous-sided Towhee		B	B	B	B	
Chipping Sparrow		B	B	B	B	
Brewer's Sparrow	B	T		B		
Vesper Sparrow	B	B		B	B	
Lark Sparrow	B	B			B	
[c]Lark Bunting	T					
Savannah Sparrow	B					
Grasshopper Sparrow	B	B				
Song Sparrow	B	B	B	B		
Lincoln's Sparrow			B	B		
White-crowned Sparrow			B	B		
Dark-eyed Junco				B	B	
Bobolink	B		B			
Red-winged Blackbird	B	B	B			B
Western Meadowlark	B	B	B	B	B	
Yellow-headed Blackbird			B			B
Brewer's Blackbird	B	B	B			
Common Grackle	B	B	B	B	B	
Brown-headed Cowbird	B		B	B	B	

Table 2. Continued.

SPECIES	Habitat Type[a]					
	AG	G	R	MS	C	L&P
Northern Oriole	B	B	B	B		
House Finch	B		B			
Red Crossbill				B	B	
Pine Siskin	B			B	B	
Lesser Goldfinch			B	B		
American Goldfinch	B		B	B	B	
Evening Grosbeak					B	
House Sparrow	B		B			
Total Breeding Species	53	40	68	57	43	29
Total Species	56	42	69	58	43	38

Total Breeding Species in all Habitats = 120 (120 in 1984)

Total Species in all Habitats = 133 (145 in 1984)

[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.

Doves, American Robins, and Rufous-sided Towhees were the most abundant species and together accounted for 71% of the population in this habitat (Table 3). These were also the 6 most common species in 1984, although their order differed.

Red Crossbills were the only breeding species on Open Space whose 1985 density (43.63±32.89/10 ha) differed from their 1984 density (5.3±3.5/10 ha). Crossbill numbers alone represented 45% of all birds observed on conifer plots. Flocks greater than 500 birds were observed on the Stengel 2 parcel. Crossbills were observed on all 8 conifer plots and 155 were recorded on plot C2 (Stengel 2) during a 15-minute count on 12 May.

Red Crossbill occurrence in a given area is erratic; the species may be abundant in one year and then absent in others. This pattern depends on the local abundance of cone crops on which the birds depend. 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 density in conifer habitat was 96.25±40.81 birds/10 ha (Table 3), an increase from 1984's 65±15 birds/10 ha, due primarily to increased Crossbill numbers. The 1985 bird population in conifer habitat 9,625±4,081, up from 1984's 6,444±1,480 birds, again due to the estimated 4,365±3,290 Crossbills (Table 3). Only 14.1 ha (34.9 acres) of conifer habitat was added to the system in 1985 and this addition represents 1.4% of the total conifer habitat.

Riparian habitats contained more breeding species (57) at higher mean densities (101.25±21.92 birds/10 ha) than other Open Space habitats (Table 4). The density is similar to 1984's 104.0±34.9 birds/10ha. The total 1985 riparian population was 1,974±427 birds, up from 1,710±575 birds in 1984. This 15% population increase is largely due to 1985's 19% increase in the area of existing riparian and wetland habitats. Red-winged Blackbirds, European Starlings, Black-billed Magpies, American Goldfinches and Brown-headed Cowbirds were the most abundant species

Table 3. Mean 1985 plot densities, mean habitat densities, and Boulder Open Space population estimates for breeding birds in conifer habitat.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 90% CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Mourning Dove	3.2	1.4	0.6	0	0.2	1.0	0.8	0.6	4.88 ± 3.35	488 ± 336
Common Nighthawk	0.2	1.6	0	0	0	0	0	0	1.13 ± 1.88	113 ± 188
White-throated Swift	0	0	0.2	0	0	0	0	0	0.13 ± 0.24	13 ± 24
Broad-tailed Hummingbird	0	0	0.2	0	0	0	0.2	0.2	0.38 ± 0.35	38 ± 35
Downy Woodpecker	0	0	0	0	0	0.2	0	0	0.13 ± 0.24	13 ± 24
Hairy Woodpecker	0	0	0.2	0	0	0.4	0.2	0	0.50 ± 0.51	50 ± 51
Northern Flicker	0	0	0	0	0	0.2	0	0.4	0.38 ± 0.50	38 ± 50
Western Wood Pewee	1.0	1.8	2.0	0.4	1.2	1.2	1.2	0.2	5.63 ± 2.06	563 ± 206
Violet-green Swallow	0	0.6	0	0	0	0	0	1.6	1.38 ± 1.93	138 ± 193
Steller's Jay	0.6	0.2	0	0.2	0	1.4	0.4	1.0	2.38 ± 1.68	238 ± 168
Black-billed Magpie	0.2	0	0.8	0.4	0	0.4	0.2	0.4	1.50 ± 0.88	150 ± 88
American Crow	0	0	0	0	0.2	0	0	0.4	0.38 ± 0.50	38 ± 50
Common Raven	0	0	0	0	0	0	0	0.2	0.13 ± 0.24	13 ± 24
Mountain Chickadee	0.6	0.8	0	0.8	0.6	0.6	0.2	0	2.25 ± 1.12	225 ± 112
Red-breasted Nuthatch	0	0	0.4	0	0	0	0	0.2	0.38 ± 0.50	38 ± 50
Pygmy Nuthatch	0.2	0	1.0	0	0	0.2	0	0	0.88 ± 1.16	88 ± 116
Townsend's Solitaire	0	0	0	0.2	0.2	0	0.4	0	0.50 ± 0.51	50 ± 51
American Robin	0.8	1.4	0	0.4	1.0	0.4	1.0	1.4	4.00 ± 1.68	400 ± 168
European Starling	0	0	0	0	0	0	0	0.2	0.13 ± 0.24	13 ± 24
Solitary Vireo	0.6	0.4	0	0	1.0	0.2	0.8	0	1.88 ± 1.31	188 ± 131
Virginia's Warbler	0	0	0	0	0	0.4	0.4	0	0.50 ± 0.62	50 ± 62
Yellow Warbler	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	13 ± 24
Yellow-rumped Warbler	0	0.2	0	0	0	0.6	0	0.4	0.75 ± 0.78	75 ± 78
Western Tanager	0	0	0	0	0.2	0.2	0.4	0.2	0.63 ± 0.50	63 ± 50
Rufous-sided Towhee	0.4	0.2	1.6	0.4	0.4	0.8	1.0	0.8	3.50 ± 1.52	350 ± 152
Chipping Sparrow	1.8	0.4	1.2	2.0	2.0	1.2	1.2	0.4	6.38 ± 2.15	638 ± 215
Vesper Sparrow	0	3.0	0	0	0	0	0	0	1.88 ± 3.55	188 ± 355
Lark Sparrow	0	2.0	0	0	0	0	0	0	1.25 ± 2.37	125 ± 237
Dark-eyed Junco	0.4	0	0	0	0.4	0	0	0.6	0.88 ± 0.84	88 ± 84

Table 3. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 90% CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Western Meadowlark	0	0.4	0.2	0.6	0	0	0	0	0.75 ± 0.78	75 ± 78
Brown-headed Cowbird	0.4	1.0	0.2	0	0.4	0.8	0.8	1.0	2.88 ± 1.26	288 ± 126
Red Crossbill	3.6	32.2	9.2	5.6	5.0	6.4	0.6	7.2	43.63 ± 32.89	4,365 ± 3,290
Pine Siskin	0.8	0.2	0	0.4	0.8	0	0.6	0.6	2.13 ± 1.10	213 ± 110
American Goldfinch	0	0.6	0	0	0	0.4	0	0	0.63 ± 0.80	63 ± 80
Unidentified Finch	0	0	0	0	0	0	0	0.2	0.13 ± 0.24	13 ± 24
Evening Grosbeak	0	0	0.2	0	1.0	0	0.4	0	1.00 ± 1.19	100 ± 119
Total Plot Density	14.8	48.6	18.0	11.4	14.6	17.4	11.0	18.2	96.25 ± 40.81	9,625 ± 4,081
Total Birds Observed	74	243	90	57	73	87	55	91	770[c]	
Total Species Observed	15	18	14	11	15	19	19	21	35[d]	

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

[b]Estimates are number of birds ± 90% confidence interval in 1,000.4 ha (2,471.1 acres) of conifer habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Table 4. Mean 1985 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 ± 90%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Great Blue Heron	0	0	0.8	0	0.8	0.2	0	0	1.13 ± 1.21	22 ± 24
Black-crowned Night Heron	0	0	0.2	0	0	0.4	0	0	0.38 ± 0.50	7 ± 10
Canada Goose	0	0	0.2	0	0	0.4	0	0	0.38 ± 0.50	7 ± 10
Wood Duck	0	0	0.6	0	0	0.8	0	0	0.88 ± 1.10	17 ± 22
Mallard	1.0	0.4	1.6	0.2	1.6	1.4	0	0.8	4.38 ± 2.12	85 ± 41
Blue-winged Teal	0	0	0.4	0	0.4	0	0	0	0.50 ± 0.62	10 ± 12
Cinnamon Teal	0	0	0	0	0.4	0.4	0	0	0.50 ± 0.62	10 ± 12
American Kestrel	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	3 ± 5
Ring-necked Pheasant	0	0	0	0.4	0	0.2	0	0	0.38 ± 0.50	7 ± 10
Spotted Sandpiper	0	0	0	0	0	0	0	0.4	0.25 ± 0.47	5 ± 9
Common Snipe	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	3 ± 5
Rock Dove	0	0	0.2	0	0	0.6	0.2	0	0.63 ± 0.71	12 ± 14
Mourning Dove	0.8	0.2	1.2	0	0.6	1.0	0	0.4	2.63 ± 1.52	51 ± 30
Great Horned Owl	0	0	0	0.8	0	0.4	0	0	0.75 ± 1.00	15 ± 20
Common Nighthawk	0	0	0	0	0	0	0	0.2	0.13 ± 0.24	3 ± 5
Downy Woodpecker	0	0	0	0.2	0	0	0	0	0.13 ± 0.24	3 ± 5
Northern Flicker	0.4	1.6	0	1.6	0	0.4	0.6	0	2.88 ± 2.25	56 ± 44
Western Wood Pewee	0.4	0	0.2	0	0	0.2	0	0.2	0.63 ± 0.50	12 ± 10
Hammond's Flycatcher	0.6	0	0	0	0	0	0	0	0.38 ± 0.71	7 ± 14
Western Kingbird	0	0	0	0	0	0.4	0	0	0.25 ± 0.47	5 ± 9
Tree Swallow	0	0	0.2	0	0	0	0	0	0.13 ± 0.24	3 ± 5
Violet-green Swallow	0	0.2	0	0	0	0	0	0	0.13 ± 0.24	3 ± 5
Northern Rough-winged Swallow	0.4	0	0.2	0	0.2	0	0	0	0.50 ± 0.51	10 ± 10
Bank Swallow	0	0	0	0	1.2	0	0	0	0.75 ± 1.42	15 ± 28
Cliff Swallow	1.0	0.2	0.4	0	0.6	0	0	1.0	2.00 ± 1.43	39 ± 28
Barn Swallow	1.8	0	0.2	0	0.8	0	0	0	1.75 ± 2.17	34 ± 42
Black-billed Magpie	0.2	5.2	0	3.8	0.2	3.2	0.6	1.0	8.89 ± 6.69	173 ± 131
American Crow	0.4	0.2	0	0.6	0	0	0	0	0.75 ± 0.78	15 ± 15
Black-capped Chickadee	0.8	1.8	0	0.2	0	0.6	0	0.6	2.50 ± 2.06	49 ± 40
House Wren	0	0.2	0	0	0	0.4	0	0.4	0.63 ± 0.61	12 ± 12

Table 4. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a] 1	2	3	4	5	6	7	8	MEAN HABITAT DENSITY (n/10ha ± 90%CI)	OPEN SPACE POPULATION[b]
American Dipper	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	3 ± 5
American Robin	0	0.2	1.0	0.2	0.4	0.2	0	0	1.25 ± 1.19	24 ± 22
Gray Catbird	0	0	0	0.2	0	0	0.4	0.8	0.88 ± 0.98	17 ± 19
European Starling	3.2	4.2	0.6	2.4	0.2	3.0	0.4	0.8	9.25 ± 5.14	180 ± 100
Red-eyed Vireo	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	3 ± 5
Yellow Warbler	0	0	0.2	0.4	0	0.4	0.4	2.0	2.13 ± 2.22	42 ± 43
Yellow-rumped Warbler	0	0	0	0.2	0	0.2	0	0	0.25 ± 0.31	5 ± 6
Common Yellowthroat	1.2	0.2	1.2	1.0	2.0	2.0	0	0	4.75 ± 2.74	93 ± 54
Wilson's Warbler	0.2	0	0	0	0.2	0	0.4	0	0.50 ± 0.51	10 ± 10
Yellow-breasted Chat	0	0	0	0	0	0	0.2	0.8	0.63 ± 0.94	12 ± 18
Black-headed Grosbeak	0	0	0	0	0	0	0.2	0.2	0.25 ± 0.31	5 ± 6
Lazuli Bunting	0	0	0	0	0	0.4	0.4	0.2	0.63 ± 0.61	12 ± 12
Rufous-sided Towhee	0	0	0	0.2	0	0	0.2	2.4	1.75 ± 1.47	34 ± 29
Chipping Sparrow	0	0	0	0	0	0	0	0.4	0.25 ± 0.47	5 ± 9
Song Sparrow	0	0.4	1.4	0.8	1.4	0.8	1.6	0.4	4.25 ± 1.92	83 ± 37
Lincoln's Sparrow	0	0	0.2	0	0	0	0	0.4	0.38 ± 0.50	7 ± 10
White-crowned Sparrow	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	3 ± 5
Red-winged Blackbird	1.0	0.4	3.8	2.8	15.0	0.6	0	0.4	15.00 ± 16.84	293 ± 328
Western Meadowlark	0.4	0.2	1.4	0	0.2	0.4	0.2	2.0	3.00 ± 2.38	59 ± 46
Brewer's Blackbird	0.2	0	0	0	0	0	0	0.6	0.50 ± 0.72	10 ± 14
Common Grackle	2.0	0.6	1.8	1.0	0.2	1.0	0.6	0.2	4.63 ± 2.26	90 ± 44
Brown-headed Cowbird	0.2	0	1.4	0.2	1.8	1.2	0.2	3.2	5.13 ± 3.71	100 ± 72
Northern Oriole	0	0	0	0	0	0.4	0.4	1.2	1.25 ± 1.42	24 ± 28
House Finch	0	0	0	0.6	0	0	0	0	0.38 ± 0.71	7 ± 14
Lesser Goldfinch	0	0	0.4	0	0	0	0	0	0.25 ± 0.47	5 ± 9
American Goldfinch	0.4	0	1.6	0	3.0	0.8	2.0	4.8	7.88 ± 5.60	154 ± 109
House Sparrow	0	0.2	0	0.4	0	0	0	0	0.38 ± 0.50	7 ± 10

Table 4. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 90%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Total Plot Density	17.0	16.4	21.4	18.2	31.2	22.4	9.6	25.8	101.25 ± 21.92	1,974 ± 427
Total Birds Observed	85	82	107	91	156	112	48	129	810[c]	
Total Species Observed	22	17	25	21	15	29	20	26	57[d]	

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

[b]Estimates are number of birds ± 90% confidence interval in 195 ha (481.7 acres) of riparian and wetland habitats.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

together representing 45.6% 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 a similar 46% of the population.

Forty-eight breeding bird species were observed on plots in mountain shrub habitats. Mean 1985 breeding density (65.38 $\pm$ 6.42 birds/10ha) in mountain shrub (Table 5) was virtually identical to that in 1984 (65.0 $\pm$ 12.5 birds/10ha). The 1985 breeding population was estimated at 1,513 $\pm$ 148 birds with Rufous-sided Towhees, Lazuli Buntings, Black-billed Magpies, and Green-tailed Towhees comprising 43% of the species present (Table 5). Composition and order of these 4 most abundant species was unchanged from 1984 when they together represented 52% of the species present. The 10% increase in 1985's population over that of 1984 is consistent with the additional area of recently acquired mountain shrub habitat.

In both 1984 and 1985, grassland habitats had the lowest number of breeding species (25 in 1985) and the lowest mean density (40.5 $\pm$ 17.71 birds/ha) for major habitats in the Open Space system (Table 6). Although the 90% confidence limits of 1984 and 1985 density estimates overlap, the 1985 mean is considerably larger (67%) than the 1984 estimate of 24.3 $\pm$ 8.7 birds/10ha. Similarly, the 1985 breeding population of 9,458 $\pm$ 4,136 birds was 92% larger than the 1984 mean of 4,913 $\pm$ 1,759 birds. 1985 additions of Open Space parcels only increased grassland acreage (and consequent population estimate) by 16%. Therefore, it appears that the density of grassland birds may have been higher in 1985. Western Meadowlarks, Cliff Swallows, and Vesper Sparrows were 1985's 3 most common species accounting for 70% of breeding birds. Meadowlarks alone represented 32% of the population.

Twenty-nine breeding species were observed on agricultural grassland plots, one less species than in 1984. Red-winged Blackbirds, Western Meadowlarks, Common Grackles, and Barn Swallows accounted for 64% of the population, estimated at 8,387 $\pm$ 3,171 birds (Table 7). In 1984, Red-winged Blackbirds, Meadowlarks, and Cliff and Barn Swallows accounted for a similar 67% of the population, estimated at 5,489 $\pm$ 3,036 birds. Red-winged Blackbird numbers, which alone represented 44% of the population in 1984, accounted for 37% of the 1985 population estimate.

Table 5. Mean 1985 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 ± 90%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Mallard	0	0.4	0	0	0	0	0	0	0.25 ± 0.47	6 ± 11
Northern Harrier	0	0.2	0	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Red-tailed Hawk	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	3 ± 6
American Kestrel	0	0.2	0.2	1.4	0	0	0	0	1.13 ± 1.62	26 ± 27
Mourning Dove	0	1.8	0	0.6	0	0	0.4	0	1.75 ± 2.11	40 ± 49
White-throated Swift	0	0	0	0	1.0	0	0.2	0	0.75 ± 1.17	17 ± 27
Broad-tailed Hummingbird	0	0	0.2	0	0.4	0.2	0	2.4	2.00 ± 2.75	46 ± 64
Northern Flicker	0	0	0	0	0	0	0.6	0	0.38 ± 0.71	9 ± 16
Western Wood Pewee	0.2	0	0	0	0	0.4	0	0	0.38 ± 0.50	9 ± 12
Hammond's Flycatcher	0.6	0	0	0	0	0	0.2	0	0.50 ± 0.72	12 ± 17
Eastern Kingbird	0	0	0	0.2	0	0	0	0	0.13 ± 0.24	3 ± 6
Violet-green Swallow	0	0	0	0	1.2	0	0	0.4	1.00 ± 1.43	23 ± 33
Cliff Swallow	0	0.2	0	0.2	0	0	0	0	0.25 ± 0.31	6 ± 7
Barn Swallow	0	0.6	0.2	0.2	0	0	0	0	0.63 ± 0.71	15 ± 16
Black-billed Magpie	0.6	1.4	0.6	2.2	0.2	1.0	1.4	0.4	4.89 ± 2.22	113 ± 51
Common Raven	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Mountain Chickadee	0	0	0	0	0	0.2	0	0	0.13 ± 0.24	3 ± 6
Rock Wren	0	0.8	0.4	0.8	0	0.2	2.0	0.2	2.75 ± 2.23	64 ± 52
House Wren	0	2.8	0	0.2	0.6	0	1.0	0.4	3.13 ± 3.17	72 ± 73
American Robin	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	3 ± 6
Gray Catbird	0	0	0	0	0.4	0	0	0	0.25 ± 0.47	6 ± 11
European Starling	0	2.4	0	2.2	0	0	0	0	2.88 ± 3.57	67 ± 83
Virginia's Warbler	0.8	0	0.4	0	0.8	0	0	1.4	2.13 ± 1.77	49 ± 41
Yellow Warbler	0	0.2	0	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Yellow-rumped Warbler	0	0	0	0	0	0	0.8	0	0.50 ± 0.95	12 ± 22
McGillivray's Warbler	0.2	0	0.4	0	0.6	0	0.2	0	0.88 ± 0.75	20 ± 17
Wilson's Warbler	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Yellow-breasted Chat	1.2	0	0	0	1.0	0.4	0.2	0.8	2.25 ± 1.63	52 ± 38
Black-headed Grosbeak	0	0	0	0	0.6	0	0	0.4	0.63 ± 0.80	15 ± 19
Indigo Bunting	0	0	0	0	0	0.2	0	0.2	0.25 ± 0.31	6 ± 7
Lazuli Bunting	1.0	0	1.8	0.2	2.8	0.2	1.6	2.0	6.00 ± 3.40	139 ± 79
Green-tailed Towhee	2.2	0.6	0.4	0	0.6	2.0	0.4	0.6	4.25 ± 2.67	98 ± 62

Table 5. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a] 1	2	3	4	5	6	7	8	MEAN HABITAT DENSITY (n/10ha ± 90%CI)	OPEN SPACE POPULATION[b]
Rufous-sided Towhee	3.2	0	3.6	0.2	3.0	2.6	3.4	4.8	13.00 ± 5.59	301 ± 129
Chipping Sparrow	0	0.2	0.2	0	0.4	1.8	0	1.0	2.25 ± 2.14	52 ± 50
Brewer's Sparrow	0	0.4	0	0	0	0.2	0.8	0	0.88 ± 0.98	20 ± 23
Vesper Sparrow	0	0	0.4	0	0	0.4	0	0	0.50 ± 0.62	12 ± 14
Song Sparrow	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Lincoln's Sparrow	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	3 ± 6
White-crowned Sparrow	0	0	0	0	0	0.2	0	0	0.13 ± 0.24	3 ± 6
Unidentified Sparrow	0	0	0.2	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Dark-eyed Junco	0	0	0.2	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Western Meadowlark	0.2	1.0	0.4	0.8	0	1.4	0.6	0	2.75 ± 1.67	64 ± 39
Common Grackle	0	0.2	0	0.2	0	0	0	0	0.25 ± 0.31	6 ± 7
Brown-headed Cowbird	0.8	0	0.4	0.2	0.4	0.8	1.0	0.2	2.38 ± 1.18	55 ± 27
Northern Oriole	0	0.2	0	0	0	0	0	0	0.13 ± 0.24	3 ± 6
Red Crossbill	0.4	0	0	0	0	0	0	0	0.25 ± 0.47	6 ± 11
Pine Siskin	0	0	0	0	0	0.4	0	0	0.25 ± 0.47	6 ± 11
Lesser Goldfinch	0	0	0	0	0.2	0	0	0	0.13 ± 0.24	3 ± 6
American Goldfinch	0.6	0	0	1.4	0	0	0	0	1.24 ± 1.71	29 ± 40
Total Plot Density	12.6	13.6	10.0	11.0	14.2	12.6	15.4	15.2	65.38 ± 6.42	1,513 ± 148
Total Birds Observed	63	68	50	55	71	63	77	76	523[c]	
Total Species Observed	16	17	15	15	16	17	19	14	48[d]	

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

[b]Estimates are number of birds ± 90% confidence interval in 231.4 ha (571.6 acres) of mountain shrub habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Table 6. Mean 1985 plot densities, mean habitat densities, and Boulder Open Space population estimates for breeding birds in grassland habitat.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 90%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Mallard	0	0	0	0	0	0	0.2	0	0.13 ± 0.24	30 ± 56
American Kestrel	0.2	0	0	0.2	0	0	0	0	0.25 ± 0.31	58 ± 72
Killdeer	0	0	0	0	0	0.2	0	0	0.13 ± 0.24	30 ± 56
Mourning Dove	0.2	0	0	0	0.8	0.4	0	0.4	1.13 ± 0.98	263 ± 228
Common Nighthawk	0	0	0	0	0.2	0	0	0	0.13 ± 0.24	30 ± 56
White-throated Swift	0	0	0	0	0.4	0	0	0	0.25 ± 0.47	58 ± 110
Tree Swallow	0	0	0	0.2	0	0	0	0	0.13 ± 0.24	30 ± 56
Violet-green Swallow	0	0.2	0	0	0	0	0	0	0.13 ± 0.24	30 ± 56
Bank Swallow	0.6	0	0	0	0	0	0	0	0.38 ± 0.71	89 ± 166
Cliff Swallow	0.2	0	0	0	0	0	15.6	0	9.88 ± 18.44	2,306 ± 4,307
Barn Swallow	0.6	0	0	0.2	0	0	0.2	0.2	0.75 ± 0.69	175 ± 162
Black-billed Magpie	0.6	1.2	0	0.2	0	0.2	0	0	1.38 ± 1.43	321 ± 334
Rock Wren	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	30 ± 56
European Starling	4.4	0.2	0.2	0	0	0	0	0.2	3.13 ± 5.12	730 ± 1,196
Blue Grosbeak	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	30 ± 56
Rufous-sided Towhee	0	0	0	0.2	0	0	0	0	0.13 ± 0.24	30 ± 56
Chipping Sparrow	0	0	0.6	0	0	0	0	0	0.38 ± 0.71	89 ± 166
Brewer's Sparrow	0	0	0	0	0	0.2	0	0.2	0.25 ± 0.31	58 ± 72
Vesper Sparrow	0	0	0.2	0	2.2	4.0	0	2.2	5.38 ± 5.14	1,255 ± 1,200
Lark Sparrow	0	0	0.2	0	0	0	0	2.2	1.50 ± 2.58	350 ± 603
Grasshopper Sparrow	0	0	0	0	0	0.4	0.4	0	0.50 ± 0.62	117 ± 145
Red-winged Blackbird	0.8	0	0	0	0	0.4	0.6	0	1.13 ± 1.10	263 ± 257
Western Meadowlark	2.6	1.0	3.6	2.4	2.4	3.4	2.0	3.4	13.00 ± 2.91	3,036 ± 679
Brewer's Blackbird	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	30 ± 56
Common Grackle	0.2	0	0	0	0	0	0	0	0.13 ± 0.24	30 ± 56

Table 6. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 90%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Total Plot Density	11.0	2.6	4.2	4.0	6.0	9.2	19.0	8.8	40.50 ± 17.71	9,458 ± 4,136
Total Birds Observed	55	13	21	20	30	46	95	44	324[c]	
Total Species Observed	13	4	4	7	5	8	6	7	25[d]	

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

[b]Estimates are number of birds ± 90% confidence interval in 2,335.4 ha (5,768 acres) of grassland habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Table 7. Mean 1985 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]								MEAN HABITAT DENSITY (n/10ha ± 90%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Mallard	1.2	0.2	0	0	0.6	0	0	1.0	1.88 ± 1.66	200 ± 177
Northern Harrier	0	0	0	0.2	0	0	0	0	0.13 ± 0.24	14 ± 26
Red-tailed Hawk	0	0	0	0	0.2	0	0.2	0	0.25 ± 0.31	27 ± 33
American Kestrel	0	0	0	0	0.2	0	0	0	0.13 ± 0.24	14 ± 26
Killdeer	0	0	0.4	0	0	0.6	0	0	0.63 ± 0.80	67 ± 85
Common Snipe	1.0	0	0.2	0	0.6	1.4	0	1.2	2.75 ± 1.95	294 ± 209
Wilson's Phalarope	0	0	0	0	0	3.2	0	1.2	2.75 ± 3.85	294 ± 412
Rock Dove	0	1.6	0	0	0	0	0	0.4	1.25 ± 1.89	134 ± 202
Mourning Dove	0.2	0.8	0	0.2	1.2	0.2	0.2	0.2	1.88 ± 1.36	200 ± 145
Northern Flicker	0	0.2	0	0	0	0	0	0	0.13 ± 0.24	14 ± 26
Western Kingbird	0	0	0	0	0.2	0	0	0	0.13 ± 0.24	14 ± 26
Horned Lark	0	0	0.8	0	0	0	0	0	0.50 ± 0.95	53 ± 101
Violet-green Swallow	0	0.4	0	0	0	0	0	0	0.25 ± 0.47	27 ± 50
Cliff Swallow	0.2	1.6	0.2	0	1.8	1.6	0.4	0.4	3.88 ± 2.52	414 ± 269
Barn Swallow	0.2	1.2	0.8	0	0.8	2.0	1.2	1.6	4.88 ± 2.25	521 ± 240
Black-billed Magpie	0	0.4	0	0	0	0	0.4	0	0.50 ± 0.62	53 ± 66
American Crow	0.8	0	0	0.2	0	0	0	0	0.63 ± 0.94	67 ± 101
American Robin	0	0	0	0	0	0.8	0	0.4	0.75 ± 1.00	80 ± 107
European Starling	2.8	0.8	0	0.2	0	1.4	0	1.4	4.13 ± 3.35	441 ± 358
Vesper Sparrow	0.2	0.2	1.6	1.6	0	0	0	0	2.25 ± 2.40	240 ± 256
Lark Sparrow	0	0	0.6	0	0	0	0	0	0.38 ± 0.71	41 ± 76
Bobolink	1.8	0	0	0	0	0	0	0	1.13 ± 2.13	120 ± 228
Red-winged Blackbird	14.2	0.8	2.8	1.4	1.8	12.8	0	12.8	29.13 ± 20.86	3,112 ± 2,229
Western Meadowlark	0.6	2.4	2.8	3.0	3.6	1.4	2.8	0.6	10.75 ± 3.82	1,149 ± 408
Brewer's Blackbird	0.2	0	0	0	0	0	0.8	0	0.63 ± 0.94	67 ± 101
Common Grackle	1.8	1.2	0	0	0.8	3.6	0	1.6	5.63 ± 4.14	601 ± 443
Brown-headed Cowbird	0	0	0.2	0	0	0	0	0	0.13 ± 0.24	14 ± 26
American Goldfinch	0	1.0	0	0	0	0.2	0	0	0.75 ± 1.17	80 ± 125
House Sparrow	0.2	0.4	0	0	0	0	0	0	0.38 ± 0.50	41 ± 53

Table 7. Continued.

SPECIES	MEAN PLOT DENSITY (n/2ha)[a]								MEAN HABITAT DENSITY (n/10ha ± 90%CI)	OPEN SPACE POPULATION[b]
	1	2	3	4	5	6	7	8		
Total Plot Density	25.4	13.2	10.4	6.8	11.8	29.2	6.0	22.8	78.5 ± 29.68	8,387 ± 3,171
Total Birds Observed	127	66	52	34	59	146	30	114	628[c]	
Total Species Observed	14	15	10	7	11	12	7	12	29[d]	

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

[b]Estimates are number of birds ± 90% confidence interval in 1,068.4ha (2,639 acres) of agricultural grassland habitat.

[c]Total birds observed during plot counts.

[d]Total species observed during plot counts.

Although the 1985 population mean was 53% larger than the 1984 estimate, while agricultural grassland habitats increased only 12% since 1984, the confidence limits surrounding the 1984-85 estimates overlap. Mean habitat density was 78.5 $\pm$ 29.7 birds/10ha (Table 7) compared to 57.5 $\pm$ 31.8 birds/10ha in 1984. This density estimate, 37% higher than in 1984, does not differ statistically with the 1984 estimate.

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 90% confidence interval, which follow the density and population estimates, simply means that we are 90% confident that the actual value lies within this interval. For example, there is a 90% probability that the 1985 breeding bird population in Open Space conifer habitat is between 5,544 and 13,706 birds (9,625 $\pm$ 4,081) (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. 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 Table 8 which have no 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 a plot count.

As discussed above, estimates derived from plot counts are less accurate for uncommon species and groups such as raptors and waterfowl. For this and additional reasons, raptor and waterfowl numbers were estimated by total counts.

Table 8. Summary of 1985 habitat densities and population estimates for breeding birds in major Boulder Open Space habitats.

SPECIES	MEAN/HABITAT/DENSITY (n/10ha ± 90% CI)						POPULATION[c]
	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	
Pied-billed Grebe						9	9.0
Western Grebe[d]							
American Bittern						1	1.0
Great Blue Heron		1.13 ± 1.21				14	22 ± 24
Great Egret[e]						1	1.0
Snowy Egret[d]							
Green-backed Heron[d]							
Black-crowned Night-Heron		0.38 ± 0.50				9	7 ± 10
Canada Goose		0.38 ± 0.50				110	110
Wood Duck		0.88 ± 1.10					17 ± 22
Mallard		4.38 ± 2.12	0.25 ± 0.47	0.13 ± 0.24	1.88 ± 1.36	56	377 ± 285
Blue-winged Teal		0.50 ± 0.62				8	10 ± 12
Cinnamon Teal						5	5.0
Green-winged Teal						2	2.0
Northern Shoveler[d]							
Gadwall						1	1.0
Common Merganser							
Ruddy Duck						2	2.0
Turkey Vulture[e]							
Northern Harrier			0.13 ± 0.24		0.13 ± 0.24		17 ± 32
Sharp-shinned Hawk[d]							
Red-tailed Hawk			0.13 ± 0.24		0.25 ± 0.31		30 ± 39
Golden Eagle[e]							
American Kestrel		0.13 ± 0.24	1.13 ± 1.62	0.25 ± 0.31	0.13 ± 0.24		101 ± 130
Prairie Falcon[e]							
Ring-necked Pheasant		0.38 ± 0.50					7 ± 10
Blue Grouse[d]							
Virginia Rail[d]							
American Coot						25	25.0
Killdeer				0.13 ± 0.24	0.63 ± 0.80	35	132 ± 141
American Avocet						3	3.0
Spotted Sandpiper		0.25 ± 0.47				3	5 ± 9

Table 8. Continued.

SPECIES	MEAN/HABITAT/DENSITY (n/10ha ± 90% CI)						POPULATION[c]
	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	
Common Snipe		0.13 ± 0.24			2.75 ± 1.95	1	297 ± 214
Wilson's Phalarope					2.75 ± 3.85	1	295 ± 412
Rock Dove		0.63 ± 0.71			1.25 ± 1.89		146 ± 216
Mourning Dove	4.88 ± 3.35	2.63 ± 1.52	1.75 ± 2.11	1.13 ± 0.98	1.88 ± 1.36		1,044 ± 788
Common Barn-Owl							4.0
Eastern Screech Owl							2.0
Great Horned Owl		0.75 ± 1.00					15 ± 20
Northern Pygmy-Owl[d]							
Burrowing Owl							4.0
Common Nighthawk		0.13 ± 0.24		0.13 ± 0.24			146 ± 249
White-throated Swift	0.13 ± 0.24		0.75 ± 1.17	0.25 ± 0.47			88 ± 161
Broad-tailed Hummingbird	0.38 ± 0.35		2.00 ± 2.75				84 ± 99
Belted Kingfisher						3	3.0
Downy Woodpecker	0.13 ± 0.24	0.13 ± 0.24					16 ± 29
Hairy Woodpecker	0.50 ± 0.51						50 ± 51
Northern Flicker	0.38 ± 0.50	2.88 ± 2.25	0.38 ± 0.71		0.13 ± 0.24		117 ± 136
Western Wood Pewee	5.63 ± 2.06	0.63 ± 0.50	0.38 ± 0.50				584 ± 228
Willow Flycatcher[d]							
Hammond's Flycatcher		0.38 ± 0.71	0.50 ± 0.72				19 ± 31
Say's Phoebe[d]							2.0
Western Kingbird		0.25 ± 0.47			0.13 ± 0.24		19 ± 37
Eastern Kingbird			0.13 ± 0.24				3 ± 6
Horned Lark					0.50 ± 0.95		53 ± 101
Tree Swallow		0.13 ± 0.24		0.13 ± 0.24			33 ± 61
Violet-green Swallow	1.38 ± 1.93	0.13 ± 0.24	1.00 ± 1.43	0.13 ± 0.24	0.25 ± 0.47		221 ± 337
Northern Rough-winged Swallow		0.50 ± 0.51					10 ± 10
Bank Swallow		0.75 ± 1.42		0.38 ± 0.71			104 ± 194
Cliff Swallow		2.00 ± 1.43	0.25 ± 0.31	9.88 ± 18.44	3.88 ± 2.52		2,767 ± 4,610
Barn Swallow		1.75 ± 2.17	0.63 ± 0.71	0.75 ± 0.69	4.88 ± 2.25		745 ± 459

Table 8. Continued.

SPECIES	MEAN/HABITAT/DENSITY (n/10ha ± 90% CI)						POPULATION[c]
	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	
Steller's Jay	2.38 ± 1.68						238 ± 168
Blue Jay[d]							
Scrub Jay[d]							
Black-billed Magpie	1.50 ± 0.88	8.89 ± 6.69	4.89 ± 2.22	1.38 ± 1.43	0.50 ± 0.62		811 ± 669
American Crow	0.38 ± 0.50	0.75 ± 0.78			0.63 ± 0.94		120 ± 165
Common Raven	0.13 ± 0.24		0.13 ± 0.24				16 ± 30
Black-capped Chickadee		2.50 ± 2.06					49 ± 40
Mountain Chickadee	2.25 ± 1.12		0.13 ± 0.24				228 ± 118
Red-breasted Nuthatch	0.38 ± 0.50						38 ± 50
Pygmy Nuthatch	0.88 ± 1.16						88 ± 116
Rock Wren			2.75 ± 2.23	0.13 ± 0.24			94 ± 108
House Wren		0.63 ± 0.61	3.13 ± 3.17				84 ± 85
American Dipper		0.13 ± 0.24					3 ± 5
Townsend's Solitaire	0.50 ± 0.51						50 ± 51
American Robin	4.00 ± 1.68	1.25 ± 1.19	0.13 ± 0.24		0.75 ± 1.00		507 ± 304
Gray Catbird		0.88 ± 0.98	0.24 ± 0.47				23 ± 30
Loggerhead Shrike[d]							
European Starling	0.13 ± 0.24	9.25 ± 5.14	2.88 ± 3.57	3.13 ± 5.12	4.13 ± 3.35		1,432 ± 1,761
Solitary Vireo	1.88 ± 1.31						188 ± 131
Red-eyed Vireo		0.13 ± 0.24					3 ± 5
Virginia's Warbler	0.50 ± 0.62		2.13 ± 1.77				99 ± 103
Yellow Warbler	0.13 ± .024	2.13 ± 2.22	0.13 ± 0.24				58 ± 73
Yellow-rumped Warbler	0.75 ± 0.78	0.25 ± 0.31	0.50 ± 0.95				92 ± 106
McGillivray's Warbler			0.88 ± 0.75				20 ± 17
Common Yellowthroat		4.75 ± 2.74					93 ± 53
Wilson's Warbler		0.50 ± 0.51	0.13 ± 0.24				13 ± 16
Yellow-breasted Chat		0.63 ± 0.94	2.25 ± 1.63				64 ± 56
Western Tanager	0.63 ± 0.50						63 ± 50

Table 8. Continued.

SPECIES	MEAN/HABITAT/DENSITY (n/10ha ± 90% CI)						POPULATION[c]
	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	
Black-headed Grosbeak		0.25 ± 0.31	0.63 ± 0.80				20 ± 25
Blue Grosbeak				0.13 ± 0.24			30 ± 56
Lazuli Bunting		0.63 ± 0.61	6.00 ± 3.40				151 ± 91
Indigo Bunting			0.25 ± 0.31				6 ± 7
Dickcissel[d]							
Green-tailed Towhee			4.25 ± 2.67				98 ± 62
Rufous-sided Towhee	3.50 ± 1.52	0.50 ± 0.51	13.00 ± 5.59	0.13 ± 0.24			691 ± 347
Chipping Sparrow	6.38 ± 2.15	0.25 ± 0.47	2.25 ± 2.14	0.38 ± 0.71			784 ± 440
Brewer's Sparrow			0.88 ± 0.98	0.25 ± 0.31			78 ± 95
Vesper Sparrow	1.88 ± 3.55		0.50 ± 0.62	5.38 ± 5.14	2.25 ± 2.40		1,696 ± 1,825
Lark Sparrow	1.25 ± 2.37			1.50 ± 2.58	0.38 ± 0.71		516 ± 916
Lark Bunting[d]							
Savannah Sparrow[d]							
Grasshopper Sparrow				0.50 ± 0.62			117 ± 145
Song Sparrow		4.25 ± 1.92	0.13 ± 0.24				86 ± 43
Lincoln's Sparrow		0.38 ± 0.50	0.13 ± 0.24				10 ± 16
White-crowned Sparrow		0.13 ± 0.24	0.13 ± 0.24				6 ± 11
Dark-eyed Junco	0.88 ± 0.84		0.13 ± 0.24				91 ± 90
Bobolink					1.13 ± 2.13		121 ± 228
Red-winged Blackbird		15.00 ± 16.84		1.13 ± 1.10	29.13 ± 20.86		3,668 ± 2,814
Western Meadowlark	0.75 ± 0.78	3.00 ± 2.38	2.75 ± 1.57	13.00 ± 2.91	10.75 ± 3.82		4,383 ± 1,251
Yellow-headed Blackbird						27	27.0
Brewer's Blackbird		0.50 ± 0.72		0.13 ± 0.24	0.63 ± 0.94		107 ± 170
Common Grackle		4.63 ± 2.26	0.25 ± 0.31	0.13 ± 0.24	5.63 ± 4.14		728 ± 549
Brown-headed Cowbird	2.88 ± 1.26	5.13 ± 3.71	2.38 ± 1.18		0.13 ± 0.24		397 ± 251
Northern Oriole		1.25 ± 1.42	0.13 ± 0.24				27 ± 34
House Finch		0.38 ± 0.71					7 ± 14
Red Crossbill	43.63 ± 32.89		0.25 ± 0.47				4,371 ± 3,301
Pine Siskin	2.13 ± 1.10		0.25 ± 0.47				219 ± 121
Lesser Goldfinch		0.25 ± 0.47	0.13 ± 0.24				8 ± 15
American Goldfinch	0.63 ± 0.80	7.88 ± 5.60	1.25 ± 1.71		0.75 ± 1.17		326 ± 354

Table 8. Continued.

SPECIES	MEAN/HABITAT/DENSITY (n/10ha ± 90% CI)						POPULATION[c]
	C[a]	R[a]	MS[a]	G[a]	AG[a]	L&P[b]	
Evening Grosbeak	1.00 ± 1.19						100 ± 119
House Sparrow		0.38 ± 0.50			0.38 ± 0.50		48 ± 63
Combined Unidentified Species	0.13 ± 0.24		0.13 ± 0.24				16 ± 30

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 ± 90% confidence interval in 4,885.6 ha (12,067.7 acres) occupied by the 6 major habitat types and wetland (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 1985.

Results of these counts provide more accurate abundance estimates and are discussed seperately below under "Waterfowl" and "Raptors".

AVIAN USE OF HABITAT TYPES

Breeding Species

Breeding bird use on Open Space differed significantly between ($F=22.60$, $P<0.0005$) and within ($F=2.93$, $P<0.0005$) major habitat types (Table B2), a conclusion also reached from 1984's data. 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 9). In 1984, the only habitats that did not differ in species richness were conifer and mountain shrub. Species richness was highest in 1985 riparian habitats (9.5 species/plot) followed by conifer (6.9), mountain shrub (6.8), agricultural grassland (5.4) and grassland (2.9) habitats (Table B5). Although mean 1985 species richness was slightly higher than in 1984, the relative 1985 ranking of habitats was identical to 1984's.

Density of breeding birds also differed between ($F = 3.38$, $P<0.025$) and within ($F = 2.06$, $P<0.0025$) major habitat types (Table B8). SNK test results indicate breeding densities in grassland habitat differed from those in riparian and conifer habitats, but all other habitat comparisons were similar (Table 9). In 1984, riparian and grassland densities differed with those of all other habitats. Breeding density in 1985 was highest in riparian habitats (20.5 birds/plot) followed by conifer (19.2), agricultural grassland (15.7), mountain shrub (12.8) and grassland (8.1) habitats (Table B12). Densities in all habitats were higher than in 1984, except riparian and mountain shrub habitats which were virtually unchanged.

Table 9. Student-Newman-Keuls test results for 1985 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[a]
MS				S	NS[a]
G					S
AG					

BREEDING SPECIES DENSITY

	R	C	MS	G	AG
R		NS[a]	NS[a]	S	NS[a]
C			NS	S	NS
MS				NS[a]	NS
G					NS[a]
AG					

[a]Result different from the 1984 test.

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 1985 ANOVA results showed no statistical difference in species richness between the 8 mountain shrub plots (Table B13). The 1985 LSD test results (LSD = 2.66) yield a similar conclusion (Table B14). Last year's ANOVA results indicated a borderline result ($F = 1.97$, $0.10 > P > 0.05$) which we conservatively interpreted as no significant difference in species richness. In 1985, the 2 Ertl plots did not differ from each other (P 0.05) nor did either differ from any other mountain shrub plot. The mean 1985 richness value for the 8 mountain shrub plots was 6.75 ± 0.33 species/plot; the values for the east and west Ertl plots were 7.8 ± 5 and 6.6 ± 0.81 species/plot, respectively.

In contrast to 1984's results, 1985 breeding species density did not differ between the 8 mountain shrub plots ($F=0.78$, $P > 0.25$) (Table B15). SNK and LSD test results (Table B16) 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 13.1 ± 0.75 birds/plot compared to values of 13.6 ± 2.6 and 11.0 ± 1.9 for the east and west Ertl plots, respectively.

Two riparian bird plots located in the Cottonwood Grove permitted a comparison with other riparian plots in the system. As in 1984, 1985 species richness differed among riparian plots ($F=3.73$, $P < 0.1$) (Table B17). Mean richness for all riparian

plots was 9.5 ± 0.47 species/plot; values for the north (R2) and south (R4) Cottonwood Grove plots were, as in 1984, slightly lower (R2 = 7.0 ± 0.84, R4 = 8.8 ± 1.1). 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).

Like 1984, 1985 breeding species density also differed among riparian plots ($F=6.4$, $P<0.0005$, Table B19). Densities for the north (16.4 ± 1.69 birds/plot) and south (18.2 ±2.6 birds/plot) Cottonwood Grove plots were lower than the mean riparian value (20.5 ± 1.2 birds/plot). The Cottonwood Grove plots did not differ from each other, however, both plots were significantly (LSD = 6.95, alpha = 0.05) lower than plots R5 and R8 (Table B20).

In summation, avian use of the 2 Ertl mountain shrub plots did not differ in species richness or density from any other mountain shrub plot 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 cliff face, none of the habitat types present on the Ertl property are above average value to birds. 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 the cliff nesting habitat proximal to Boulder Creek (Starlings, Rock Doves, Rock Wrens, American Kestrels, Great Horned Owls, Common Barn-Owls, and Common Mergansers nested in the Ertl cliff in 1984 and/or 1985), the isolated mountain shrub habitat interspersed with sandstone rimrock (providing numerous additional nest sites), and the close interspersion of several major and minor habitats with Boulder Creek.

The 2 riparian plots in the Cottonwood Grove were slightly below the mean riparian richness and density values. 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 10, B21, B23).

Breeding species richness differed between the 8 agricultural grassland plots ($F=5.07$, $P<0.001$). Plots supporting 4 of the 5 highest species richness values were all irrigated (Table B22). These conclusions are similar to those reached in 1984. Richness differences between irrigated and nonirrigated plots are illustrated in Table 10. With the exception of plot P8(I, S=8.0) which differed from P4 (S=3.2) and P7 (S=3.4), all other differences were not significant. Difference between irrigated and nonirrigated plots were more distinct in terms of breeding species density (Table 10). Density differed between the 8 agricultural grassland plots ($F=14.81$, $P<0.0005$)(Table B23). Three plots supporting the highest species richness values also had, by far, the greatest density values (Table B24). These plots, P6, P1, and P8 (also the 3 highest in 1984) had a combined mean of 25.8 birds/plot (S=6.7) compared to 9.6 birds/plot (S=4.6) for the 5 other agricultural grassland plots (including irrigated P5).

In both species richness and density, P5(I) appears more similar to nonirrigated plots, as it also did in 1984. All irrigated plots were flooded for several weeks during the spring and grazed for some period; however P5 was the only plot that was not managed as a hayfield. Although P5 is located on remnant tall-grass prairie, the hayfield plots appeared to have significantly more vegetative cover. This cover difference apparently corresponds to what Red-winged Blackbirds consider suitable vs. unsuitable nesting habitat because it is this species which effected the density differences between plots. Mean Red-winged Blackbird densities on hayfields 1,6, and 8 were 14.2, 12.8, and 12.8 birds/plot, respectively (11.8, 17.8, and 7.8 in 1984), compared to 1.8 birds/plot (1.2 in 1984) for P5(I), and a mean 1.3 birds/plot (0.85 in 1984) 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 11.2, 16.4 and 10.0 birds/plot, respectively (7.0, 7.4 and 10.0 in 1984), values slightly higher, but similar to the mean of 9.6 birds/plot (6.4 in 1984) 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

Table 10. Student-Newman-Keuls test results for 1985 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[b]	NS[b]	NS	NS	NS	NS	NS
2			NS	NS	NS	NS	NS	NS
3				NS	NS	NS	NS	NS
4					NS	S[b]	NS	NS
5[a]						NS	NS	NS
6[a]							S[b]	NS
7								NS
8[a]								

SPECIES DENSITY

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

[a] Irrigated plot.

[b] Result different from the 1984 test.

associated with more mesic situations. Results were entirely consistent between 1984 and 1985. Higher bird densities on hayfields were due primarily to Red-winged Blackbirds nesting at high densities and to the additional species supported by the greater vegetational density. It appears that irrigated hayfields and other agricultural grasslands warrant consideration as different, although similar, habitats.

Total Species

Twelve transients, representing 4 species, were observed during plot counts. Three of the 4 species (Swainson's Thrush, Sage Thrasher, and California Gull) are not considered breeders on Open Space although the Thrush 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. In 1985, the 12 transients observed during plot counts accounted for only 0.39% of all species observed. Total species tests were, therefore, not run in 1985, but were assumed to have provided results identical to those for breeding species.

1984 vs 1985 Habitat Use

Results of the 2xN ANOVA model examining habitat use between 1984 and 1985 are borderline ($F=2.87$, $0.1 > P > 0.05$, Table B6). Statistical significance is typically taken at the 95% level (i.e., alpha = 0.05). At this level we are 95% confident that there was no difference in habitat use (as measured by species richness) between 1984 and 1985. Species richness is plotted by habitat type and year in Figure 2. The richness curves are close and nearly parallel. Furthermore, habitat use by birds appears to be similar between years, because there is insufficent evidence ($F=0.26$, $P > 0.25$, Table B6) of a year x habitat interaction. We, therefore, conclude that there was no difference in species richness between 1984-85.

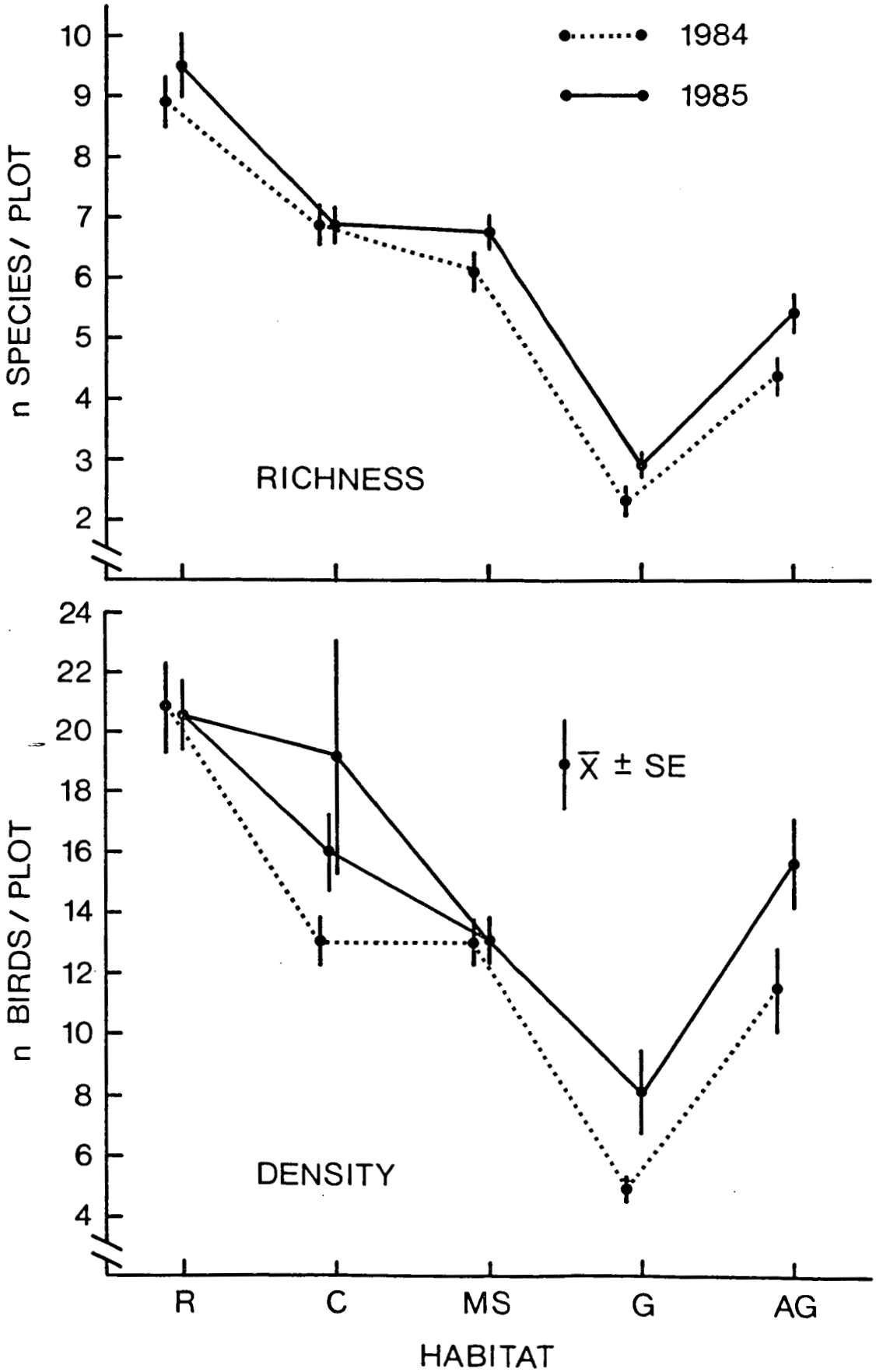


Figure 2. Breeding bird use of riparian (R), conifer (C), mountain shrub (MS), grassland (G), and agricultural grassland (AG) habitats on City of Boulder Open Space, 1984-85. Lower 1985 conifer density estimate does not include the anomalous Red Crossbill flock from plot C2, rep. 1.

Although 1984-85 species richness was statistically similar, the species composing the annual values obviously varied. Most of this variation was attributable to species uncommonly observed during plot counts that may not be recorded 1 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, 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 we would expect, relatively similar between years.

The 2xN ANOVA results of 1984 vs. 1985 breeding bird densities indicate that density did not differ significantly ($F=2.43$, $P>0.10$, Table B28) between years, but differed between habitats ($F=23.6$, $P<0.0005$, Table B28). The annual density-habitat relationship is illustrated in Figure 2. Absence of a significant year x habitat interaction indicates habitat use between years was similar ($F=0.55$, $P>0.25$, Table B28).

Bird densities are more likely to exhibit considerable interyear variation as individual species numbers increase and decrease. The large difference between 1984 and 1985 conifer densities was due to 2 large Red Crossbill flocks recorded on plot C2 on 12 May. Including these 2 flocks, crossbills averaged 8.2 times more abundant in 1985 than in 1984 and represented 45% of all birds observed on conifer plots. Variability attributable to the large, erratic crossbill flocks is manifested in the broad standard error about the conifer mean in Figure 2. Before these 2 anomalous observations were eliminated, the 2XN ANOVA results were statistically borderline (Table B12). Nevertheless, while some species were more or less common in 1985, the intraspecific variations averaged out to yield densities statistically similar to those of 1984.

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 populations wintering in Central or South America that have no relation to habitat quality or natural cycles in the Boulder area.

Qualitatively, 1985 was an early, dry spring relative to 1984's late, wet spring. Plant phenology at the advent of 1985's peak breeding season was 1-2 weeks more advanced than in 1984. Such 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. To further confuse the identification of factors largely responsible for fluctuations, 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. Whatever factors affected 1984 and 1985 bird numbers, their influence was insufficient to effect statistically significant differences in breeding species richness and density between the 2 years.

WATERFOWL AND SHOREBIRDS

Survey results on Open Space lakes and ponds for 1985 are listed in Tables 11 and 12 approximately in order of decreasing productivity. The average numbers of birds/census for 1984 and 1985 are compared in Table 13.

Overall the number of birds present and the production of young were lower in 1985 than in 1984 (excluding the Ertl Ponds, for which we have no 1984 data). These differences are principally due to changes at Cowdrey Reservoir No. 2 and Wonderland Lake. Changes at the other water bodies are probably insignificant.

As in 1984, Cowdrey Reservoir No. 2 was the most productive water body, but the productivity dropped about 60% in 1985. The same 4 species (Pied-billed Grebe, Mallard, Ruddy Duck, and American Coot) bred on the reservoir in both years, breeding of the other 3 species fell. Two factors, habitat changes and human disturbance, may have resulted in the observed decline in productivity. The cattail stand on the reservoir was less dense and extensive in 1985 than in 1984. Large areas of cattails apparently died overwinter providing less cover for nesting birds in 1985. Numerous spent .22 cartridges found near the reservoir indicated that someone had been shooting in the area. In July we saw 3 people shooting at prairie dogs in nearby fields to the east of South 66th Street. We found no dead birds, but the birds present seemed to be more wary during 1985 censuses than in 1984. The large drop in American Coot numbers between the first 2 censuses (from 22 to 7) may also indicate some peturbation.

Production of young in 1985 on Teller Lake was almost identical to that found in 1984. The same 4 species (Pied-billed Grebe, Canada Goose, Mallard, and American Coot) nested there.

The production of young in 1985 on Wonderland Lake was about 60% lower than in 1984. We have found only 3 species of birds breeding on the lake; only the Canada Goose bred in both years. The Mallard bred in 1984, but not in 1985 even though more adults used the lake. The Pied-billed Grebe, which was not recorded in 1984, bred in 1985.

Table 11. Waterfowl and shorebirds observed on surveys of Boulder Open Space ponds and lakes 1985.

SPECIES		SURVEY DATE 26/28 June	2/3 July	8 July	14 July	20/21 July
Cowdrey Reservoir No. 2						
Pied-billed Grebe	adults	3	2	2		2
	chicks				2	2
Great Blue Heron		2			1	1
Black-crowned Night-Heron		1	1	4	5	1
Mallard	adults	5	2	2	8	17
	males				3	
	females	5			5	
	chicks	15(2)[a]	6	6	8(2)	2
Blue-winged Teal		2	6		3	
Cinnamon Teal		2			1	
B-w/C Teal						10
Ruddy Duck	adults			1	1	2
	chicks			3		
American Coot	adults	22	7	5	5	7
	chicks	6	6	2		5
Killdeer		1	2		3	1
Common Snipe						1
Wilson's Phalarope						1
Totals		58	32	35	37	52
Wonderland Lake						
Pied-billed Grebe	adults	1	1	1	1	
	chicks	3	3	3	3	
Black-crowned Night-Heron		1				
Canada Goose	adults	29	25	34	28	32
	chicks	11		5	7	
Mallard		5	5			
Killdeer		1	1	2	2	
Totals		51	35	45	41	32

Table 11. Continued.

SPECIES		SURVEY DATE 26/28 June	2/3 July	8 July	14 July	20/21 July
Teller Lake						
Pied-billed Grebe	adults	4	6	4	4	2
	chicks				2	5
Great Blue Heron		1				
Canada Goose		18[b]		26		
Mallard	adults		3	4	3	4
	chicks			4	4	9(2)
Cinnamon Teal		1				
American Coot	adults	3	3	3	3	5
	chicks					4
Killdeer					3	
Belted Kingfisher					1	
Total		27	12	41	20	29
Ertl Ponds						
American Bittern			1			1
Great Blue Heron		8	11	9	10	11
Great Egret		1				
Black-crowned Night-Heron			1		2	
Canada Goose	adults	20	25	33	21	
	chicks	14				
Green-winged Teal		2				
Mallard		20	40	7	10	12
Blue-winged Teal			1	7		1
Cinnamon Teal		2				
B-w/C Teal					4	
Gadwall				1		
Killdeer	adults	10	12	10	14	8
	chicks			1	1	
American Avocet	adults	3	2	3	1	
	chicks		3	1	3	
Greater Yellowlegs		4	2	4	2	

Table 11. Continued.

SPECIES		SURVEY DATE 26/28 June	2/3 July	8 July	14 July	20/21 July
Lesser Yellowlegs					2	1
Spotted Sandpiper		2	1	1	1	1
Common Snipe			1			
Wilson's Phalarope				1		
Belted Kingfisher		2	1		1	
Totals		88	101	78	72	35
Short-Milne						
Pied-billed Grebe	adults	1		1	2	
	chicks			3	1	
Great Blue Heron				1	2	
Black-crowned Night-Heron				4	2	2
Canada Goose	adults	10	4	17	33	
	chicks		4	11		
Mallard		2	1	2		
Killdeer		1	2			
Totals		14	11	39	40	2
Flatirons Vista Reservior						
Eared Grebe		1				
Great Blue Heron				1		
Mallard			4	5		5
Redhead		1	1	1	1	1
Killdeer	adults	3	4		8	
	chicks	1				
Spotted Sandpiper						1
Totals		6	9	7	9	7
Marshall Lake						
Killdeer			3	3	1	no survey
Spotted Sandpiper			1			
Gull sp.		1	2			
Totals		1	6	3	1	

Table 11. Continued.

SPECIES		SURVEY DATE 26/28 June	2/3 July	8 July	14 July	20/21 July
Boulder Valley Ranch Reservoir						
Great Blue Heron		1		3		1
Mallard		5				
Killdeer		1				1
Totals		7	0	3	0	2
Hogan Pond						
Great Blue Heron						1
Black-crowned Night-Heron						1
Mallard[c]	adults	2	1	5	8	4
	chicks				8	13
Teal sp.[c]	adult			1		
	chicks			8		
Killdeer		1	4	4	4	2
Spotted Sandpiper					1	
Belted Kingfisher					1	
Totals		3	5	18	21	21
Ranger Pond						
Killdeer			1	4		
Spotted Sandpiper					1	
Totals		0	1	4	1	0
Church Pond						
Totals		0	0	0	0	0

a Number in parentheses is the number of broods observed.

b On 26 June there were 4 broods of Canada Geese seen on Teller Lake, but only the total number of geese were recorded.

c Some of these may have been domestic birds.

Table 12. Maximum observed waterbird productivity on Boulder Open Space ponds and lakes, 1984 and 1985.

WATERBODY SPECIES	MAXIMUM PRODUCTIVITY 1984	 1985
Cowdrey Reservoir No. 2[a]		
Pied-billed Grebe	13	2
Mallard	18	15
Ruddy Duck	6	3
American	35	6
Total	72	26
Wonderland Lake		
Pied-billed Grebe	0	3
Canada Goose	27	11
Mallard	7	0
Total	34	14
Teller Lake		
Pied-billed Grebe	5	5
Canada Goose	14	13[b]
Mallard	9	9
American Coot	3	4
Total	31	26
Ertl Ponds		
Canada Goose	-	14
Killdeer	-	1
American Avocet	-	3
Total		18
Short-Milne		
Pied-billed Grebe	0	3
Canada Goose	17	11
Total	17	14

Table 12. Continued.

WATERBODY SPECIES	MAXIMUM PRODUCTIVITY 1984	 1985
Flatirons Vista Reservoir		
Mallard	8	0
Killdeer	0	1
Total	8	1
Marshall Lake		
Mallard	7	0
Ranger Pond		
Mallard	1	0
Hogan Pond		
Mallard[c]	0	13
Teal sp.[c]	0	8
Total	0	21

[a] Count made on entire reservoir, not just Open Space portion.

[b] Productivity determined in May.

[c] Some of these may have been domestic.

Table 13. Average number of birds/census on Boulder Open Space ponds and lakes, 1984-85.

WATER BODY	AVERAGE NUMBER OF BIRDS/CENSUS	
	1984	1985
Cowdrey Reservoir No. 2	107.2	42.8
Wonderland Lake	53.2	40.8
Teller Lake	29.0	25.8
Ertl Ponds	-	74.8
Short-Milne	26.0	21.2
Flatirons Vista Reservoir	6.2	7.6
Marshall Lake	13.4	2.4
Ranger Pond	2.8	1.2
Boulder Valley Ranch Reservoir	3.6	2.4
Hogan Pond	8.6	13.6
Church Pond	0.2	0.0

Canada Goose production on Wonderland Lake was down in 1985. We suspect that use of the area by free-running dogs is probably a contributing factor in this decline. We found dogs at the lake during every census. Some were running free with owners nearby whereas other were not attended. In July we found a recently killed adult Canada Goose on the northwest shore of the lake. The bird had been dead for 2-8 hours. An unattended dog was seen only a few hundred yards from the site. The dead bird was probably one of a pair that had been tending chicks up to that date. At that time and thereafter only 1 adult was found tending those chicks. The absence of Mallard chicks and a drop of Killdeer numbers at Wonderland Lake in 1985 may also indicate increased disturbance of birds using the lake margin for breeding.

Production of young at other water bodies in 1985 was similar to that found in 1984, most of the differences being accounted for by the presence or absence of only 1 pair of birds. We found no young birds on Hogan Pond in 1984, but 21 chicks of 2 species of ducks in 1985. Most or all of these birds are probably domestic stock.

The Ertl Ponds were censused for the first time in 1985. The production of young was surprisingly low, considering the extent and diversity of the ponds. In May we found 3 pair of Canada Geese on nests and 2 pair with young. One brood each of Killdeer and American Avocet were found. Fluctuating water levels may have discouraged birds, especially ducks, from breeding in the area.

The same 5 species of waterfowl that nested on Open Space in 1984 were found nesting in 1985 (excluding the probable domestic teal on Hogan Pond). Pied-billed Grebes were found nesting on 4 areas, Canada Geese on 4, Mallard on 2, Ruddy Duck on 1, and American Coot on 2. Pied-billed Grebes were found on twice as many sites in 1985, whereas Mallards were found on only a third as many sites.

RAPTORS

Six species of raptors have been found breeding on Open Space (Red-tailed Hawk, American Kestrel, Common Barn Owl, Great Horned Owl, Burrowing Owl, and Eastern Screech Owl). In 1984, 15 pairs of raptors were found breeding, while in 1985 17 pairs were found breeding. All species found breeding in 1984 bred in 1985. Eastern Screech Owls were found only in 1985, although they may have used the same nest tree in 1984. In addition, 8 species bred on areas adjacent to Open Space (Northern Harrier, Red-tailed Hawk, Golden Eagle, American Kestrel, Prairie Falcon, Great Horned Owl, Northern Pygmy-Owl, and Northern Saw-whet Owl). In 1985, 30 pairs of 11 species bred on or near Open Space (Table 14). At least 3 other species (Turkey Vulture, Sharp-shinned Hawk, and Cooper's Hawk) are suspected to nest on or near Open Space.

The most common nesting species in 1984 and 1985 were the American Kestrel and the Great Horned Owl. Three Red-tailed Hawk nests were found on Open Space in 1985 and 1 on nearby land.

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 is 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).

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.

Table 14. Breeding raptors on City of Boulder Open Space, 1984-85.

SPECIES	BREEDING OBSERVATIONS
Turkey Vulture[a]	Suspected to nest.
Northern Harrier	Nested on Mountain Parks land near Boulder Reservoir in 1983 and 1985.
Sharp-shinned Hawk[a]	Suspected to nest.
Cooper's Hawk[a]	Suspected to nest.
Swainson's Hawk[a]	Nests in eastern Boulder County.
Red-tailed Hawk	Nested on Boulder Valley Ranch, the McCann parcel, and on the Ertl Easement in 1984 and 1985. One pair also nested on private land near White Rocks. Additional pairs may have nested on or near the Kaufmann parcel, VanVleet Ranch, and Dowdy Draw.
Golden Eagle	At least 3 pairs nested in the foothils near Open Space in 1984 and 1985.
American Kestrel	At least 10 known or suspected nests scattered throughout Open Space.
Peregrine Falcon[a]	Not known to have nested in Boulder area since 1958.
Prairie Falcon	Four nests in 1984 and 5 nests in 1985 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.
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. In 1985 a pair raised 3 young near Burke 2.
Great Horned Owl	Nested on Boulder Valley Ranch; in or near the Cottonwood Grove; and on the East Rudd in 1984 and 1985. McKenzie and THP parcels in 1984. One nest at Sawhill Ponds in 1984 and 1985.
Northern Pygmy-Owl	One nest on Enchanted Mesa in 1985.
Burrowing Owl	Two pair nested on Boulder Valley Ranch in 1984 and 1985.
Long-eared Owl	Nested near White Rocks and in Skunk Canyon in 1984.
Northern Saw-whet Owl	One nest on Enchanted Mesa in 1985.

a No evidence of nesting on or near City of Boulder Open Space in 1984-85.

We made 15 sightings of the species during this study in 1984, most of them concentrated between Shirttail Peak and South Boulder Peak (Fig. 3). 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. 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 while 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/yr since 1979. Most observations are 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 during migration around Boulder in recent years. Many of these may be Colorado birds using lower elevations between migration and moving to or from breeding areas.

Northern Harrier

Henderson (1909) reported the Northern Harrier as a common summer resident of the plains and mountains in Boulder County. However, Betts (1913) remarked that there was no definite record except for one just to the north of the County. Alexander (1937) reported the species as an infrequent to common summer resident.

BASWI records indicate sightings occur thoughout 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.

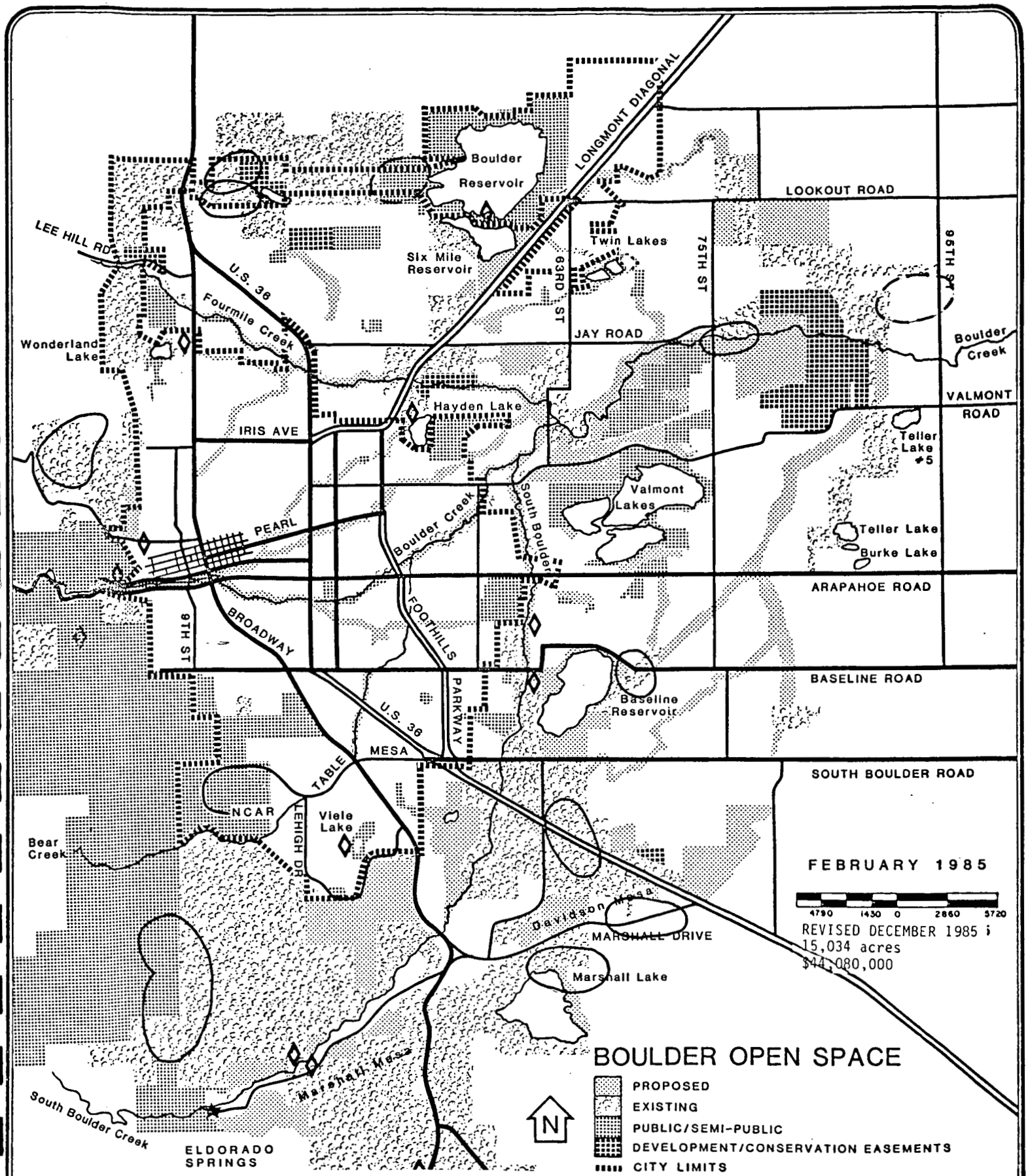


Figure 3. Locations of Turkey Vulture observations made during 1984 (solid line) and 1985 (dashed line).

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 1 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. 4). 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.

The species appears to have decreased as a breeding bird in Boulder County since 1937. It has now bred in the same area 2 out of the last 3 years. Every effort should be made to protect this site which is 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 site no definite breeding records. BASWI records indicate the species is seen throughout the year, with peaks during migration and few birds reported in June and July.

We had 2 sightings of the species in 1984 and 1 in 1985, both on the southern part of City of Boulder Open Space (Fig. 5). 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.

Cooper's Hawk

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

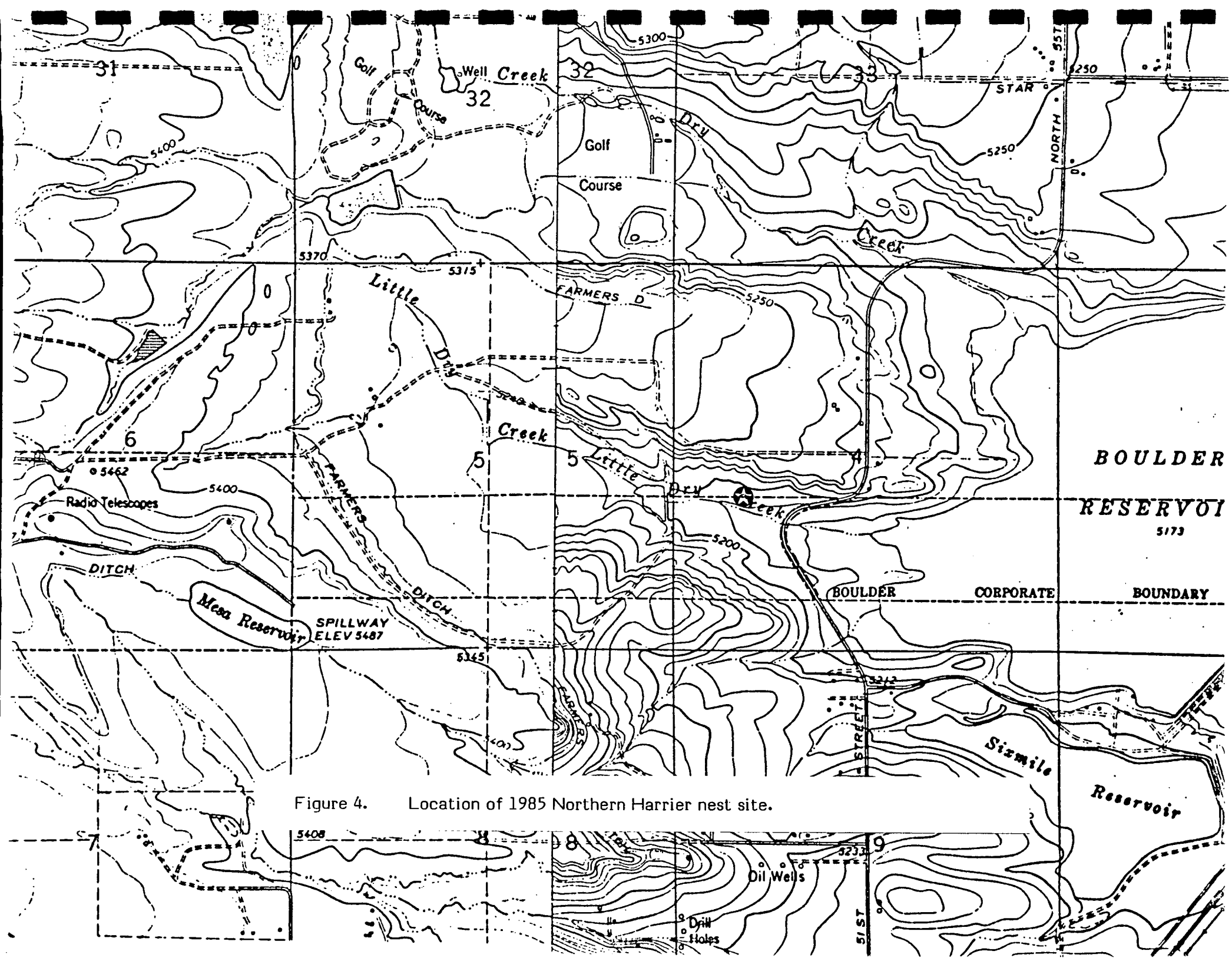


Figure 4. Location of 1985 Northern Harrier nest site.

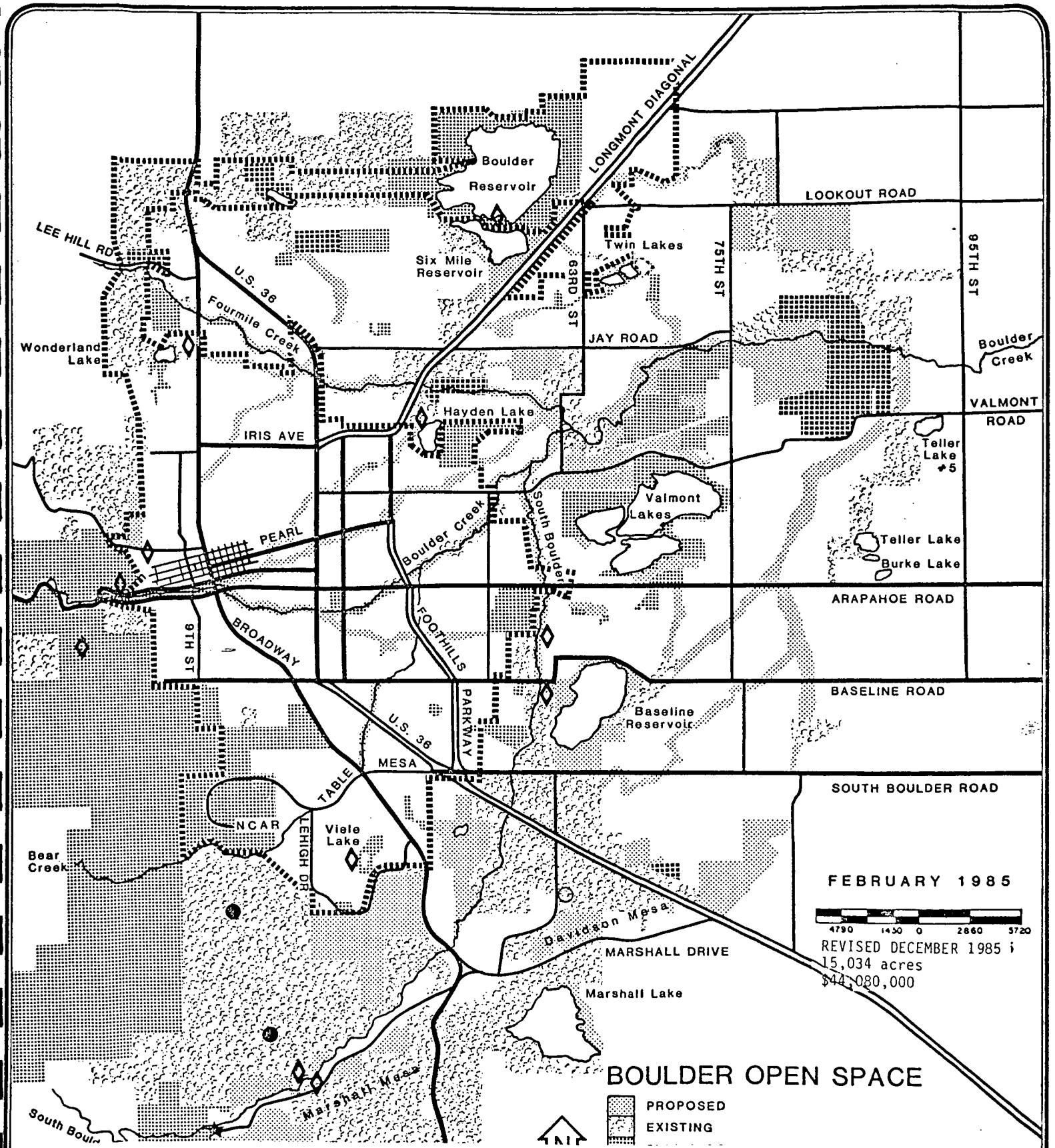


Figure 5. Locations of 1984 (closed circles) and 1985 (open circles) Sharp-shinned Hawk observations.

BASWI records show the species is reported 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 and none in 1985 (Fig. 6). However, like the Sharp-shinned Hawk, this species may be more common than reports indicate.

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. BASWI records list small numbers of Swainson's Hawks from April to November, with a slight increase in sightings 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.

Red-tailed Hawk

The Red-tailed Hawk is a permanent resident which is common in summer (Henderson 1909, Betts 1913, Alexander 1937). Nests with eggs have been found 26 March to 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. 7). A pair has bred for the last 4 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. We found an adult on the nest in late April and activity continued there until late May when the nest was abandoned (Dan Blumstein, pers. commun., this study). No young were seen. Adults were seen on or near Boulder Valley Ranch into July.

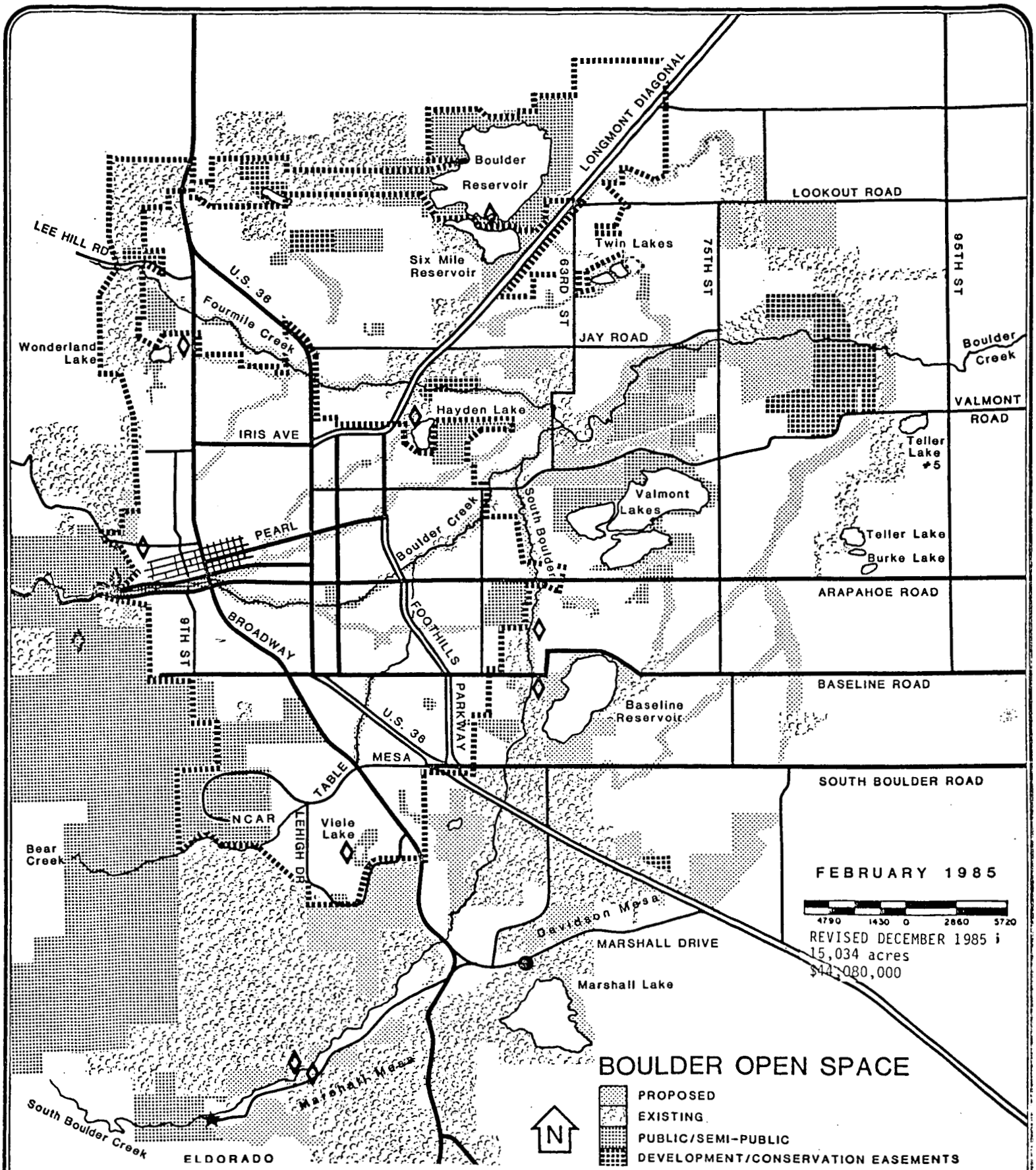


Figure 6. Location of 1984 (closed circle) Cooper's Hawk observation.

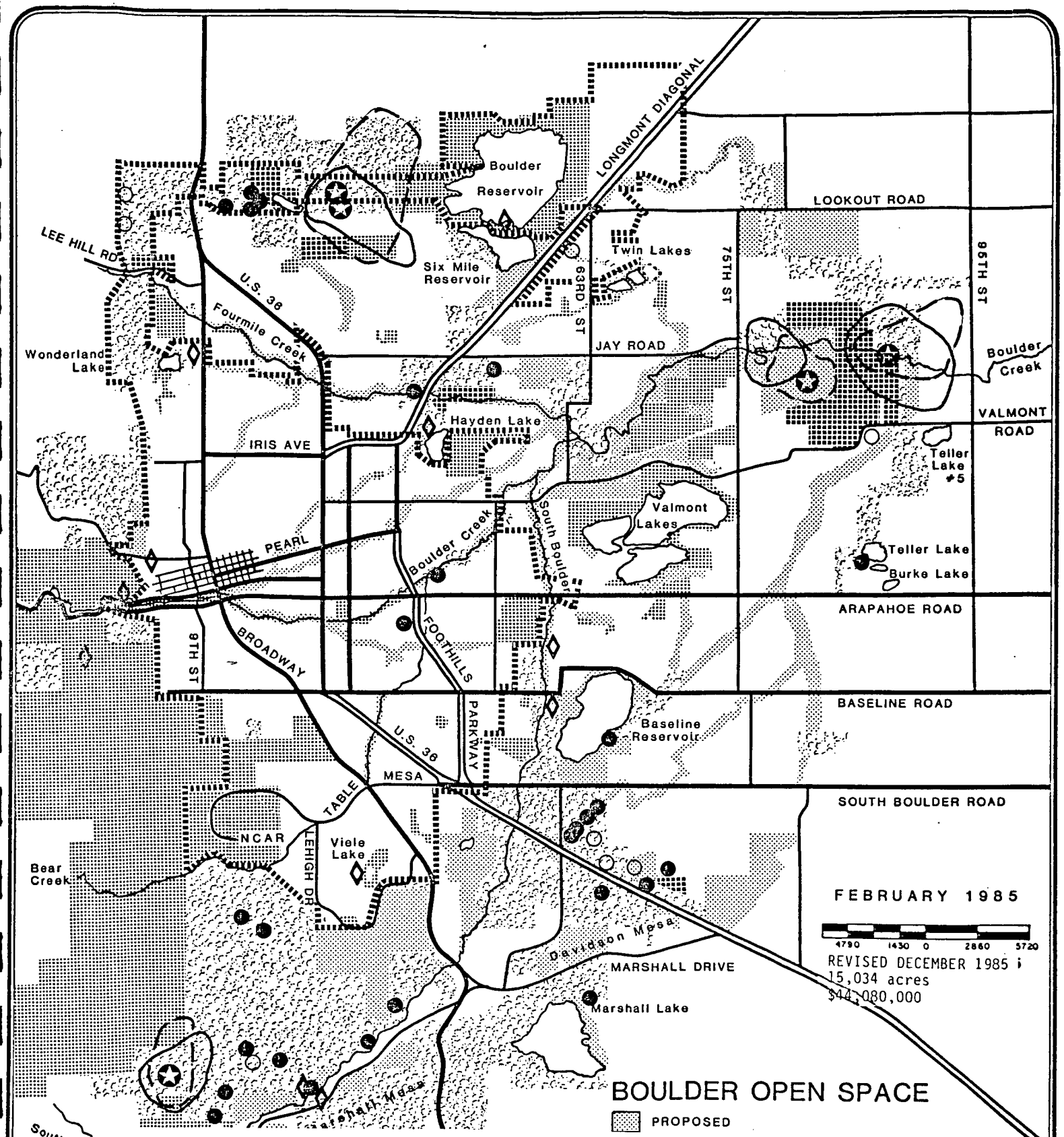


Figure 7. Location of 1984 (closed circles) and 1985 (open circles) Red-tailed Hawk observations and nest sites (star in circle). Lines around nests, which delineate areas where the nesting pair was observed, are solid for 1984 and dashed for 1985. Suspected nests are identified by an "S".

Red-tailed Hawks have nested near the Matron Rock for the last 4 years (Mike Figgs, Dan Blumestein, pers. commun., this study). Two young were seen on the nest in 1984 and 1 in 1985.

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.).

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). We thought that a pair of Red-tailed Hawks nested on or near the Kaufmann parcel in 1984, but were unable to find a nest. It is not clear whether these birds are the same as the pair nesting on the Weiser property.

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 suspected to occur 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. 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 this species 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 records report 2 active nests in the foothills near Boulder, in 1978.

The BASWI indicates moderate to low numbers of sightings of this species occur throughout the year. Number of sightings appear to be 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. 8). 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 (Appendix C; for data up to and including 1984 see Appendix B of Thompson and Strauch 1985). 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 (1985) and Appendix C. One nest site is on City of Boulder Open Space and may have been used in 1978. Two Sites are on Boulder Mountain Park 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 from 3 nests in 1985. (Appendix C).

Golden Eagles are easily disturbed by human activity near their nests and 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 made many sightings of this species on City of Boulder Open Space during this study (Fig. 9). We found 9 active nests and 5 probable nests scattered throughout Open Space in the last 2 years (Fig 9). Flying young were 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. At least 3 young were fledged at White Rocks in 1985. On 20 July, we found 2-3 dozen American Kestrels feeding on grasshoppers in the wheat fields just north of White Rocks. About half that many were still present a week later.

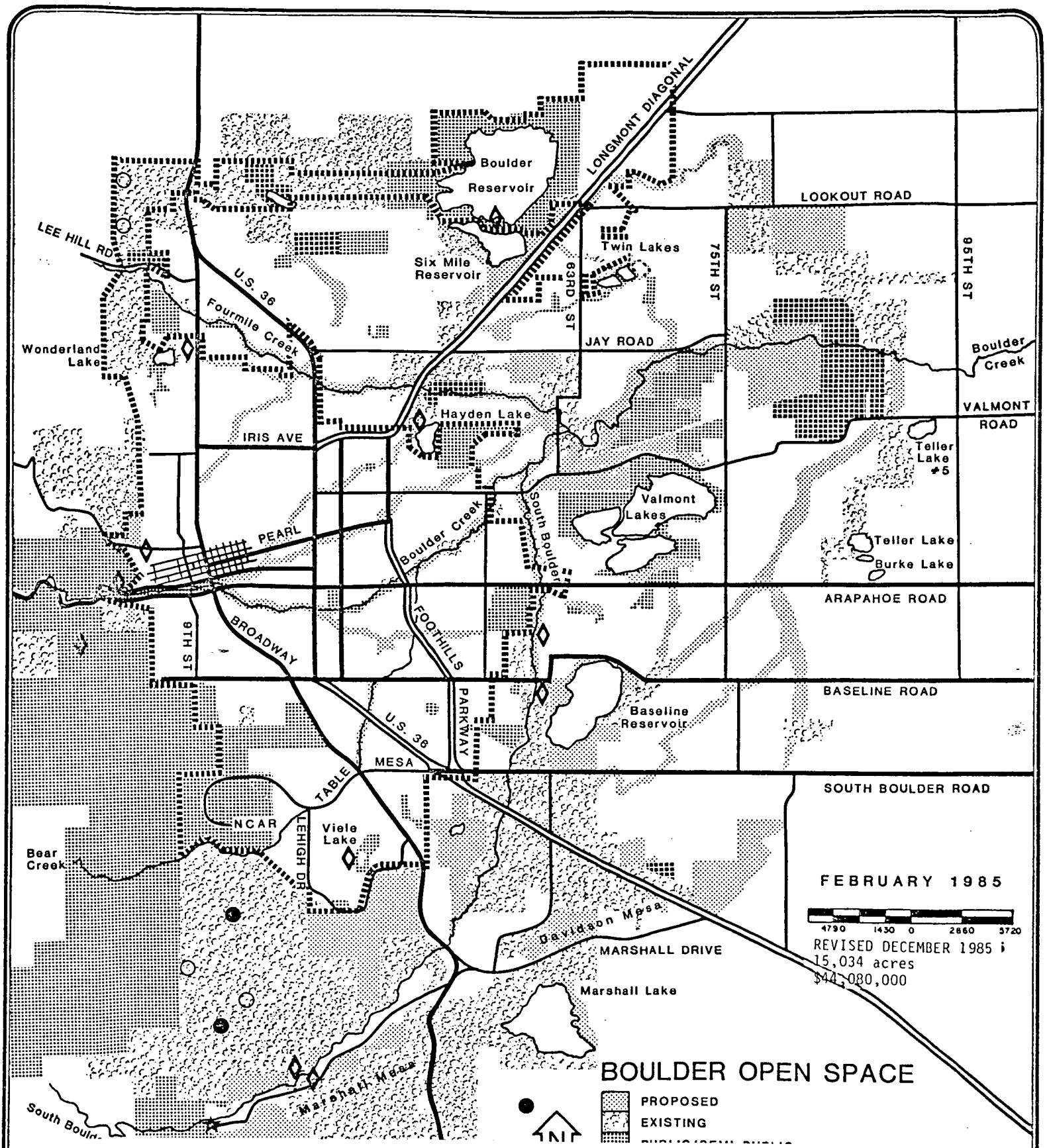
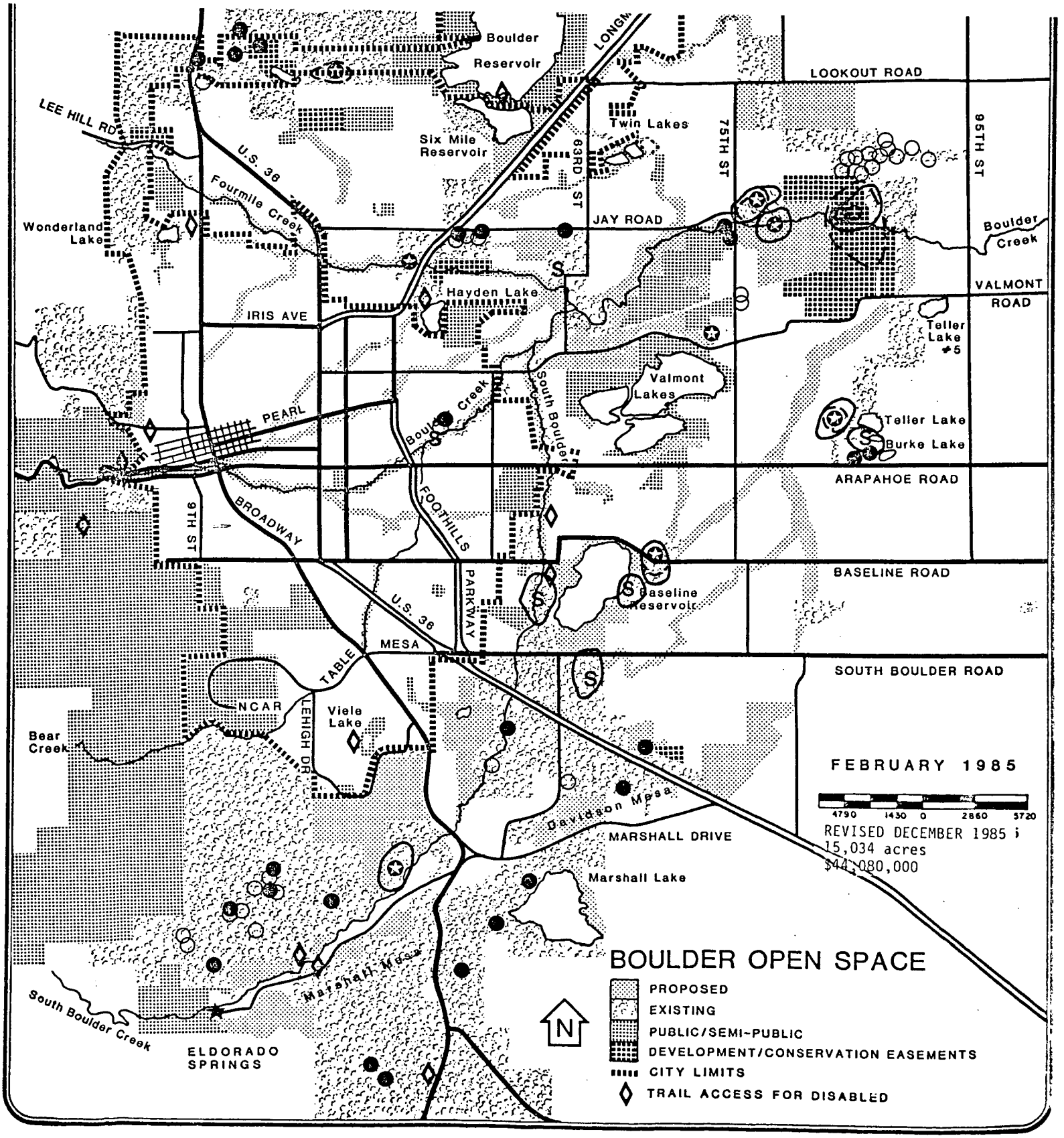


Figure 8. Locations of Golden Eagle observations in 1984 (closed circles) and 1985 (open circles).

Figure 9. Locations of 1984 (closed circles) and 1985 (open 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 and dashed for 1985. Suspected nests are identified by an "S".



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 had no sightings of Peregrine Falcons during this study.

Prairie Falcon

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

Mike Figgs and Nancy Lederer have been monitoring this species in the Boulder area and report 6 active nests sites in both years (see Thompson and Strauch 1985 and Appendix C). None of these nests are on City of Boulder Open Space, but 4 of them 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.

We had several sightings of Prairie Falcons during this study (Fig. 10). Some of these were near the known nest sites. 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.

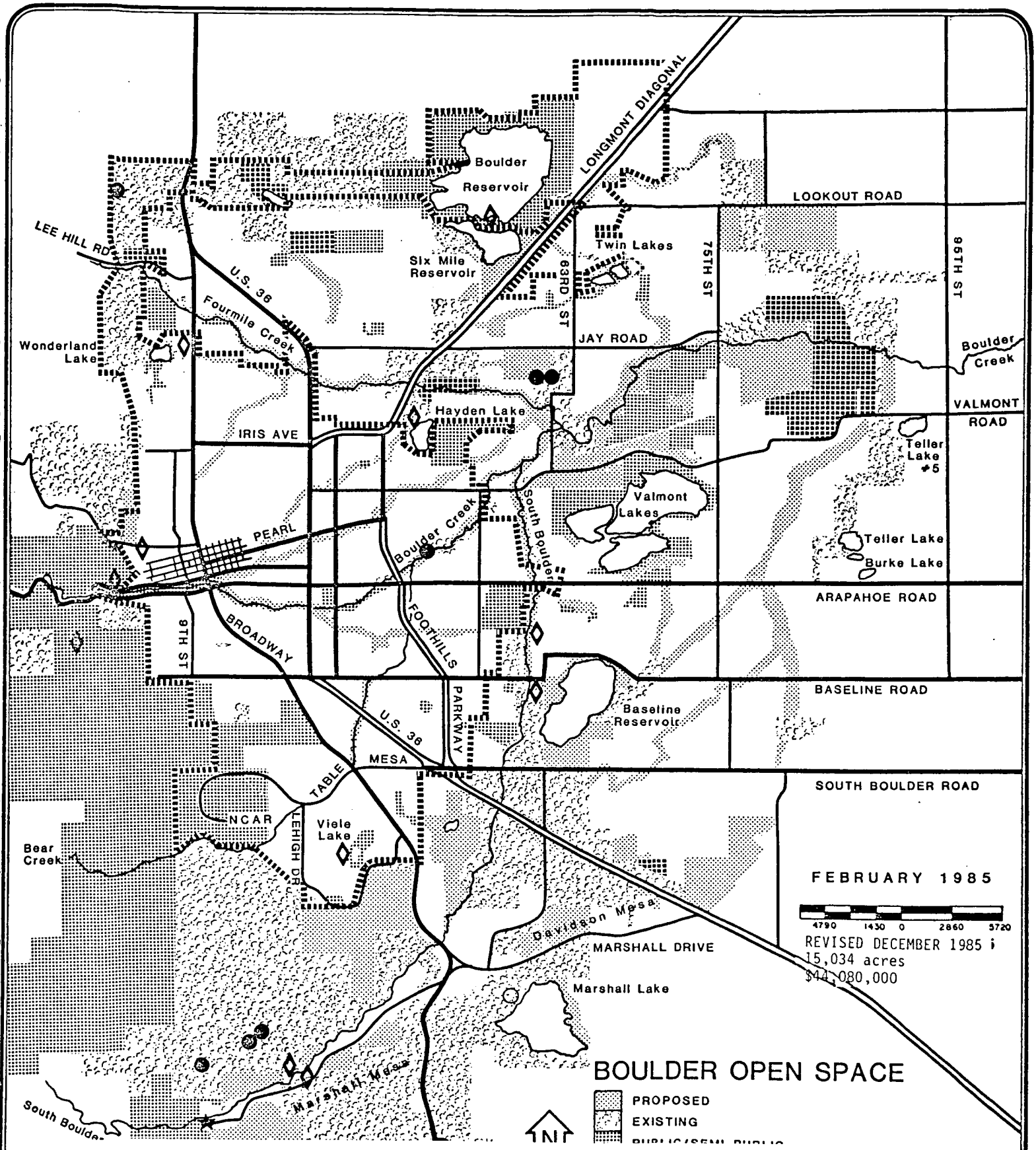


Figure 10. Locations of 1984 (closed circles) and 1985 (open circles) Prairie Falcon observations.

Preventing disturbance of nests by hikers and climbers will be necessary to preserve the local breeding population. More systematic observations need to be made on the prairie dog town on the Andrus Parcel to determine whether this is an important foraging 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 over the last 7 years.

Breeding at White Rocks was first suspected in 1941 (Jollie 1945) and 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.). Barn-Owls were found nesting in 1983 and 1984 along Boulder and Whiterock Ditch, just east of the Minitrista Parcel (Tod Decelli, pers. commun.)(Fig. 11). Four young were fledged in 1983, the outcome of the 1984 nesting attempt is unknown.

We found an adult Barn-Owl in a hole in White Rocks in 1984 on 15 July and on 24 July saw 2 adults and at least 1 young bird (Fig. 11). 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 there were 2 pairs nesting, neither of which used the hole used in 1984. One nest produced 3 young; we never saw young from the second nest. The species probably nests in small numbers thoughout the County. Preservation of dead cottonwoods might encourage them to use other Open Space parcels.

Eastern Screech-Owl

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

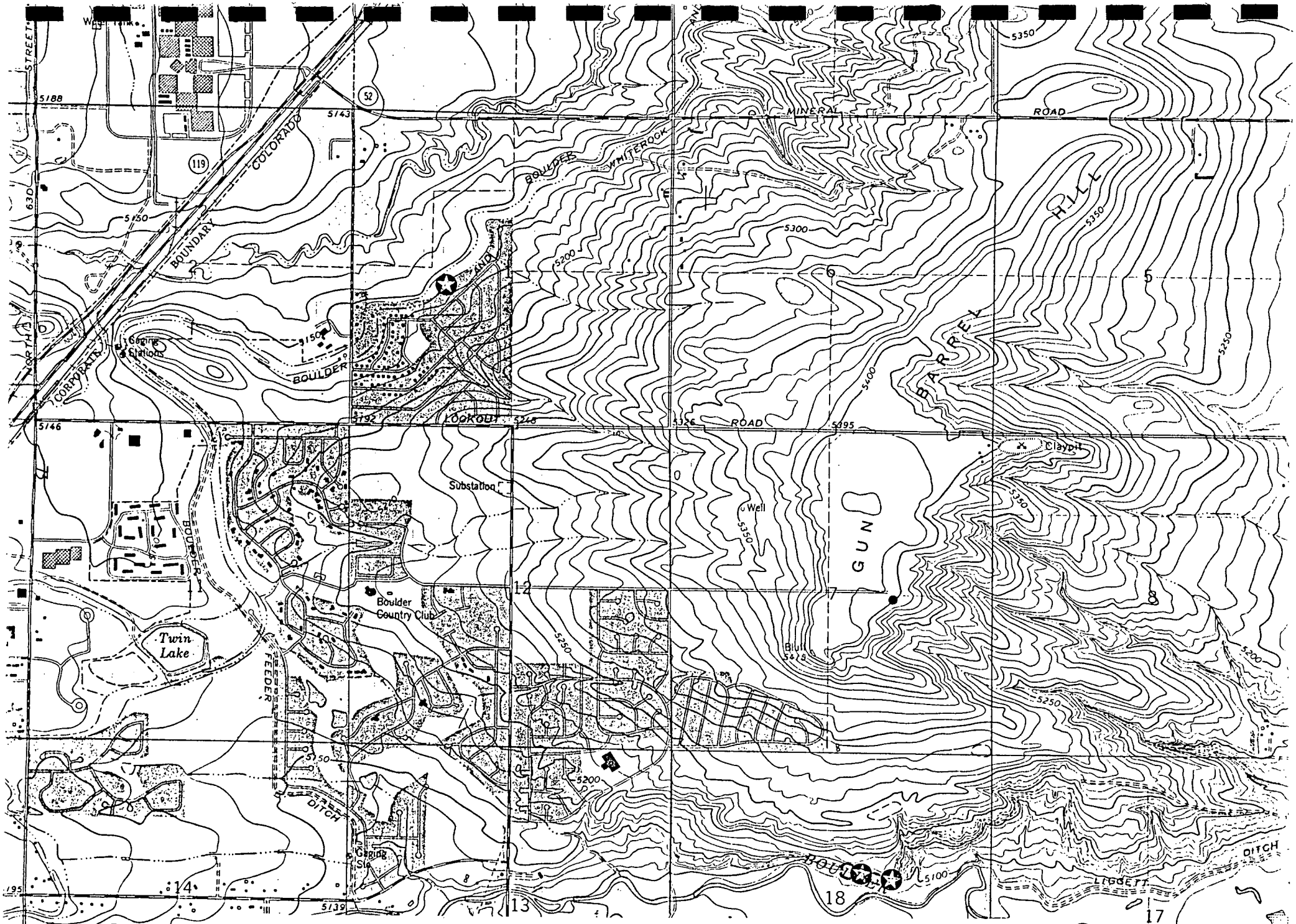


Figure 11. Locations of 1984-85 Common Barn-Owl nest sites.

We had 4 sightings of Eastern Screech-Owls on City of Boulder Open Space during this study (Fig. 12). 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 Kaufmann Parcel. We also observed a pair with 3 flying young in the 800-block of Juniper Street in 1984. Screech-Owls have been seen regularly in that neighborhood for at least the last 2 years.

(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 reports moderate numbers throughout the year.

We have seen Great Horned Owls many times during this study. There are at least 5 regularly used nesting areas on or near Open Space: Boulder Valley Ranch, Saw Hill Ponds, the Ertl Conservation Easement, the Cottonwood Grove, and Marshall Mesa (Fig. 13). There is probably at least 1 pair nesting regularly in or near White Rocks. The Boulder Valley Ranch nest fledged 3 young in 1985, the Saw Hill Pond nest produced 2 young (Steve Jones, pers. commun.), the Ertl Conservation Easement nest fledged at least 1 bird, the Marshall Mesa nest fledged 3, and the Cottonwood Grove pair fledged 2 birds. Thus we know of at least 11 young fledged in 1985 compared to at least 10 in 1984.

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 Neidrach 1965) 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.

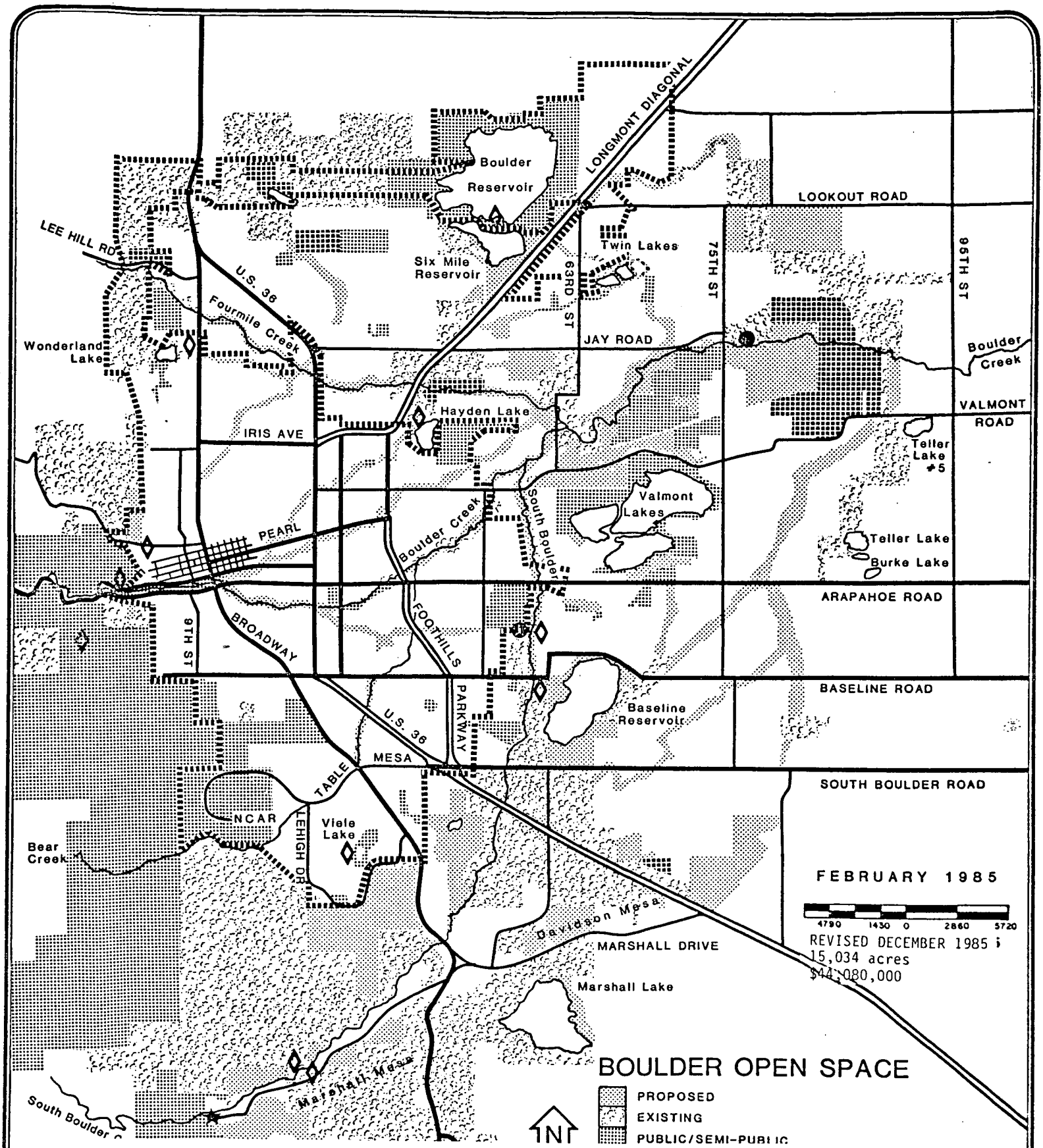
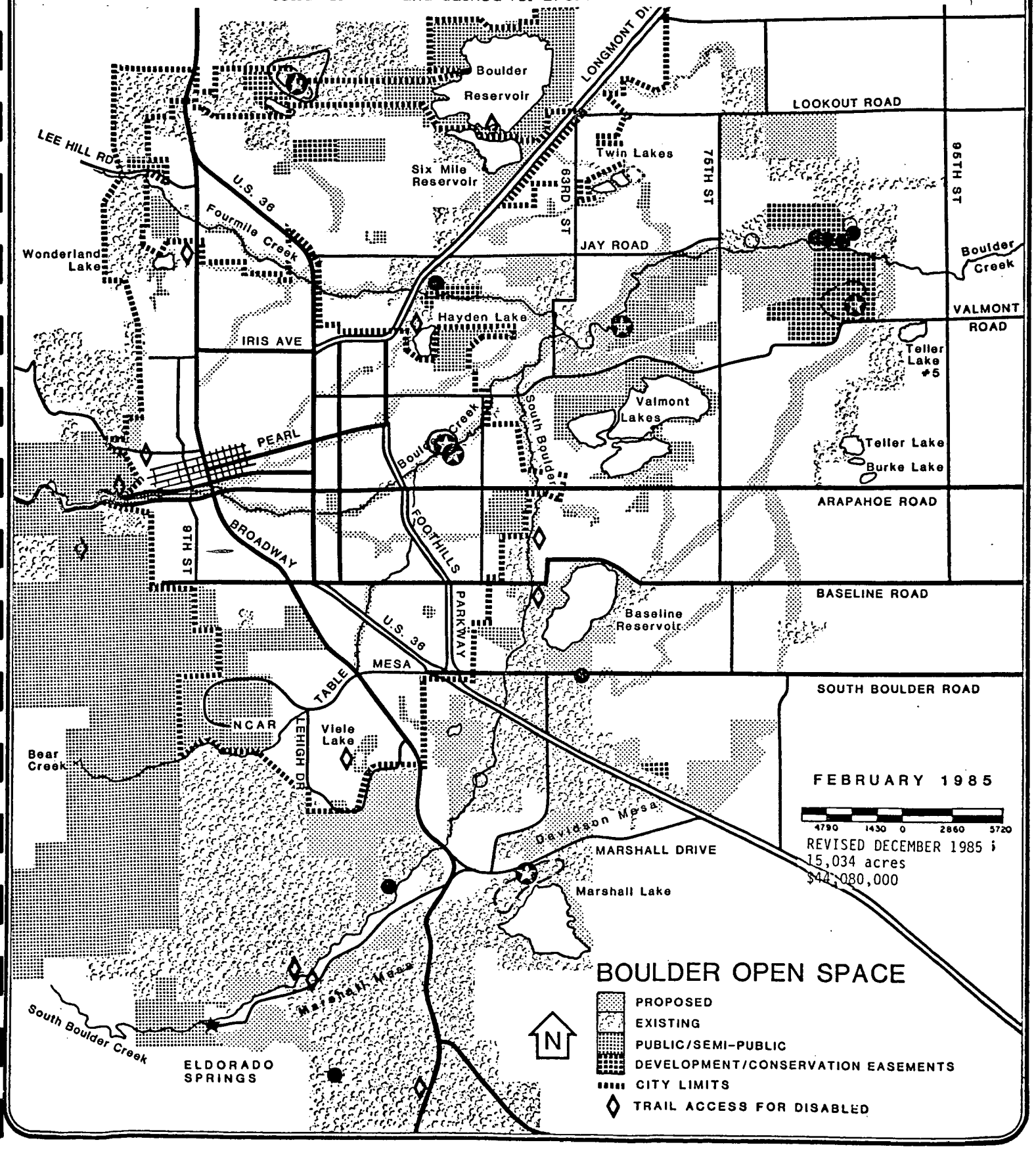


Figure 12. Locations of 1984 Eastern Screech-Owl observations (closed circle) and 1985 nest site (star in circle).

Figure 13. Locations of 1984 (closed circles) and 1985 (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 and dashed for 1985.



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 presumedly had moved to lower elevations between breeding season. The BASWI lists 10 sightings of 14 birds from 1978 through 1984.

In 1985, the Boulder County Nature Association (BCNA) began a small owl survey in the foothills and mountains of Boulder County. The 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. Since large areas of suitable habitat on Open Space weren't 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 occured locally, but was "much less common than a few years ago". The Colorado Division of Wildlife records show 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 reports 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 Wickmann, 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. 14). Two pair 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 pair 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 (D. Amerman, pers. commun.). In 1985, the eastern pair used the 1984 burrow, or one near it; the western birds used a new burrow (D. Amerman, pers. commun.).

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.

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. 15). 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.

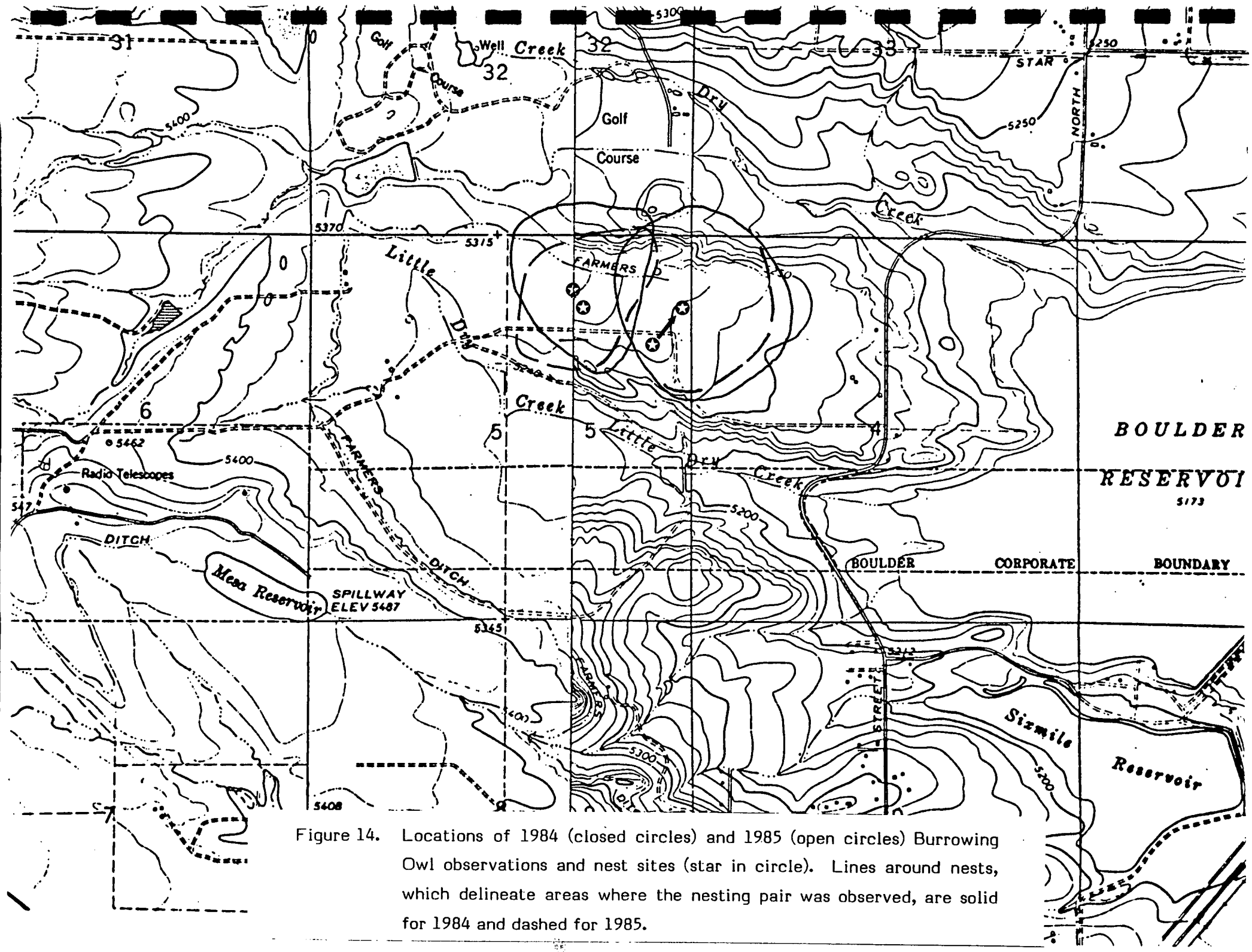


Figure 14. Locations of 1984 (closed circles) and 1985 (open circles) Burrowing Owl observations and nest sites (star in circle). Lines around nests, which delineate areas where the nesting pair was observed, are solid for 1984 and dashed for 1985.

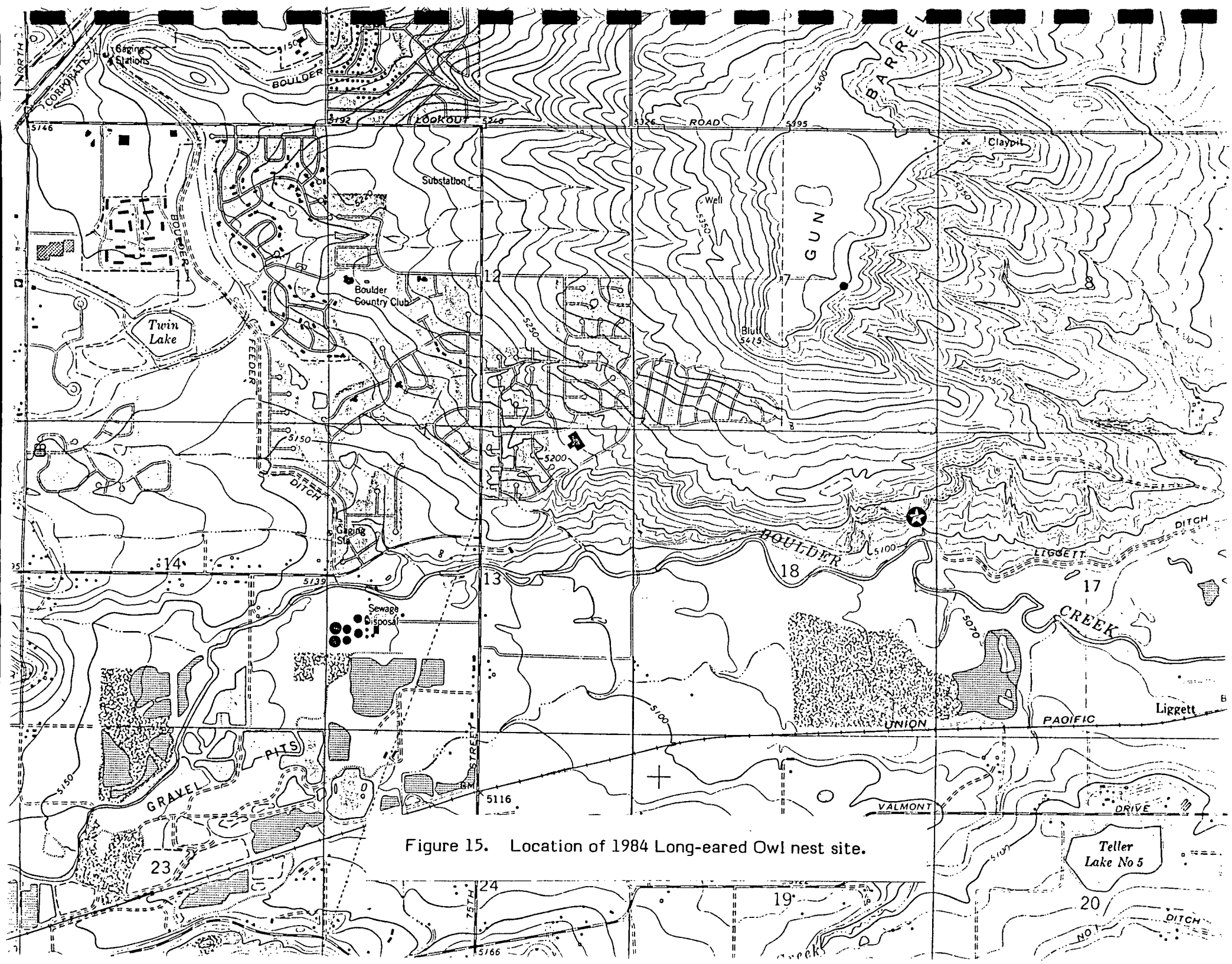


Figure 15. Location of 1984 Long-eared Owl nest site.

Northern Saw-whet Owl

Northern Saw-whet Owls have been know to nest in Boulder County for many years (Henderson 1909, Betts 1913, Alexander 1937). Saw-whets have been considered to be 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.

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

Other Owls

Flammulated Owls, are residents of Boulder County (Henderson 1909, Betts 1913, Alexander 1937) but they are seldom recorded and their status in unknown. The BCNA small owl survey found 2 Flammulated Owls in Boulder County.

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

Small owls are largely nocturnal, secretive, difficult to find, and may be more common than reported. These owls rely on tree cavities for nesting and preserving large dead trees and snags is necessary for their maintenance.

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 fire wood 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 trap shooting on Open Space.

Dogs were seen several times on 4 of our study plots, usually accompanying people walking on established trails. Dogs were seen several times running free on the Yunker parcels, some of which we saw come from nearby houses. 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 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 nesting 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 there is no indication that they 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 four breeding-bird species. They are usually dominated by one or two 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 one or more phases of the nesting cycle, a patchy distribution throughout their range, and are especially sensitive to habitat disturbances (Graul 1980). We identified two 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 grass, 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 enhancement features 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 once 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 non-critical 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 value 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 or 1985 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.

LITERATURE CITED

Alexander, G. 1937. The birds of Boulder County, Colorado. Univ. Colo. Stud. 24:79-105.

AOU. 1983. Checklist of North American birds. 6th ed. Lawrence, American Ornithologists' Union.

Bailey, A.M., and R.J. Niedrach. 1965. Birds of Colorado. Denver. Mus. Natl. Hist.

Bellrose, F.C. 1980. Ducks, geese and swans of North America. 3rd ed. Stackpole Books, Harrisburg, PA. 540 pp.

Bent, A.C. 1958. Life histories of North American blackbirds, orioles, tanagers, and allies. U.S. Natl. Mus. Bull. 211.

Betts, N.D. 1913. Birds of Boulder County, Colorado. Univ. Colo. Stud. 10:177-232.

Bock, J. and M. O'Shea-Stone. Unpubl. data. Report on the Cottonwood Grove. Available from J. Bock. Dept. EPOB, Univ. of Colorado, Boulder.

Boeher, E.L., and T.D. Ray. 1971. Golden Eagle population studies in the southwest. Condor 73:463-467.

Bunin, J.E. 1985. Vegetation of the City of Boulder, Colorado Open Space lands. Natural Science Assoc., Boulder, CO.

Buttery, R.F., and P.W. Shields. 1975. Range management practices and bird habitat evaluation. Pages 183-189. in: D.R. Smith (Tech. Coord.) Proceedings of the symposium on management of forest and range habitats for nongame birds. U.S.D.A. For. Serv. Cen. Tech. Rep. WO-1.

Conner, R.N. and J.G. Dickson. 1980. Strip transect sampling for avian habitat studies. Wildl. Soc. Bull. 8:4-10.

Diem, K.L., and S.I. Zeveloff. 1980. Ponderosa pine bird communities. Pages 170-197. in: R.M. DeGraff and N.G. Tilghman (Comps.) Workshop proceedings management of western forests and grasslands for nongame birds. U.S.D.A. for. Serv. Gen. Tech. Rep. INT-86.

Eberhardt, L.L. 1978. Transect methods for population studies. J. Wildl. Manage. 42:1-31.

Emlen, J.T. 1971. Population densities of birds derived from transect count. Auk 88:323-342.

Energy Resources Technology Lands, Inc. 1982. N.U.D.U.D. Sketch Plan Submittal, Ertl Farm, Boulder County, Colorado. 45 pp.

French, N.R. 1951. Duck Hawk nesting in Colorado. Condor 53:54.

Fyfe, R.W., and R.R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and their sensitive species. Can. Wildl. Serv. Occ. Paper No. 23.

Graul, W.D. 1980. Grassland management practices and bird communities. Pages 38-47. in: R.M. DeGraff and N.G. Tilghman (Comps.) Workshop proceedings management of western forests and grasslands for nongame birds. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-86.

Henderson, J. 1909. An annotated list of the birds of Boulder County, Colorado. Univ. Colo. Stud. 6:219-242.

Jollie, M.T. 1945. Notes on raptors of the Boulder area, Colorado. Condor 47:38-39.

Keammerer, W.R. and D.B. Keammerer. 1983. Vegetation studies on the Fox Hills Formation outcrop east of Boulder Colorado. Stoecker-Keammerer and Assoc.

MacPhail, D.D., H.L. Young, and D.I. Netoff. 1970. White Rocks natural area study. Dept. of Geography, Univ. of Colorado, Boulder. 51 pp.

Marr, J.W. 1961. Ecosystems of the east slope of the Front Range in Colorado. Univ. of Colorado Studies, Ser. Bio. 8, Univ. of Colorado Press, Boulder, 134 pp.

Marr, J.W. 1964. The vegetation of the Boulder area. Pages 34-42 in H.G. Rodeck, ed. Natural history of the Boulder area. Univ. of Colorado Museum, Boulder. Leafl. 13. 100 pp.

Petersen, L. 1979. Ecology of Great Horned Owls and Red-tailed Hawks in southeastern Wisconsin. Wisc. Dept. Nat. Res. Tech. Bull. 11.

Ryder, R.A. 1980. Effects of grazing on bird habitats. Pages 51-66. in: R.M. DeGraff, and N.G. Tilghman (Comps.) Workshop proceedings management of western forests and grasslands for nongame birds. U.S.D.A. For. Serv. Gen. Tech. Rep. INT 86.

Scott, V.E., J.A. Whelan, and P.L. Svoboda. 1980. Cavity-nesting birds and forest management. Pages 311-324. in: R.M. DeGraff and N.G. Tilghman (Comps.) Workshop proceedings management of western forests and grasslands of nongame birds. U.S.D.A. For. Serv. Gen. Tech. Rep. INT 86.

Sokal, R.R. and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Co., San Francisco, CA. 776 pp.

Szaro, R.C. 1980. Factors influencing bird populations in southwestern riparian forests. Pages 403-418. in: R.M. DeGraff and N.G. Tilghman (Comps.). Workshop proceedings management of western forests and grasslands for nongame birds. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-86.

Vestal, A.G. 1914. Prairie vegetation of a mountain-front area in Colorado. Bot. Gaz. 58:377-400.

Weber, W.A. 1964. Botany of the Boulder region. Pages 43-46 in H.G. Rodeck, ed. Natural history of the Boulder area. Univ. of Colorado Museum, Boulder. Leafl. 13. 100 pp.

Zar, J.H. 1974. Biostatistical analysis. Prentice-Hall, Inc., Englewood Cliffs, N.J. 620 pp.

Zarn, M. 1974. Burrowing Owl. Habitat Manage. Ser. Unique Endang. Sp. B.L.M. Tech Note TN-250.

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*
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*
Bufflehead	*Bucephala albeola*
Common Merganser	*Mergus merganser*
Cathartidae	
Turkey Vulture	*Cathartes aura*

Table A1. Continued.

FAMILY	COMMON NAME	SCIENTIFIC NAME
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
	Pectoral Sandpiper	Calidris melanotos
	Common Snipe	Gallinago gallinago
	Wilson's Phalarope	Phalaropus tricolor
Laridae		
	Ring-billed Gull	Larus delawarensis
	California Gull	Larus californicus

Table A1. Continued.

FAMILY	COMMON NAME	SCIENTIFIC NAME
	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	Phalaeniptilus nuttallii
Apodidae		
	White-throated Swift	Aeronautes saxatalis
Trochilidae		
	Broad-tailed Hummingbird	Selasphorus platycercus
Alcedinidae		
	Belted Kingfisher	Ceryle alcyon
Picidae		
	Downy Woodpecker	Picoides pubescens
	Hairy Woodpecker	Picoides villosus
	Northern Flicker	Colaptes auratus
Tyrannidae		
	Olive-sided Flycatcher	Contopus borealis
	Western Wood Pewee	Contopus sordidulus
	Willow Flycatcher	Empidonax traillii
	Hammond's Flycatcher	Empidonax hammondii
	Dusky Flycatcher	Empidonax oberholseri
	Western Flycatcher	Empidonax difficilis

Table A1. Continued.

FAMILY	COMMON NAME	SCIENTIFIC NAME
	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
Sittidae		
	Red-breasted Nuthatch	Sitta canadensis
	Pygmy Nuthatch	Sitta pygmaea
Troglodytidae		
	Rock Wren	Salpinctes obsoletus
	House Wren	Troglodytes aedon
Cinclidae		
	American Dipper	Cinclus mexicanus

Table A1. Continued.

FAMILY	COMMON NAME	SCIENTIFIC NAME
Muscicapidae		
	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
	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
	Black-headed Grosbeak	Pheucticus melanocephalus
	Blue Grosbeak	Guiraca caerulea
	Lazuli Bunting	Passerina amoena
	Indigo Bunting	Passerina cyanea

Table A1. Continued.

FAMILY	COMMON NAME	SCIENTIFIC NAME
	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
	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 1985 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 1985.

RAW DATA PRINTOUT 08-14-1985 R.W.THOMPSON

RIPARIAN SPECIES RICHNESS 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 08-14-1985 R.W.THOMPSON

CONIFER SPECIES RICHNESS 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 08-14-1985 R.W.THOMPSON

MOUNTAIN SHRUB SPECIES RICHNESS 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 08-14-1985 R.W.THOMPSON

GRASSLAND SPECIES RICHNESS 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 08-14-1985 R.W.THOMPSON

AGRICULTURAL GRASSLAND SPECIES RICHNESS 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

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

08-14-1985

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

1985 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	920.23	4	230.0575	22.6022	53.30302 %
AMONG SUBGROUPS	356.249	35	10.17854	2.929072	13.00057 %
WITHIN GROUPS (ERROR)	556.001	160	3.475006		33.69642 %
TOTAL	1832.48	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).

08-14-1985

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

1985 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	9.45	.4654058	40	4.924928
GROUP 2	6.85	.3407194	40	4.974007
GROUP 3	6.75	.3257142	40	4.825396
GROUP 4	2.875	.2093565	40	7.281964
GROUP 5	5.375	.3196302	40	5.946608

Table B4. 1985 Species richness means, standard errors, and coefficients of variation of the mean for breeding birds in plots.

08-14-1985

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

1985 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CVM(%)
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
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
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
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
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

Table B5. Student-Newman-Keuls test results for 1985 breeding species richness sampled in grassland (group 1), agricultural grassland (group 2), mountain shrub (group 3), conifer (group 4), and riparian (group 5) habitats.

08-15-1985

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

1985 SPECIES RICHNESS - FIVE MAJOR BOULDER OPEN SPACE HABITATS

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	2.875	9.45	BR.S85
2	5.375	6.850001	BC.S85
3	6.75	6.75	BM.S85
4	6.850001	2.875	BG.S85
5	9.45	5.375	BP.S85

CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 13.03414
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = 8.078192
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = 5.352422
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = 5.154183
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 7.879956
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = 2.924009
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = .1982386
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 7.681717
CALCULATED Q-VALUE FOR COMPARISON: 3 vs 2 Q' = 2.725771
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 4.955946

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.

08-15-1985

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

1985 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 = 1.448186 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 ? 1.690,0.1

LSD =  1.205633              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 B6. Two-way ANOVA results comparing species richness in habitats between 1984 and 1985.

TWO-WAY ANALYSIS OF VARIANCE - MIXED MODEL ANOVA2XN. R. W. THOMPSON

BREEDING SPECIES RICHNESS - 1984 VS 1985 - FIVE MAJOR BOULDER OPEN SPACE HABITAT S

SOURCE OF VARIATION		SS	DF	MS	F
A	(YEAR)	5.723877	1	5.723877	2.872694
B	(HABITAT)	381.0122	4	95.25305	184.6239
A X B	(INTERACTION)	2.063721	4	.5159302	.2589346
WITHIN SUBGROUPS (ERROR)		139.4758	70	1.992512	
TOTAL		528.2756	79		

TEST THE F's CALCULATED FOR A, B, AND A X B.

EXAMPLE: FACTOR A REPRESENTS YEARS, SAY 1984 AND 1985. IF THE F(A) IN THE TABLE IS > F (0.05)(DF(A),DF(ERROR)) (i.e., 0.05 at 1,42 DF) FROM THE CRITICAL VALUES STARTING ON p. 415 OF ZAR, THERE IS A SIGNIFICANT DIFFERENCE BETWEEN THE TWO YEARS (Ho IS REJECTED). SEE SOKAL & ROHLF p. 337 FOR FURTHER EXPLANATION, PARTICULARLY ON INTERACTION INTERPRETATION.

Table B7. Raw data printout for density (n/2ha) of breeding birds sampled in riparian (R), conifer (C), and mountain shrub (M) plots on City of Boulder Open Space, spring 1985.

RAW DATA PRINTOUT 08-15-1985 R.W.THOMPSON

RIPARIAN 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 08-15-1985 R.W.THOMPSON

CONIFER DENSITY DATA

BC1.D85	BC2.D85	BC3.D85	BC4.D85	BC5.D85	BC6.D85	BC7.D85	BC8.D85
14.00	162.00	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 08-15-1985 R.W.THOMPSON

MOUNTAIN SHRUB 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 08-15-1985 R.W.THOMPSON

GRASSLAND 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 08-14-1985 R.W.THOMPSON

AGRICULTURAL GRASSLAND 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

Table B8. Results of two-level nested analysis of variance test examining differences in 1985 breeding species density between and within major Open Space habitats.

08-15-1985

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

1985 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	3975.77	4	993.9424	3.380183	9.173512 %
AMONG SUBGROUPS	10291.75	35	294.0499	2.055754	15.83459 %
WITHIN GROUPS (ERROR)	22886.01	160	143.0375		74.9919 %
TOTAL	37153.52	199			

NO TRANSFORMATION

Table B9. Means, standard errors, and coefficients of variation of the mean for breeding species density (n/2ha) in 1985 habitats (group 1 = riparian = R; group 2 = conifer = C; group 3 = mountain shrub = m; group 4 = grassland = G; group 5 = agricultural grassland = P).

08-15-1985

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

1985 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	20.5	1.196683	40	5.83748
GROUP 2	19.225	3.872568	40	20.14339
GROUP 3	13.075	.7513982	40	5.746832
GROUP 4	8.100001	1.403202	40	17.32348
GROUP 5	15.7	1.518349	40	9.671015

Table B10. Basic statistics for breeding species density in 1985 plots.

08-15-1985

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

1985 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CVM(%)
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
BC1.D85	14.8	.5830973	5	3.939847
BC2.D85	48.4	28.4176	5	58.71405
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
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
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
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

Table B11. Student-Newman-Keuls test results for 1985 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.

08-15-1985

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

1985 DENSITY - FIVE MAJOR BOULDER OPEN SPACE HABITATS

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	8.100001	20.5	BR.D85
2	12.75	19.225	BC.D85
3	15.7	12.75	BM.D85
4	19.225	8.100001	BG.D85
5	20.5	15.7	BP.D85

CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 4.569886
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = 2.856179
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = 1.768988
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = .4698873
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 4.099998
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = 2.386291
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = 1.2991
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 2.800898
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 1.087191
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 1.713707

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.

08-15-1985

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

1985 DENSITY - 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 = 7.789819 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 B12. Two-way ANOVA results comparing breeding bird density in 1984 vs 1985 habitats.

TWO-WAY ANALYSIS OF VARIANCE - MIXED MODEL ANOVA2XN. R. W. THOMPSON

BREEDING BIRD DENSITY - 1984 VS 1985 - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SOURCE OF VARIATION		SS	DF	MS	F
A	(YEAR)	135.1953	1	135.1953	3.034697
B	(HABITAT)	1700.342	4	425.0855	13.31216
A X B	(INTERACTION)	127.7285	4	31.93213	.7167728
WITHIN SUBGROUPS (ERROR)		3118.49	70	44.54986	
TOTAL		5081.756	79		

TEST THE F's CALCULATED FOR A, B, AND A X B.

EXAMPLE: FACTOR A REPRESENTS YEARS, SAY 1984 AND 1985. IF THE F(A) IN THE TABLE IS > F (0.05)(DF(A),DF(ERROR)) (i.e., 0.05 at 1,42 DF) FROM THE CRITICAL VALUES STARTING ON p. 415 OF ZAR, THERE IS A SIGNIFICANT DIFFERENCE BETWEEN THE TWO YEARS (Ho IS REJECTED). SEE SOKAL & ROHLF p. 337 FOR FURTHER EXPLANATION, PARTICULARLY ON INTERACTION INTERPRETATION.
Ok

Table B13. One-way analysis of variance results testing for differences in 1985 breeding species richness between 2 mountain shrub plots on the Ertl parcel (BM2.S85 and BM4.S85) 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.

08-15-1985

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

1985 SPECIES RICHNESS - ERTL VS NONERTL MOUNTAIN SHRUB

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	29.1001	7	4.157157	.9752868	.4918334 %
WITHIN GROUPS	136.3999	32	4.262497		99.50816 %
TOTAL	165.5	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BM1.S85	MEAN+/-SE(n)=	6.6 +/- .2449487 (5)	CUM=	3.711343 %
BM2.S85	MEAN+/-SE(n)=	7.8 +/- 1.496663 (5)	CUM=	19.18799 %
BM3.S85	MEAN+/-SE(n)=	5.2 +/- .6633251 (5)	CUM=	12.75625 %
BM4.S85	MEAN+/-SE(n)=	6.6 +/- .8124038 (5)	CUM=	12.30915 %
BM5.S85	MEAN+/-SE(n)=	6.6 +/- .9273618 (5)	CUM=	14.05094 %
BM6.S85	MEAN+/-SE(n)=	6.6 +/- .9273618 (5)	CUM=	14.05094 %
BM7.S85	MEAN+/-SE(n)=	8.2 +/- .8602322 (5)	CUM=	10.49064 %
BM8.S85	MEAN+/-SE(n)=	6.4 +/- .9797958 (5)	CUM=	15.30931 %

Table B14. Student-Newman-Keuls and least significant difference test results for 1985 breeding species richness between 2 mountain shrub plots on the Ertl parcel (ranked means 2 and 4; unranked means file names BM2.S85 and BM4.S85) and the 6 other mountain shrub plots on Open Space.

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

1985 SPECIES RICHNESS - ERTL VS NONERTL MOUNTAIN SHRUB

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	5.2	6.6	BM1.S85
2	6.4	7.8	BM2.S85
3	6.6	5.2	BM3.S85
4	6.6	6.6	BM4.S85
5	6.6	6.6	BM5.S85
6	6.6	6.6	BM6.S85
7	7.8	8.2	BM7.S85
8	8.2	6.4	BM8.S85

CALCULATED Q VALUE FOR COMPARISON: 8 vs 1 Q' = 3.249184
CALCULATED Q VALUE FOR COMPARISON: 8 vs 2 Q' = 1.94951
CALCULATED Q VALUE FOR COMPARISON: 8 vs 3 Q' = 1.732898
CALCULATED Q VALUE FOR COMPARISON: 8 vs 4 Q' = 1.732898
CALCULATED Q VALUE FOR COMPARISON: 8 vs 5 Q' = 1.732898
CALCULATED Q VALUE FOR COMPARISON: 8 vs 6 Q' = 1.732898
CALCULATED Q VALUE FOR COMPARISON: 8 vs 7 Q' = .4332241
CALCULATED Q VALUE FOR COMPARISON: 7 vs 1 Q' = 2.81596
CALCULATED Q VALUE FOR COMPARISON: 7 vs 2 Q' = 1.516286
CALCULATED Q VALUE FOR COMPARISON: 7 vs 3 Q' = 1.299674
CALCULATED Q VALUE FOR COMPARISON: 7 vs 4 Q' = 1.299674
CALCULATED Q VALUE FOR COMPARISON: 7 vs 5 Q' = 1.299674
CALCULATED Q VALUE FOR COMPARISON: 7 vs 6 Q' = 1.299674
CALCULATED Q VALUE FOR COMPARISON: 6 vs 1 Q' = 1.516286
CALCULATED Q VALUE FOR COMPARISON: 6 vs 2 Q' = .216612
CALCULATED Q VALUE FOR COMPARISON: 6 vs 3 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 6 vs 4 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 6 vs 5 Q' = 0

CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 1.516286
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = .216612
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 1.516286
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = .216612
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 1.516286
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = .216612
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = 1.299674

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.

08-15-1985

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

1985 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 = 2.659825 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 = 2.211951 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 1985 breeding species density between 2 mountain shrub plots on the Ertl parcel (BM2.D85 and BM4.D85) 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.

08-15-1985

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

1985 DENSITY - ERTL VS NONERTL MOUNTAIN SHRUB

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	128.3755	7	18.33936	.7799838	4.214856 %
WITHIN GROUPS	752.3995	32	23.51248		95.78514 %
TOTAL	880.7749	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BM1.D85	MEAN+/-SE(n)=	12.6 +/- 1.208305 (5)	CVM= 9.589722 %
BM2.D85	MEAN+/-SE(n)=	13.6 +/- 2.56125 (5)	CVM= 18.83272 %
BM3.D85	MEAN+/-SE(n)=	10 +/- 1.095445 (5)	CVM= 10.95445 %
BM4.D85	MEAN+/-SE(n)=	11 +/- 1.923539 (5)	CVM= 17.48671 %
BM5.D85	MEAN+/-SE(n)=	14.2 +/- 1.881489 (5)	CVM= 13.24992 %
BM6.D85	MEAN+/-SE(n)=	12.6 +/- 1.83303 (5)	CVM= 14.54786 %
BM7.D85	MEAN+/-SE(n)=	15.4 +/- 3.17175 (5)	CVM= 20.59578 %
BM8.D85	MEAN+/-SE(n)=	15.2 +/- 2.782086 (5)	CVM= 18.3032 %

Table B16. Student-Newman-Keuls and least significant difference test results for 1985 breeding species density (n/2ha) between 2 mountain shrub plots on the Ertl parcel (ranked means 2 and 5; unranked means file names BM2.D85 and BM4.D85) and the 6 other mountain shrub plots on Open Space.

08-15-1985

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

1985 DENSITY - ERTL VS NONERTL MOUNTAIN SHRUB

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	10	12.6	BM1.D85
2	11	13.6	BM2.D85
3	12.6	10	BM3.D85
4	12.6	11	BM4.D85
5	13.6	14.2	BM5.D85
6	14.2	12.6	BM6.D85
7	15.2	15.4	BM7.D85
8	15.4	15.2	BM8.D85

CALCULATED Q VALUE FOR COMPARISON:	8 vs 1	Q' =	2.490173
CALCULATED Q VALUE FOR COMPARISON:	8 vs 2	Q' =	2.02903
CALCULATED Q VALUE FOR COMPARISON:	8 vs 3	Q' =	1.291201
CALCULATED Q VALUE FOR COMPARISON:	8 vs 4	Q' =	1.291201
CALCULATED Q VALUE FOR COMPARISON:	8 vs 5	Q' =	.8300573
CALCULATED Q VALUE FOR COMPARISON:	8 vs 6	Q' =	.5533717
CALCULATED Q VALUE FOR COMPARISON:	8 vs 7	Q' =	9.222854E-02
CALCULATED Q VALUE FOR COMPARISON:	7 vs 1	Q' =	2.397944
CALCULATED Q VALUE FOR COMPARISON:	7 vs 2	Q' =	1.936801
CALCULATED Q VALUE FOR COMPARISON:	7 vs 3	Q' =	1.198972
CALCULATED Q VALUE FOR COMPARISON:	7 vs 4	Q' =	1.198972
CALCULATED Q VALUE FOR COMPARISON:	7 vs 5	Q' =	.7378288
CALCULATED Q VALUE FOR COMPARISON:	7 vs 6	Q' =	.4611432
CALCULATED Q VALUE FOR COMPARISON:	6 vs 1	Q' =	1.936801
CALCULATED Q VALUE FOR COMPARISON:	6 vs 2	Q' =	1.475658
CALCULATED Q VALUE FOR COMPARISON:	6 vs 3	Q' =	.7378288
CALCULATED Q VALUE FOR COMPARISON:	6 vs 4	Q' =	.7378288
CALCULATED Q VALUE FOR COMPARISON:	6 vs 5	Q' =	.2766856
CALCULATED Q VALUE FOR COMPARISON:	5 vs 1	Q' =	1.660116
CALCULATED Q VALUE FOR COMPARISON:	5 vs 2	Q' =	1.198972
CALCULATED Q VALUE FOR COMPARISON:	5 vs 3	Q' =	.4611432
CALCULATED Q VALUE FOR COMPARISON:	5 vs 4	Q' =	.4611432
CALCULATED Q VALUE FOR COMPARISON:	4 vs 1	Q' =	1.198972
CALCULATED Q VALUE FOR COMPARISON:	4 vs 2	Q' =	.7378292
CALCULATED Q VALUE FOR COMPARISON:	4 vs 3	Q' =	0
CALCULATED Q VALUE FOR COMPARISON:	3 vs 1	Q' =	1.198972
CALCULATED Q VALUE FOR COMPARISON:	3 vs 2	Q' =	.7378292
CALCULATED Q VALUE FOR COMPARISON:	2 vs 1	Q' =	.4611432

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.

08-15-1985

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

1985 DENSITY - 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 = 6.246982 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 = 5.195085 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 1985 breeding species richness between 2 riparian plots in the Cottonwood Grove (BR2.S85 and BR4.S85) and the 6 other riparian plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

08-14-1985

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

1985 SPECIES RICHNESS - COTTONWOOD GROVE VS OTHER RIPARIAN HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	151.8997	7	21.69995	3.73332	35.34472 %
WITHIN GROUPS	186.0003	32	5.812508		64.65528 %
TOTAL	337.8999	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BR1.S85	MEAN+/-SE(n)=	8.600001 +/- 1.208305 (5)	CVM= 14.05006 %
BR2.S85	MEAN+/-SE(n)=	7 +/- .83666 (5)	CVM= 11.95229 %
BR3.S85	MEAN+/-SE(n)=	11.8 +/- 1.356466 (5)	CVM= 11.49547 %
BR4.S85	MEAN+/-SE(n)=	8.8 +/- 1.113553 (5)	CVM= 12.65401 %
BR5.S85	MEAN+/-SE(n)=	9.2 +/- 1.067708 (5)	CVM= 11.60552 %
BR6.S85	MEAN+/-SE(n)=	12.2 +/- .8602322 (5)	CVM= 7.051084 %
BR7.S85	MEAN+/-SE(n)=	6.8 +/- .8000001 (5)	CVM= 11.76471 %
BR8.S85	MEAN+/-SE(n)=	11.2 +/- 1.240967 (5)	CVM= 11.08006 %

Table B18. Student-Newman-Keuls and least significant difference test results for 1985 breeding species richness between 2 riparian plots in the Cottonwood Grove (ranked means 2 and 4; unranked means file names BR2.S85 and BR4.S85) and the 6 other riparian plots on Open Space.

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

1985 SPECIES RICHNESS - COTTONWOOD GROVE VS OTHER RIPARIAN HABITATS

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	6.8	8.600001	BR1.S85
2	7	7	BR2.S85
3	8.600001	11.8	BR3.S85
4	8.8	8.8	BR4.S85
5	9.2	9.2	BR5.S85
6	11.2	12.2	BR6.S85
7	11.8	6.8	BR7.S85
8	12.2	11.2	BR8.S85

CALCULATED Q VALUE FOR COMPARISON: 8 vs 1 Q' = 5.008376
CALCULATED Q VALUE FOR COMPARISON: 8 vs 2 Q' = 4.822881
CALCULATED Q VALUE FOR COMPARISON: 8 vs 3 Q' = 3.338917
CALCULATED Q VALUE FOR COMPARISON: 8 vs 4 Q' = 3.153422
CALCULATED Q VALUE FOR COMPARISON: 8 vs 5 Q' = 2.782432
CALCULATED Q VALUE FOR COMPARISON: 8 vs 6 Q' = .9274772
CALCULATED Q VALUE FOR COMPARISON: 8 vs 7 Q' = .3709905
CALCULATED Q VALUE FOR COMPARISON: 7 vs 1 Q' = 4.637386
CALCULATED Q VALUE FOR COMPARISON: 7 vs 2 Q' = 4.451891
CALCULATED Q VALUE FOR COMPARISON: 7 vs 3 Q' = 2.967927
CALCULATED Q VALUE FOR COMPARISON: 7 vs 4 Q' = 2.782432
CALCULATED Q VALUE FOR COMPARISON: 7 vs 5 Q' = 2.411441
CALCULATED Q VALUE FOR COMPARISON: 7 vs 6 Q' = .5564867
CALCULATED Q VALUE FOR COMPARISON: 6 vs 1 Q' = 4.080899
CALCULATED Q VALUE FOR COMPARISON: 6 vs 2 Q' = 3.895404
CALCULATED Q VALUE FOR COMPARISON: 6 vs 3 Q' = 2.41144

CALCULATED Q VALUE FOR COMPARISON: 6 vs 4 Q' = 2.225945
CALCULATED Q VALUE FOR COMPARISON: 6 vs 5 Q' = 1.854954
CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 2.225945
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = 2.04045
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = .5564858
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = .3709905
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 1.854954
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = 1.669459
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = .1854953
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 1.669459
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 1.483964
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = .1854953

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.

08-14-1985

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

1985 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 = 3.10601 t-value = 2.037 α = .05

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) .05 ? 1.694,0.10

LSD = 2.583005 t-value = 1.694 α = .1

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

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 1985 breeding species density between 2 riparian plots in the Cottonwood Grove (BR2.D85 and BR4.D85) and the 6 other riparian plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

08-14-1985

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

1985 DENSITY - COTTONWOOD GROVE VS OTHER RIPARIAN HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	1302.799	7	186.1141	6.395666	51.90304 %
WITHIN GROUPS	931.2012	32	29.10004		48.09697 %
TOTAL	2234	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BR1.D85	MEAN+/-SE(n)=	17 +/- 2.50998 (5)	CVM= 14.76459 %
BR2.D85	MEAN+/-SE(n)=	16.4 +/- 1.691153 (5)	CVM= 10.31191 %
BR3.D85	MEAN+/-SE(n)=	21.4 +/- 2.135415 (5)	CVM= 9.978575 %
BR4.D85	MEAN+/-SE(n)=	18.2 +/- 2.596151 (5)	CVM= 14.26457 %
BR5.D85	MEAN+/-SE(n)=	31.2 +/- 3.05614 (5)	CVM= 9.795319 %
BR6.D85	MEAN+/-SE(n)=	22.4 +/- 1.749285 (5)	CVM= 7.809307 %
BR7.D85	MEAN+/-SE(n)=	11.6 +/- 2.088061 (5)	CVM= 18.00053 %
BR8.D85	MEAN+/-SE(n)=	25.8 +/- 3.056142 (5)	CVM= 11.84551 %

Table B20. Student-Newman-Keuls and least significant difference test results for 1985 breeding species density between 2 riparian plots in the Cottonwood Grove (ranked means 2 and 4; unranked means file names BR2.D85 and BR4.D85) and the 6 other riparian plots on Open Space.

08-14-1985

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

1985 DENSITY - COTTONWOOD GROVE VS OTHER RIPARIAN HABITATS

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	11.6	17	BR1.D85
2	16.4	16.4	BR2.D85
3	17	21.4	BR3.D85
4	18.2	18.2	BR4.D85
5	21.4	31.2	BR5.D85
6	22.4	22.4	BR6.D85
7	25.8	11.6	BR7.D85
8	31.2	25.8	BR8.D85

CALCULATED Q VALUE FOR COMPARISON:	8 vs 1	Q' =	8.124456
CALCULATED Q VALUE FOR COMPARISON:	8 vs 2	Q' =	6.134794
CALCULATED Q VALUE FOR COMPARISON:	8 vs 3	Q' =	5.886086
CALCULATED Q VALUE FOR COMPARISON:	8 vs 4	Q' =	5.38867
CALCULATED Q VALUE FOR COMPARISON:	8 vs 5	Q' =	4.062229
CALCULATED Q VALUE FOR COMPARISON:	8 vs 6	Q' =	3.647716
CALCULATED Q VALUE FOR COMPARISON:	8 vs 7	Q' =	2.238371
CALCULATED Q VALUE FOR COMPARISON:	7 vs 1	Q' =	5.886085
CALCULATED Q VALUE FOR COMPARISON:	7 vs 2	Q' =	3.896423
CALCULATED Q VALUE FOR COMPARISON:	7 vs 3	Q' =	3.647715
CALCULATED Q VALUE FOR COMPARISON:	7 vs 4	Q' =	3.150299
CALCULATED Q VALUE FOR COMPARISON:	7 vs 5	Q' =	1.823857
CALCULATED Q VALUE FOR COMPARISON:	7 vs 6	Q' =	1.409344
CALCULATED Q VALUE FOR COMPARISON:	6 vs 1	Q' =	4.476741
CALCULATED Q VALUE FOR COMPARISON:	6 vs 2	Q' =	2.487079
CALCULATED Q VALUE FOR COMPARISON:	6 vs 3	Q' =	2.238371
CALCULATED Q VALUE FOR COMPARISON:	6 vs 4	Q' =	1.740954
CALCULATED Q VALUE FOR COMPARISON:	6 vs 5	Q' =	.4145131
CALCULATED Q VALUE FOR COMPARISON:	5 vs 1	Q' =	4.062228
CALCULATED Q VALUE FOR COMPARISON:	5 vs 2	Q' =	2.072565
CALCULATED Q VALUE FOR COMPARISON:	5 vs 3	Q' =	1.823857
CALCULATED Q VALUE FOR COMPARISON:	5 vs 4	Q' =	1.326441
CALCULATED Q VALUE FOR COMPARISON:	4 vs 1	Q' =	2.735787
CALCULATED Q VALUE FOR COMPARISON:	4 vs 2	Q' =	.746124
CALCULATED Q VALUE FOR COMPARISON:	4 vs 3	Q' =	.497416
CALCULATED Q VALUE FOR COMPARISON:	3 vs 1	Q' =	2.238371
CALCULATED Q VALUE FOR COMPARISON:	3 vs 2	Q' =	.248708
CALCULATED Q VALUE FOR COMPARISON:	2 vs 1	Q' =	1.989662

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.

08-14-1985

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

1985 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 = 6.949728 t-value = 2.037 α = .05

ENTER t-value (FROM p. 413-414 of Zar) FOR DF2 = 32
THEN ALPHA (2) LEVEL (e.g., 2.037,0.05) .05 ? 1.694,0.10

LSD = 5.779499 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 richness between 4 irrigated (BP1.S 85, BP5.S 85, BP6.S 85 and BP8.S 85) and 4 nonirrigated agricultural grassland plots. Means, standard errors, and coefficients of variation of the mean are provided below test results.

08-15-1985

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

1985 SPECIES RICHNESS - IRRIGATED VS NONIRRIGATED AGRICULTURAL GRASSLAND

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	83.77503	7	11.96786	5.065763	44.84745 %
WITHIN GROUPS	75.59998	32	2.362499		55.15256 %
TOTAL	159.375	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BP1.S85	MEAN+/-SE(n)=	6 +/- .83666 (5)	CVM= 13.94433 %
BP2.S85	MEAN+/-SE(n)=	6 +/- .83666 (5)	CVM= 13.94433 %
BP3.S85	MEAN+/-SE(n)=	5.2 +/- .374166 (5)	CVM= 7.1955 %
BP4.S85	MEAN+/-SE(n)=	3.4 +/- .509902 (5)	CVM= 14.99712 %
BP5.S85	MEAN+/-SE(n)=	5.2 +/- .374166 (5)	CVM= 7.1955 %
BP6.S85	MEAN+/-SE(n)=	8 +/- .9486832 (5)	CVM= 11.85854 %
BP7.S85	MEAN+/-SE(n)=	3.2 +/- .4898979 (5)	CVM= 15.30931 %
BP8.S85	MEAN+/-SE(n)=	6 +/- .83666 (5)	CVM= 13.94433 %

Table B22. Student-Newman-Keuls and least significant difference test results for 1985 breeding species richness between 4 irrigated (ranked means 4,5,7 and 8) and 4 nonirrigated agricultural grassland plots.

08-15-1985

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

1985 SPECIES RICHNESS - IRRIGATED VS NONIRRIGATED AGRICULTURAL GRASSLAND

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	3.2	6	BP1.S85
2	3.4	6	BP2.S85
3	5.2	5.2	BP3.S85
4	5.2	3.4	BP4.S85
5	6	5.2	BP5.S85
6	6	8	BP6.S85
7	6	3.2	BP7.S85
8	8	6	BP8.S85

CALCULATED Q VALUE FOR COMPARISON: 8 vs 1 Q' = 6.982974
CALCULATED Q VALUE FOR COMPARISON: 8 vs 2 Q' = 6.692017
CALCULATED Q VALUE FOR COMPARISON: 8 vs 3 Q' = 4.073402
CALCULATED Q VALUE FOR COMPARISON: 8 vs 4 Q' = 4.073402
CALCULATED Q VALUE FOR COMPARISON: 8 vs 5 Q' = 2.909572
CALCULATED Q VALUE FOR COMPARISON: 8 vs 6 Q' = 2.909572
CALCULATED Q VALUE FOR COMPARISON: 8 vs 7 Q' = 2.909572
CALCULATED Q VALUE FOR COMPARISON: 7 vs 1 Q' = 4.073402
CALCULATED Q VALUE FOR COMPARISON: 7 vs 2 Q' = 3.782444
CALCULATED Q VALUE FOR COMPARISON: 7 vs 3 Q' = 1.163829
CALCULATED Q VALUE FOR COMPARISON: 7 vs 4 Q' = 1.163829
CALCULATED Q VALUE FOR COMPARISON: 7 vs 5 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 7 vs 6 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 6 vs 1 Q' = 4.073402
CALCULATED Q VALUE FOR COMPARISON: 6 vs 2 Q' = 3.782444
CALCULATED Q VALUE FOR COMPARISON: 6 vs 3 Q' = 1.163829
CALCULATED Q VALUE FOR COMPARISON: 6 vs 4 Q' = 1.163829

CALCULATED Q VALUE FOR COMPARISON: 6 vs 5 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 4.073402
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = 3.782444
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = 1.163829
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = 1.163829
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 2.909572
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = 2.618615
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = 0
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 2.909572
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 2.618615
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = .2909573

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 H_0.

08-15-1985

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

1985 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 = 1.98019 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 = 1.646756 t-value = 1.694 α = .1

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

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

Table B23. One-way analysis of variance results testing for differences in breeding species density between 4 irrigated (BP1.D85, BP5.D85, BP6.D85 and BP8.D85) and 4 nonirrigated agricultural grassland plots. Means, standard errors, and coefficients of variation of the mean are provided below test results.

08-15-1985

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

1985 DENSITY - IRRIGATED VS NONIRRIGATED AGRICULTURAL GRASSLAND

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	2748.001	7	392.5716	14.80705	73.41421 %
WITHIN GROUPS	848.3994	32	26.51248		26.58579 %
TOTAL	3596.401	39			

NO TRANSFORMATION

FILE BREAKDOWN :

BP1.D85	MEAN+/-SE(n)=	25.4 +/- 3.234192 (5)	CVM= 12.73304 %
BP2.D85	MEAN+/-SE(n)=	13.2 +/- 2.956349 (5)	CVM= 22.39658 %
BP3.D85	MEAN+/-SE(n)=	10.4 +/- 1.122498 (5)	CVM= 10.79325 %
BP4.D85	MEAN+/-SE(n)=	6.8 +/- 1.067708 (5)	CVM= 15.70159 %
BP5.D85	MEAN+/-SE(n)=	11.8 +/- .5830947 (5)	CVM= 4.94148 %
BP6.D85	MEAN+/-SE(n)=	29.2 +/- 2.690723 (5)	CVM= 9.214804 %
BP7.D85	MEAN+/-SE(n)=	6 +/- .4472136 (5)	CVM= 7.45356 %
BP8.D85	MEAN+/-SE(n)=	22.8 +/- 3.611095 (5)	CVM= 15.83814 %

Table B24. Student-Newman-Keuls and least significant difference test results for 1985 breeding species density between 4 irrigated (ranked means 4,6,7 and 8) and 4 nonirrigated agricultural grassland plots.

08-15-1985

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

1985 DENSITY - IRRIGATED VS NONIRRIGATED AGRICULTURAL GRASSLAND

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	6	25.4	BP1.D85
2	6.8	13.2	BP2.D85
3	10.4	10.4	BP3.D85
4	11.8	6.8	BP4.D85
5	13.2	11.8	BP5.D85
6	22.8	29.2	BP6.D85
7	25.4	6	BP7.D85
8	29.2	22.8	BP8.D85

CALCULATED Q VALUE FOR COMPARISON: 8 vs 1 Q' = 10.07506
CALCULATED Q VALUE FOR COMPARISON: 8 vs 2 Q' = 9.727648
CALCULATED Q VALUE FOR COMPARISON: 8 vs 3 Q' = 8.164276
CALCULATED Q VALUE FOR COMPARISON: 8 vs 4 Q' = 7.556299
CALCULATED Q VALUE FOR COMPARISON: 8 vs 5 Q' = 6.94832
CALCULATED Q VALUE FOR COMPARISON: 8 vs 6 Q' = 2.779329
CALCULATED Q VALUE FOR COMPARISON: 8 vs 7 Q' = 1.650226
CALCULATED Q VALUE FOR COMPARISON: 7 vs 1 Q' = 8.424837
CALCULATED Q VALUE FOR COMPARISON: 7 vs 2 Q' = 8.077421
CALCULATED Q VALUE FOR COMPARISON: 7 vs 3 Q' = 6.51405
CALCULATED Q VALUE FOR COMPARISON: 7 vs 4 Q' = 5.906071
CALCULATED Q VALUE FOR COMPARISON: 7 vs 5 Q' = 5.298094
CALCULATED Q VALUE FOR COMPARISON: 7 vs 6 Q' = 1.129102
CALCULATED Q VALUE FOR COMPARISON: 6 vs 1 Q' = 7.295736
CALCULATED Q VALUE FOR COMPARISON: 6 vs 2 Q' = 6.948319
CALCULATED Q VALUE FOR COMPARISON: 6 vs 3 Q' = 5.384948
CALCULATED Q VALUE FOR COMPARISON: 6 vs 4 Q' = 4.77697

CALCULATED Q VALUE FOR COMPARISON: 6 vs 5 Q' = 4.168992
CALCULATED Q VALUE FOR COMPARISON: 5 vs 1 Q' = 3.126744
CALCULATED Q VALUE FOR COMPARISON: 5 vs 2 Q' = 2.779328
CALCULATED Q VALUE FOR COMPARISON: 5 vs 3 Q' = 1.215956
CALCULATED Q VALUE FOR COMPARISON: 5 vs 4 Q' = .6079778
CALCULATED Q VALUE FOR COMPARISON: 4 vs 1 Q' = 2.518766
CALCULATED Q VALUE FOR COMPARISON: 4 vs 2 Q' = 2.17135
CALCULATED Q VALUE FOR COMPARISON: 4 vs 3 Q' = .6079783
CALCULATED Q VALUE FOR COMPARISON: 3 vs 1 Q' = 1.910788
CALCULATED Q VALUE FOR COMPARISON: 3 vs 2 Q' = 1.563372
CALCULATED Q VALUE FOR COMPARISON: 2 vs 1 Q' = .3474161

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.

08-15-1985

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

1985 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) 0 ? 2.037,0.05

LSD = 6.633554 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 = 5.516564 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 B25. NANOVA results for 1985 breeding species density between and within habitats (same as Table B8), but excluding 2 large anomalous crossbill flocks observed 12 May on plot C2.

02-03-1986

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

1985 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SOURCE OF VARIATION	SS	DF	MS	F	VARIANCE COMPONENTS
AMONG GROUPS	3298.469	4	824.6172	5.09585	19.89561 %
AMONG SUBGROUPS	5663.746	35	161.8213	3.768762	28.54895 %
WITHIN GROUPS (ERROR)	6870.004	160	42.93753		51.55544 %
TOTAL	15832.22	199			

NO TRANSFORMATION

Table B26. Basic statistics for breeding species density in 1985 habitats excluding anomalous crossbill observations.

02-03-1986

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

1985 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

GROUP BREAKDOWNS

GROUP NO.	MEAN	+/- SE	n	CUM(%)
GROUP 1	20.5	1.196683	40	5.83748
GROUP 2	15.975	1.327948	40	8.312662
GROUP 3	13.075	.7513982	40	5.746832
GROUP 4	8.100001	1.403202	40	17.32348
GROUP 5	15.7	1.518349	40	9.671015

Table B27. Basic statistics for breeding species density in 1985 plots excluding anomalous crossbill observations on plot C2.

02-03-1986

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

1985 DENSITY (n/2ha) - FIVE MAJOR BOULDER OPEN SPACE HABITATS

SUBGROUP BREAKDOWNS

FILE	MEAN	+/- SE	n	CVM(%)
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
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
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
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
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

Table B28. 2xN ANOVA model comparing 1984 vs 1985 breeding species density between habitats, excluding anomalous crossbill observations from plot C2.

TWO-WAY ANALYSIS OF VARIANCE - MIXED (A-R;B-F) ANOVA2XN R. W. THOMPSON

BREEDING BIRD DENSITY - 1984 vs 1985 - FIVE MAJOR HABITATS (using BC-C.D85)

SOURCE OF VARIATION		SS	DF	MS	F
A	(YEAR)	76.04493	1	76.04493	2.427458
B	(HABITAT)	1620.649	4	405.1621	23.6308
A X B	(INTERACTION)	68.58203	4	17.14551	.547308
WITHIN SUBGROUPS (ERROR)		2192.889	70	31.32698	
TOTAL		3958.164	79		

TEST THE F's CALCULATED FOR A, B, AND A X B.

EXAMPLE: FACTOR A REPRESENTS YEARS, SAY 1984 AND 1985. IF THE F(A) IN THE TABLE IS > F (0.05)(DF(A),DF(ERROR)) (i.e., 0.05 at 1,42 DF) FROM THE CRITICAL VALUES STARTING ON p. 415 OF ZAR, THERE IS A SIGNIFICANT DIFFERENCE BETWEEN THE TWO YEARS (Ho IS REJECTED). SEE SOKAL & ROHLF p. 337 FOR FURTHER EXPLANATION, PARTICULARLY ON INTERACTION INTERPRETATION.

Table B29. SNK and LSD results for breeding species density in 1985 habitats, excluding anomalous crossbill flocks from plot C2.

12-02-1986

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

1985 DENSITY - 5 MAJOR OPEN SPACE HABITATS (USING BC-C.D85)

	RANKED MEANS	UNRANKED MEANS	FILENAME
1	8.100001	20.5	BR.D85
2	12.75	15.975	BC-C.D85
3	15.7	12.75	BM.D85
4	15.975	8.100001	BG.D85
5	20.5	15.7	BP.D85

CALCULATED Q VALUE FOR COMPARISON:	5 vs 1	Q' =	6.156358
CALCULATED Q VALUE FOR COMPARISON:	5 vs 2	Q' =	3.847724
CALCULATED Q VALUE FOR COMPARISON:	5 vs 3	Q' =	2.383106
CALCULATED Q VALUE FOR COMPARISON:	5 vs 4	Q' =	2.246574
CALCULATED Q VALUE FOR COMPARISON:	4 vs 1	Q' =	3.909783
CALCULATED Q VALUE FOR COMPARISON:	4 vs 2	Q' =	1.60115
CALCULATED Q VALUE FOR COMPARISON:	4 vs 3	Q' =	.1365319
CALCULATED Q VALUE FOR COMPARISON:	3 vs 1	Q' =	3.773252
CALCULATED Q VALUE FOR COMPARISON:	3 vs 2	Q' =	1.464618
CALCULATED Q VALUE FOR COMPARISON:	2 vs 1	Q' =	2.308634

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.

12-02-1986

********* 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 ? 2.03,0.05

LSD = 5.78241 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.

APPENDIX C

Status of cliff-nesting raptors in Boulder Mountain Parks and vicinity. This research was conducted by Mike Figgs and Nancy Lederer, Boulder County Nature Association, 3893 N. 75th Street, Boulder, CO 80301.

MAP KEY AND STATUS OF CLIFF NESTING RAPTORS IN THE BOULDER AREA

Golden Eagle

GE-1 and -2: refer to Fig. 1, GE-3 refer: to Fig. 2

GE-1 ELDORADO SPRINGS

NEST SITES: GE-1a and b are on the Mickey Mouse Cliff on Eldorado Mtn.; GE-1c is in Rattlesnake Gulch on Eldorado Mtn. about 300 ft. north of the railroad track; GE-1d is on the east side of Shirttail Pk.; GE-1e is on "The Matron" rock formation on Boulder Mtn.; GE-1f is just below the summit of South Boulder Pk.

HISTORY: Jollie (1943) includes this territory in the Skunk Canyon territory (GE-2); however, he suspected an additional territory in the South Draw-Scartop Mtn. area 1-2 miles west of Eldorado Mtn. He shows either GE-1d or e as active. D'Ostilio (1954) indicates that the territory was occupied, but does not include specific data. Crowley (1958) also indicates that this territory was occupied, but did not find an active nest. He specifically checked The Matron nest site (GE-1e). DOW (1978) shows GE-1f as active, and GE-1a and b as inactive.

RECENT STATUS: GE-1a active in 1983, but nest abandoned sometime after incubation begun. GE-1f active in 1984, GE-1b active in 1985.

PRODUCTIVITY: No young fledged in 1983; undetermined in 1984; 1 young fledged in 1985 (Table 1).

HUNTING GROUNDS: Centered in Eldorado Canyon; includes area east to Colo. Highway 93, south to Coal Creek Pk. in Jefferson County, west to Johnson and Martin Gulches, north to South Boulder Pk. (Fig. 1).

OTHER: GE-1c, d, and e show no signs of being recently used as nests. We regard GE-1 a and b as the most viable nest sites, with GE-1f as an occasionally used alternate site. This territory is under extreme pressure from recreational users. The Mickey Mouse Cliff (GE-1a and b) is a very popular climbing rock, and South Boulder Pk. (GE-1f) is a common destination for hikers in the Boulder Mountain Parks.

GE-2 SKUNK CANYON

NEST SITES: GE-2a is on the north side of Skunk Canyon on Green Mtn.; GE-2b is on the south side of Skunk Canyon.

HISTORY: Gale (Henderson 1907) records an active nest in Bear Canyon in 1889. Jollie (1943) shows nests on Bear Pk. and Green Mtn. GE-2b active in 1980 and GE-2a active in 1981 (Roger Briggs, pers. comm.).

RECENT STATUS: GE-2a active in 1983 and 1984; GE-2b active in 1985.

Table 1. Golden Eagle productivity in the Boulder area

	Eld. Spgs.	Sk. Can.	LH Pal.	Yg. fledged/ succ. attempt	Yg. fledgd/ territory
'83	Failed	2	Inactive	2.00	0.67
'84	Active/Undet.	1	2	1.50	1.50
'85	1	2	2	1.67	1.67
'83-'85				1.67	1.25
Average of 10 other territories in remainder of study area, '83-'85				1.48	1.13

Table 2. Prairie Falcon productivity in the Boulder area

	'83	'84	'85
Bull Gulch	Not checked	Active/Undet.	3
Mickey Mouse Cliff	Active/Undet.	Active/Undet.	Inactive
Red Garden Wall	Unknown	Unknown	4
Shadow Canyon	Not checked	4	Act./Undet.
Fern Canyon	Not checked	3	5
Bear Canyon	Active/Undet.	Active/Undet.	4
Third Flatiron	Active/Undet.	Active/Undet.	1
Young fledged per successful attempt		3.5	3.4

PRODUCTIVITY: 2 young fledged in 1983, 1 in 1984, 2 in 1985 (Table 1).

HUNTING GROUNDS: Centered over the Skunk Canyon-Bear Canyon area and east to Colo. Highway 93, southeast to Marshall Mesa, south to Colo. Highway 170, west to the back side of Green and Boulder Mtns. (Fig. 1).

OTHER: This territory is under high pressure from technical rock climbers (Figgs and Lederer 1985). Climbers came within 5 ft. of nest GE-2a in 1985 and flushed the adult eagle from the nest. Route closures during the appropriate season is recommended.

GE-3 LEFTHAND PALISADES

NEST SITES: There are at least 7 nests on the northern portion of the Lefthand Palisades. Six of these have been used in the last 10 years.

HISTORY: Gale (Henderson 1907), Jollie (1943), D'Ostilio (1954), Crowley (1958), and DOW (1978) all record this as an active territory. The Lefthand Palisades nest site has been continuously observed since 1974 by Thomas E. VanZandt of Boulder, and has been active every year except 1977 and 1983.

RECENT STATUS: Active in 1984 and 1985.

PRODUCTIVITY: 2 young fledged in 1984, and 2 in 1985 (Table 1).

HUNTING GROUNDS: Jollie (1943) mapped the hunting grounds for this territory. Our observations 40 years later closely match his boundaries (Fig. 2). Jones (1983) indicates that this pair hunts on Boulder Valley Ranch.

Prairie Falcon

Refer to Fig. 3 for nest sites.
Table 2 summarizes productivity.

PF-1 BULL GULCH

NEST SITES: There are several eyries on the north side of Bull Gulch on Eldorado Mtn.

HISTORY: Unknown to investigators prior to 1984.

RECENT STATUS: Active in 1984 and 1985.

PRODUCTIVITY: Undetermined in 1984; 3 young fledged in 1985.

HUNTING GROUNDS: Include immediate area in Bull Gulch and upper Doudy Draw. Probably hunt far to the east on Rocky Flats.

OTHER: We have not recorded any disturbance from rock climbers in this territory.

PF-2 MICKEY MOUSE CLIFF

NEST SITES: There are several eyries on the south side of Mickey Mouse Cliff.

HISTORY: Unknown to investigators prior to 1983.

RECENT STATUS: Active in 1983 and 1984; inactive in 1985.

PRODUCTIVITY: Undetermined.

HUNTING GROUNDS: Undetermined.

OTHER: Mickey Mouse Cliff is a very popular cliff for rock climbers.

PF-3 RED GARDEN WALL

NEST SITES: Eyrie located on western portion of Red Garden Wall in Eldorado Canyon.

HISTORY: Unknown to investigators prior to 1985.

RECENT STATUS: Active in 1985.

PRODUCTIVITY: 4 young fledged in 1985.

HUNTING GROUNDS: Include Eldorado Canyon, north to Shirttail Pk., west to North Draw, east to points east of Eldorado Springs.

OTHER: This is one of the most popular climbing rocks in Colorado. That 4 young fledged from this eyrie displays the extent to which falcons may adapt to human presence.

PF-4 SHADOW CANYON

NEST SITES: There are several eyries near "The Maiden" rock formation.

HISTORY: Reported to be a regularly occupied site (Greg Hayes, pers. comm.).

RECENT STATUS: Active in 1982, 1984, and 1985. Not field checked in 1983.

PRODUCTIVITY: 4 young fledged in 1984. Not determined in other years.

HUNTING GROUNDS: Include Shadow Canyon west to top of Boulder Mtn.

OTHER: No disturbance from rock climbers noted.

PF-5 FERN CANYON

NEST SITES: There are at least 2 eyries on the north side of Fern Canyon below Bear Pk.

HISTORY: Unknown to investigators prior to 1984.

RECENT STATUS: Active in 1984 and 1985.

PRODUCTIVITY: 3 young fledged in 1984; 5 in 1985.

HUNTING GROUNDS: Mostly undetermined. Area around "The Slab" is regularly hunted.

OTHER: Little disturbance from rock climbers, but hikers often come within 100 yards of eyries. This territory may include eyries on The Slab which have not recently been used.

PF-6 BEAR CANYON

NEST SITES: There are several eyries along the north side of Bear Canyon.

HISTORY: Unknown to investigators prior to 1983.

RECENT STATUS: Active 1983-85.

PRODUCTIVITY: Undetermined in 1983 and 1984; 4 young fledged in 1985.

HUNTING GROUNDS: Include Bear Canyon east to NCAR.

OTHER: Very popular hiking area. 1985 eyrie could be directly viewed from Bear Canyon Trail.

PF-7 THIRD FLATIRON

NEST SITES: Eyries are on south side of Third Flatiron.

HISTORY: Occupied in 1950 (Bailey and Niedrach 1965). Probably regularly used since 1950 (Greg Hayes, pers. comm.).

RECENT STATUS: Active 1982-85.

PRODUCTIVITY: Undetermined 1982-84. 1 young fledged in 1985.

HUNTING GROUNDS: Include Bluebell Canyon northeast to city limits, north to Gregory Canyon, southeast to NCAR.

OTHER: Very popular climbing and hiking area. On one occasion, 2 climbers about 50 ft. from eyrie elicited no response from either the incubating falcon or its mate perched nearby.

Legend for Observations of Hunting Raptors on Figs. 1 and 3

H - observation of hunting raptor on City Open Space

Supplemental Information

Fig. 1

H 1 - 7 April 1985, while driving to Golden, 2 p.m., simultaneous sighting from highway, 2 eagles soaring and gliding

H 2 - 5 May 1985, 9:30 a.m., Tallgrass Prairie Site #3, male with jackrabbit in talons, flying from Marshall Mesa towards Skunk Canyon nest

H 3 - 11 May 1985, 3:30 p.m., Doudy Draw, probably male from Mouse Ears nest; female was brooding young on nest at the time

Fig. 3

H 1 - 15 Feb. 1985, 4:30 p.m., seen from CO Highway 93, perched on power pole

H 2 - 7 March 1985, 4:30 p.m., seen from CO Highway 93, perched on transmission tower

H 3 - 24 March 1985, 11:30 a.m., hunting in Tallgrass Prairie Site #3

H 4 - 6 April 1985, 10 a.m., seen from NCAR, 2 falcons hunting over meadow

H without numbers - falcons seen while conducting winter raptor transects, Jan. to March 1985

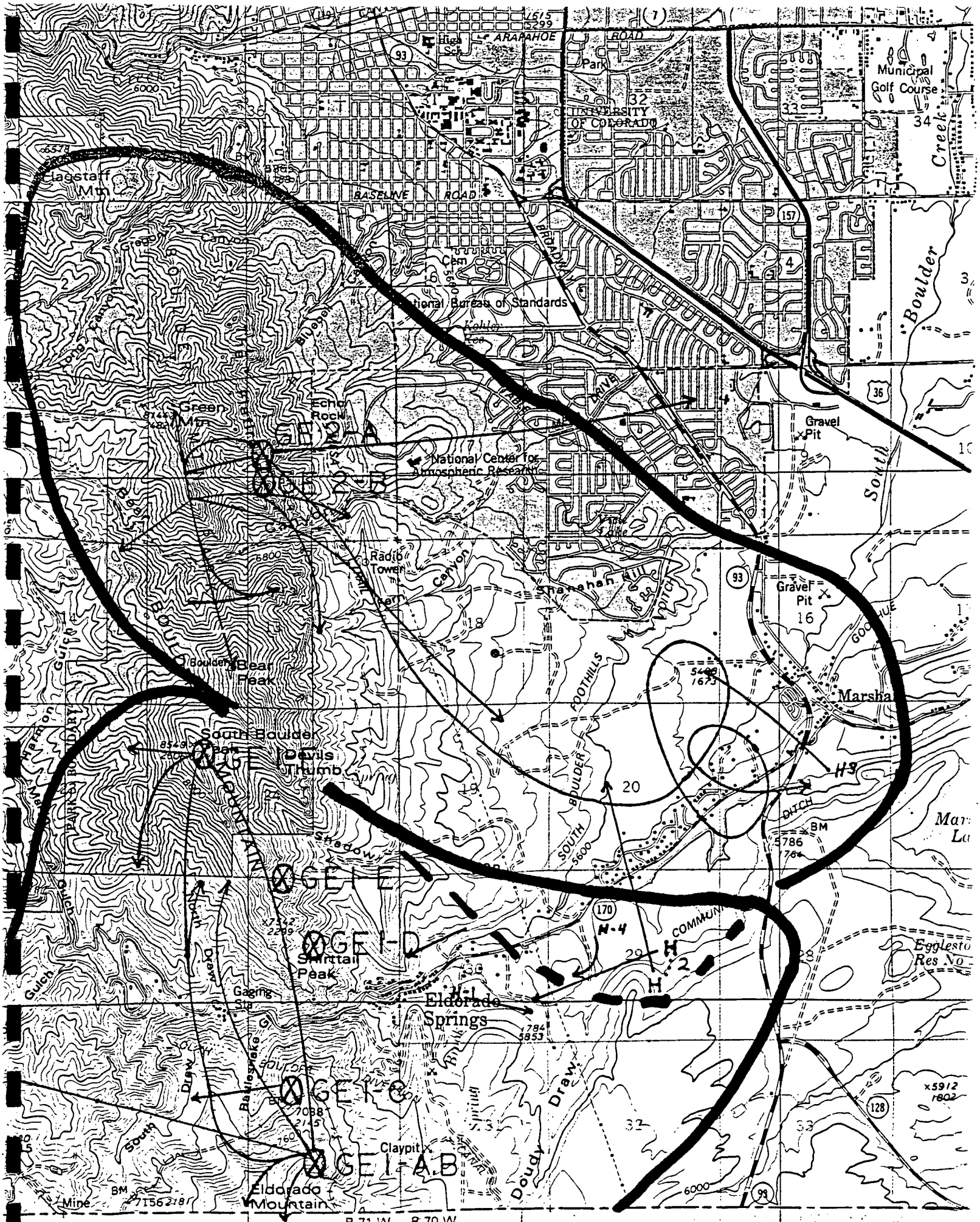

ARAPAHOE ROAD
Municipal Golf Course
UNIVERSITY OF COLORADO
Flagstaff Mtn
BASELINE ROAD
BROADWAY
Cem
National Bureau of Standards
Boulder Creek
Green Mtn
Echo Rock
GEI-A
GEI-B
National Center for Atmospheric Research
Gravel Pit
South Boulder
Radio Tower
Shanahan Hill
Gravel Pit
Bear Peak
FOOTHILLS
Marshall
South Boulder Peak
Devils Thumb
BOULDER MOUNTAIN
GEI-E
GEI-D
Shirttail Peak
H-4
H-2
H-3
Eldorado Springs
Gaging Sta
GEI-C
Claypit
GEI-AB
Eldorado Mountain
Mine
R 71 W
R 70 W

Figure 1

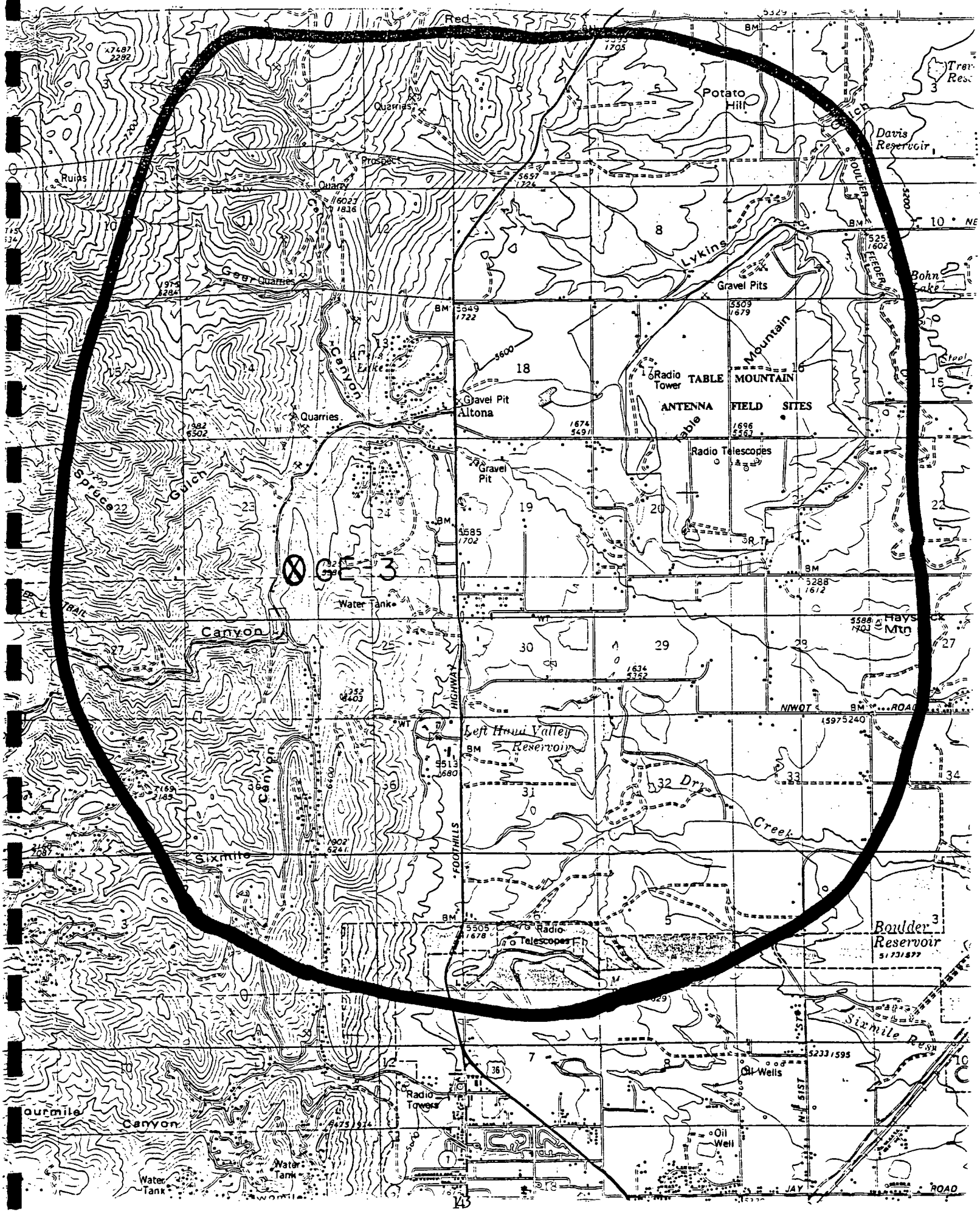
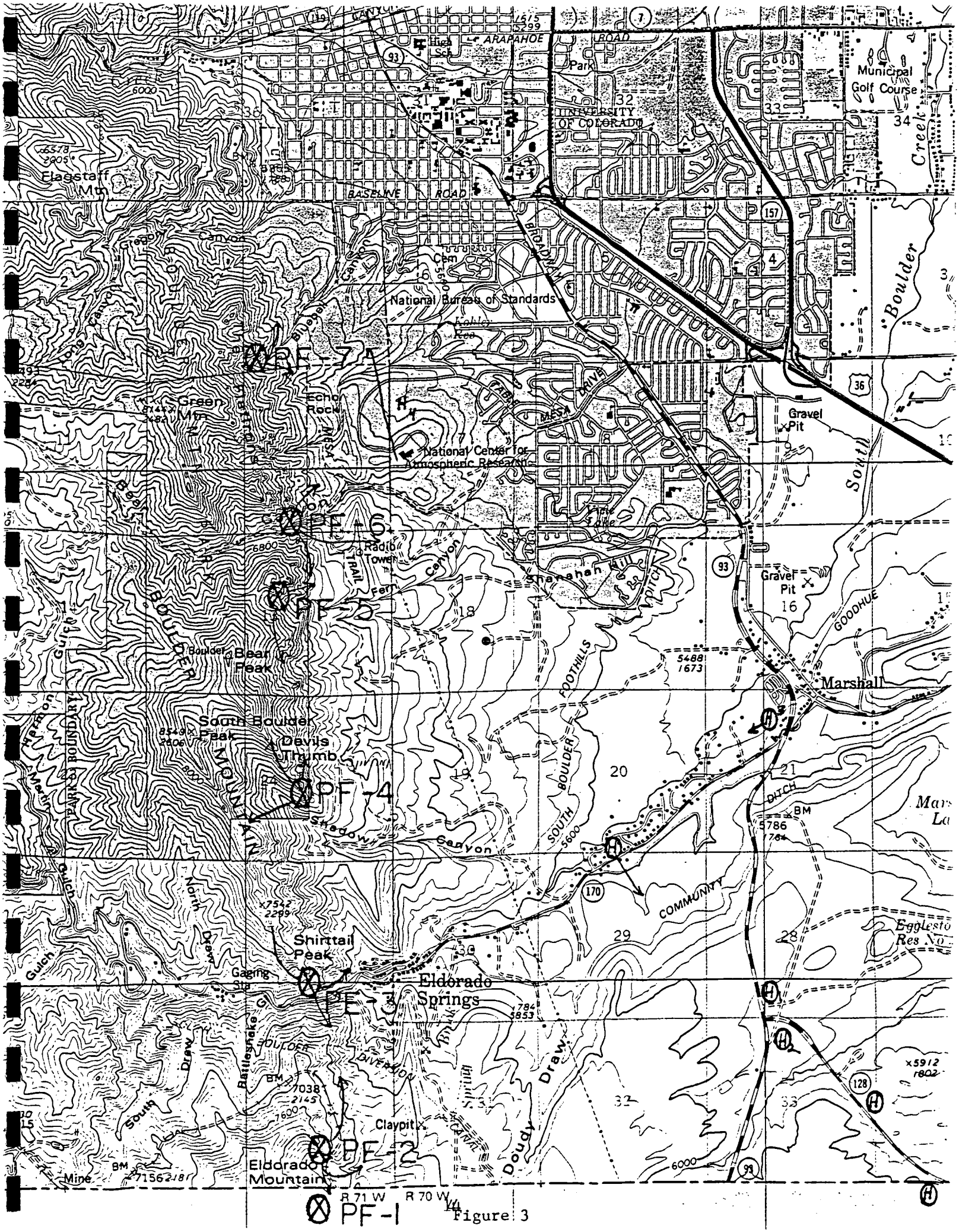

Red
Potato Hill
Davis Reservoir
Quarries
Prospect
Ruins
Quarry
Gear Quarries
Lykins
Gravel Pits
Bohn Lake
Canyon
Lake
Gravel Pit
Altona
Quarries
Radio Tower
TABLE MOUNTAIN
ANTENNA FIELD SITES
Mountain
Table
Radio Telescopes
Gravel Pit
Spruce
Gulch
GE-3
Water Tank
Canyon
Hays Mtn
NIWOT
Left Hand Valley Reservoir
Dry Creek
HIGHWAY
FOOTHILLS
Sixmile
Radio Telescopes
Boulder Reservoir
Sixmile Resv
Oil Wells
Radio Towers
Oil Well
Canyon
Water Tank
Water Tank
JAY
ROAD

Figure 2


ARAPAHOE ROAD
High Sch
Park
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UNIVERSITY OF COLORADO
Flagstaff Mtn
BASELINE ROAD
BROADWAY
Cem
National Bureau of Standards
Kohler Res
Boulder Creek
Green Mtn
Echo Rock
MESA DRIVE
Gravel Pit
National Center for Atmospheric Research
Lake
Radio Tower
TRAIL
Fern Canyon
Shanahan Hill
DITCH
Gravel Pit
GOODHUE
Bear Peak
FOOTHILLS
Marshall
South Boulder Peak
Devils Thumb
SOUTH BOULDER
DITCH
Shadow Canyon
COMMUNITY
Shirttail Peak
Gaging Sta
Eldorado Springs
DIVERSION
Doudy Draw
Claypit
CANAL
Eldorado Mountain
PF-1
PF-2
PF-3
PF-4
PF-5
PF-6
PF-7
R 71 W
R 70 W

Figure 3

LITERATURE CITED

Bailey, A.M. and R.J. Niedrach. 1965. Birds of Colorado. Denver Museum of Natural History, 2 vols.

Colorado Division of Wildlife. 1978. Aerial survey of Golden eagle nests in Boulder County, 1978. Computer printout with map.

Crowley, L.D. 1958. Nesting summary of the Golden Eagle in the foothills of northeastern Colorado. Unpublished report, University of Colorado, Boulder.

D'Ostilio, D.O. 1954. Nesting status and food of the Golden Eagle in northern Colorado. M.A. Thesis, University of Colorado, Boulder.

Figgs, M. and N. Lederer. 1985. Status of nesting Golden eagles in Boulder County and adjacent areas of the Front Range in Colorado: A preliminary report. Boulder County Nature Association Publication No. 2.

Henderson, J. 1907. The annotated notebooks of Denis Gale. Unpublished manuscript. Rare Books Room, Norlin Library, University of Colorado.

Jollie, M.T. 1943. The Golden eagle: its life history, behavior and ecology. Ph.D. Thesis, University of Colorado, Boulder.

Jones, S. 1983. Raptors of Boulder Valley Ranch: population trends 1980-1982. Unpublished report to Boulder Audubon Society and Boulder Citizens for Open Space.

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 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.

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

Systematic pedestrian surveys of all potentially suitable Open Space habitats were conducted on 9, 16, and 23 May 1985, looking and listening for birds. Parcels covered were Burke 2, Burke 1, Gebhardt, VanVleet Ranch, Yunker (NW,SW,NE,and SE) 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 as males arrived. Accumulation of flags, some repositioned after subsequent observations, facilitated identification of individual males as territories were established. After females were first observed in Burke 2 on 23 May, surveys to identify distributions were discontinued to minimize disturbance during courtship, nest building, and early incubation.

On 21 June, the City expressed interest in expanding the study area to include a non Open Space, City Parks and Recreation-owned parcel, contiguous with the Gebhardt parcels west boundary, after males had been observed on this parcel. This parcel will be developed into the recreation-oriented, East Boulder Community Park and will hereafter be referred to as the EBCP parcel.

On 17 June, we felt incubation on the Burke 2 parcel had adequately progressed to permit flushing surveys for nest locations without a high risk of abandonment. During flushing surveys, observers walked systematic north-south transects in the Burke 2 and EBCP (7 July) parcels with a 30m rope stretched between us. Transects progressed east to west until the entire parcel or all areas of suitable habitat had been covered. Bobolink nests were located and marked with adjacent pin flags and flagging when incubating females flushed as the rope passed over them. Nests not identified by flushing surveys were located by observing females bringing food to the nest and/or removing fecal sacs and triangulating in on the site.

Mist netting and banding adults and juveniles were conducted on 8 days during 4-13 July. Two 5m, 1.5 in. nylon mesh nets were suspended between 10 ft. poles. Nets were arranged in a "V" shaped with the nest located inside and near the point. Nets were checked every 15 min. to minimize stress of captured birds. Numbered U.S. Fish and Wildlife Service bands were fitted to the left leg of adults and broods. Nest checks during this period determined fledging dates in relation to the haying sequence.

RESULTS

We observed Bobolinks in the Burke 2, Gebhardt, EBCP, Burke 1, and Church parcels during 1985. Breeding occurred in the 3 former parcels (Fig. 1). One

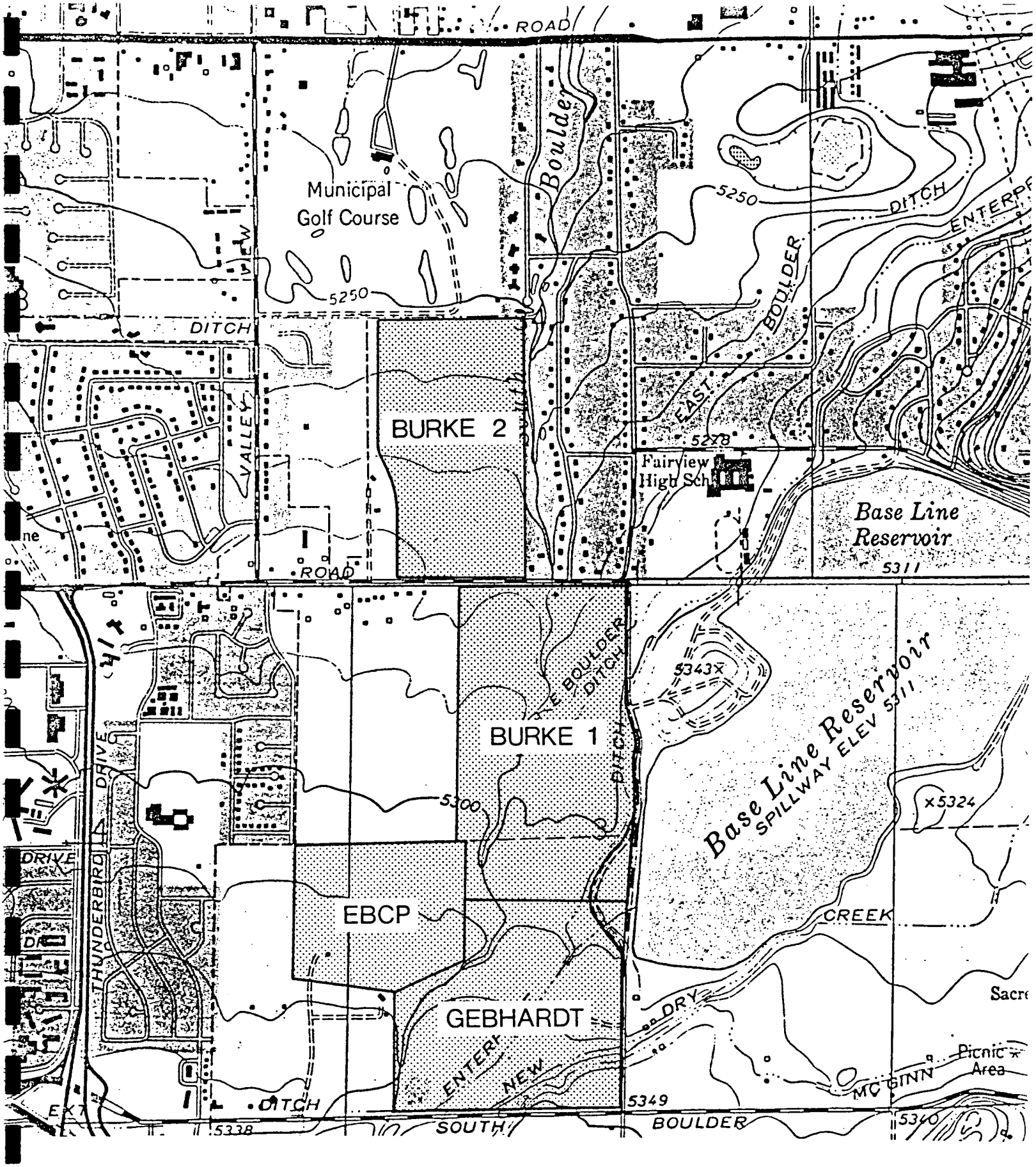

Figure 1. Location of Open Space and East Boulder Community Park (EBCP) parcels were intensive Bobolink study occurred.

probable first-year male was observed in the Church parcel on 10 July. Use of the Burke 1 field consisted of males singing from trees along Baseline Road and males flying from Burke 2 south across the parcel towards the EBCP site.

BURKE 2 PARCEL

The first male was observed on the parcel's northwest corner (in nest area D) on 9 May. By 16 May, 5 males and 1 female were present. Rough territories generally established in the field's northeast quarter by at least 4 of these 5 males on 16 May (and later refined), contained the subsequent nest areas of all 5 known nesting females. Later ariving males established territories in the south half of the field. A maximum of 10-12 males (23 May and 17 June) and 6 females (17 June) were observed in the field.

At least 5 females nested (Nests A-E) producing 14 and possibly 21 young. Nests were oriented toward the northeast corner of the field (Fig. 2). Two nests (A and B) were located containing 5 and 4 chicks. Twelve young (probably 16) are known to have fledged. The brood produced at nest E was probably killed prior to fledging by haying on 5 July. Young from 4 nests fledged 8 or 9 July (Nest A), 14-16 July (Nest B), 4-10 July (Nest C), and 4 July, (Nest D). Young from the 5 nests fledged an average of 2.4-4.4 days (range 0-7 days) before their section of field was mowed.

Haying began on 5 July and mowing was completed by 20 July. Haying followed a traditional sequence dictated by differential dessication of the irrigated field and subsequent tractor access. Mowing begins in the field's southeast to central section 1 and generally progresses northeast to section 5 (Fig. 2). One nest (E) was in section 1, 3 nests (A,B, and C) were in section 3, and nest D was on the boundary of sections 3,4, and 5.

Five adults and 11 young were banded. Both adults and all chicks associated with the A and B nests were banded. Two flying young from nest D and the female from nest E were also banded. We did not band any adults or young from nest C.

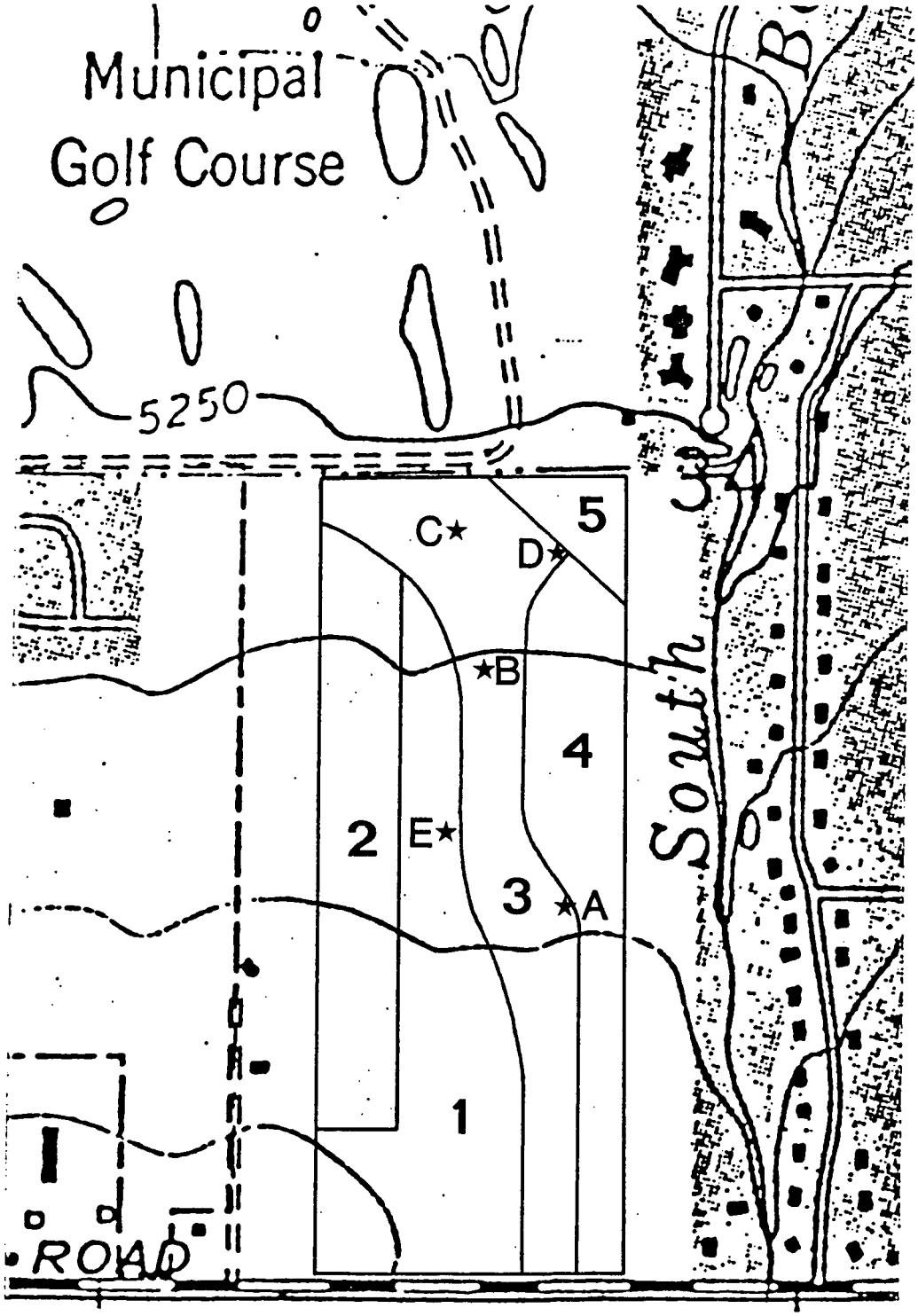

Figure 2. Traditional haying sequence of sections (1-5) and locations of 1985 Bobolink nests (A-E) on the Burke 2 parcel.

GEBHARDT PARCEL

Two males were displaying in the parcel's center on 16 May. One displayed a fidelity towards the area while the other displayed between this area and the eastern half of the adjacent EBCP parcel. Four males and 1 female were observed on the parcel on 23 May. The female displayed an affinity to a portion of the first male's apparent territory. A nest was later suspected, based on the adult's behavior, but never located (Fig. 3). By 6 July, both adults were observed feeding at least 3 well-flying young in an uncut hayfield approximately 30m south-southwest of the nest area. Young were estimated to have fledged on 2-3 July.

EBCP PARCEL

Flushing surveys covered this parcel on 7 July. Prior to this work, surveys had only been made of this parcel from the fenceline common to the Gebhardt parcel using binoculars. Two displaying males were observed on this parcel during 23 May, although interchange between it and the Gebhardt parcel was noted. The flushing surveys located 3 suspected nest areas and a minimum of 21 males and 4 females (Fig. 3). On 12 July, the female from nest F was observed with 3 young, which probably fledged 5-7 July, and the female from nest G was observed with at least 2 young, which probably fledged 5-7 July. At least 2 broods, probably 3, and possibly 4, were present in the field. All these broods and suspected broods probably nested here. No adults or young from the Gebhardt or EBCP parcels were banded.

NESTING SUMMARY

We observed males flying between the Burke 2, Gebhardt, and EBCP parcels. Assuming no interchange during our observations at least 32-34 males and 11 females were present on these 3 parcels. At least 9-10 females nested on these 3 parcels producing 21-32 young, 19-27 of which fledged. Fledging dates of the 7 broods ranged from 2-16 July with a mean estimated fledging date of 7 July.

DISCUSSION

Our observations of arriving males and females agree with the phenology observed in other areas (Bent 1958, Wittenberg 1978). The earliest arriving males

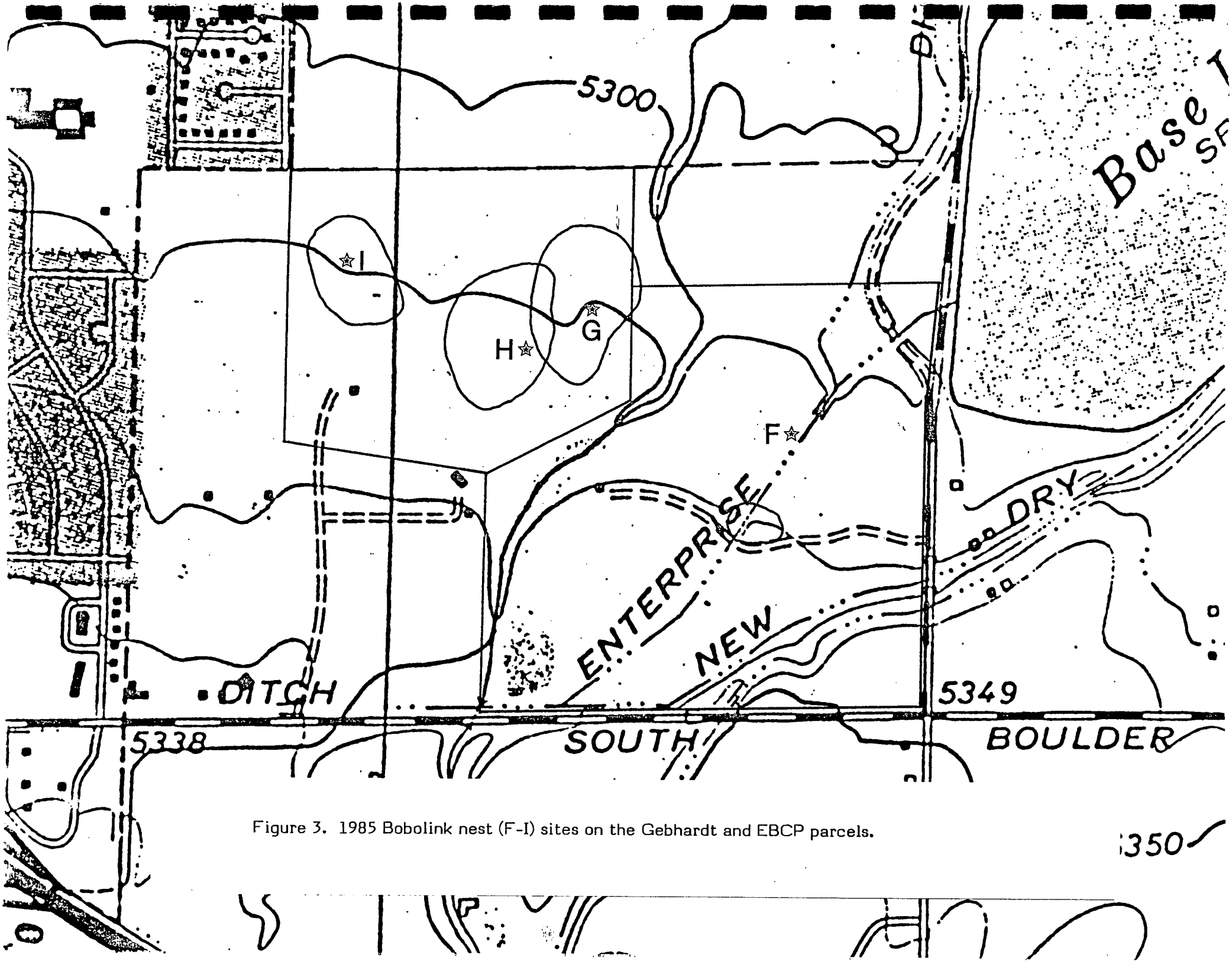

Figure 3. 1985 Bobolink nest (F-I) sites on the Gebhardt and EBCP parcels.

established territories which subsequently produced all of the known young. These territories were in the northeast part of the Burke 2 parcel. Late arriving males settled more toward the south end of the field but appeared to remain unmated.

The northeast part of the Burke 2 parcel appears to be somewhat drier than the rest of the field. Ralph Burke (pers. commun.) reports that that corner of the field is more difficult to irrigate and has less sedges in it than the field's southern half. These differences need to be quantified. This indicates that habitat selection by Bobolinks on Burke 2 corresponds to the report by Wittenberg (1978) in Oregon.

Vegetation composing this flat irrigated hayfield is a former native grassland that is harrowed, fertilized, mowed, and grazed by cattle each year. 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 northwest to southeast 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 B (Fig. 2) were too young to fledge when section 3 of the field was mowed. If we had not flagged-off an area around this nest, which was left uncut until after the young fledged, these young, like those at Nest E, 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 Rickwell 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 Gebhardt and EBCP parcels indicates that the immediate population is larger than just the birds on the Burke 2 parcel. However, development of the EBCP parcel may greatly reduce the number of local birds. 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 no 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 a 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 a individually marked population and to follow them 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 for 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 if there is space for them, 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 compatible with the small breeding population on the Burke 2 parcel. Changes in these practices could easily eliminate the birds or perhaps increase their numbers. Earlier mowing would destroy a large fraction and perhaps all of the nests before the young could fledge. Mowing one week earlier in 1985 would have killed all known young. Mowing later might increase the breeding population by insuring that all young had a chance to fledge before mowing. There is however,

no good evidence on which to base an estimate of how the population might 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 practices on other mowed fields so that patches of habitat suitable for breeding would develop. Our impression is that most of the Gebhardt parcel is too wet for breeding Bobolinks. Reduction in the amount of water delivered to some areas of that parcel might increase the number of breeding Bobolinks. It might also increase the quality of the hay produced if it decreased sedge abundance.

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 losses of habitat in other areas.

LITERATURE CITED

Avery. M., and L.W. Oring. 1977. Song dialects in the Bobolink (Dolichonyx oryzivorus). Condor 79:113-118.

Bent, A.C. 1958. Life histories of North American blackbirds, orioles, tanagers and allies. U.S. Natl. Mus. Bull. 211.

Gavin, T.A. 1984. Broodedness in Bobolinks. Auk. 101:179-181.

Hamilton, W.J. III. 1962. Bobolink migratory patterns and their experimental analysis under night skies. Auk 79:208-233.

Martin, S.G. 1971. Polygyny in the Bobolink: habitat quality and the adaptive complex. Unpubl. Ph.D. Diss. Oregon State Univ. Corvallis.

Martin, S.G. 1973. Longevity surprise: the Bobolink. Bird-Banding 44:57-58.

Niedrach, R.J., and R.B. Rockwell. 1939. The birds of Denver and mountain parks. Denver Mus. Nat. Hist. Pop. Ser. 5.

Wittenberg, J.F. 1978. The breeding biology of an isolated Bobolink population in Oregon. Condor. 80:355-371.

Wittenberg, J.F. 1980. Vegetation structure, food supply, and polygyny in Bobolinks (Dolichonyx oryzivorus). Ecology 61:140-150.

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, we (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. 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 our regular census plots. We thus felt that our estimate was probably much lower than the actual population size.

METHODS

Grasshopper Sparrows were surveyed along variable-line transects (Eberhardt 1978) on 15 and 16 July, 1985 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.

Transects were nonrandomly oriented through the "best" Grasshopper Sparrow habitats, on taller grasslands where they had been previously observed, and through all potentially suitable grassland and nonirrigated agricultural grassland habitats in the system. Parcels surveyed once during the 2-day sampling included Erni/Proper/Erni/Moore, Mann, Boulder Valley Ranch, VanVleet Ranch, Church, East Rudd, Greenbelt Plateau, Tracy Collins, Flatirons Vista, West Rudd, Dunn 2, and THP.

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). Data were analyzed using the Kelker (1945) estimator.

RESULTS

One-hundred-eleven different Grasshopper Sparrows were observed from 28,004m of line transects on 15-16 July 1985 (Table 1), an average of 3.97 sparrows/1000m. All sparrows were assumed to have been seen out to 40m (Fig. 1). The Kelker (1945) index (mean density = n/2LW, where n = total number of birds observed out to the fall-off distance, W = fall-off distance, and L = total length of transects) yielded a mean Grasshopper Sparrow desity of 0.312 birds/ha. Our observations indicated that Grasshopper Sparrows occupied about half of the 1726ha of grassland and nonirrigated agricultural grassland habitats on the parcels they were observed in (total area surveyed = 1726ha). We, therefore, estimate that approximately 269 sparrows were present on the surveyed Open Space parcels.

Although the accuracy of this population estimate is in question because of nonrandom transect orientation, ocular estimation of sighting distances and non-replication, 111 different sparrows were observed, which is far more than were heretofore thought present.

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

Table 1. Grasshopper Sparrows detected from line transects on selected Boulder Open Space parcels 15-16 July, 1985.

PARCEL	TRANSECT LENGTH(m)	SPARROWS OBSERVED	SPARROWS/1000m OF TRANSECT
THP	1,336	11	8.24
VanVleet Ranch	2,462	20	8.13
Boulder Valley Ranch	1,320	10	7.58
West Rudd	4,326	31	7.17
Greenbelt Plateau	469	3	6.40
East Rudd	3,733	12	3.22
Flatirons Vista	2,912	9	3.10
Dunn 2	1,725	5	2.90
Tracy Collins	2,599	5	1.93
Church (lower)	1,592	2	1.26
(upper)	1,158	1	0.87
Mann	2,848	2	0.71
Erni et al.	1,524	0	0.0
TOTAL →	28,004	111	
MEAN			3.97

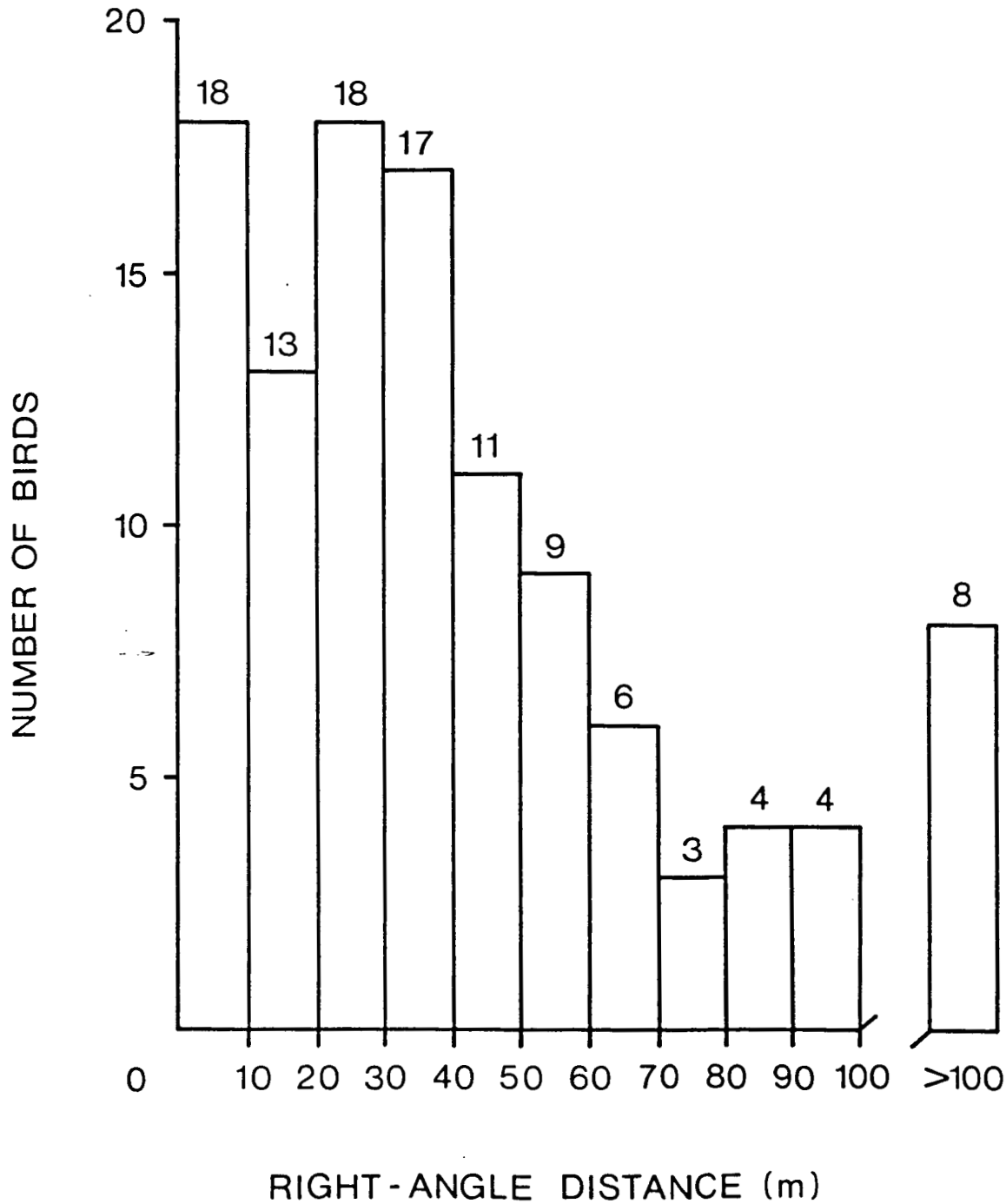

Figure 1. Histogram of right-angle sighting distances from a variable-line transect (Eberhardt 1978) to Grasshopper Sparrows on selected Boulder Open Space parcels, 15-16 July 1985.

populations fluctuate considerably from year to year in spite of the apparent availability of suitable habitat (Wiens 1969).

Our results indicate that in 1985 the species bred in good numbers in Boulder County. Our estimate of about 270 birds is probably too low since we assumed both sexes were represented equally in our observations. In most small passerines only the male sings, and the number of singing birds is often taken to indicate the numbers of pairs present. Because both male and female Grasshopper Sparrows sing, singing alone is not necessarily an indicator of sex. Of the 3 song types of the Grasshopper Sparrow (the grasshopper song, the sustained song, and the trill), the female sings only the trill (Smith 1968). Thus, song can be used, to some extent, to sex individuals. Unfortunately, we were unaware of this difference during the censuses and did not record song type, but recall that most songs were the grasshopper type. Singing birds represented at least 77% of the birds observed, most of which we believe to be males. Only females incubate and brood the young and are reported to sit close on the nest (Smith 1968). This behavioral difference would also suggest that males would be more conspicuous during surveys.

We did not search for or find nests during this study. The strongest evidence we have for breeding are several sightings of birds carrying prey, presumably to feed young, and the observation of 1 bird fluttering away on the ground, behavior typical of females disturbed from the nest (Smith 1968).

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 breeding habitat of the species 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 the hot, dry grasslands are unattractive 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 population was 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 lupin (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 a statistically rigorous survey needs to be made of the local population, fluctuations in the local population need to be documented, the physical characteristics of the habitat used need to be determined, and the possible effects of grazing on vegetation structure and sparrow populations need to be investigated. We will conduct a statistically sound survey of Grasshopper Sparrows on City Open Space during the 1986 breeding season.

LITERATURE CITED

Alexander, G. 1937. The birds of Boulder County, Colorado, Univ. Colo. Stud. 24:79-105.

Bailey, A.M., and R.J. Niedrach. 1965. Birds of Colorado. Denver Mus. Natur. Hist., Denver.

Betts, N.D. 1913. Birds of Boulder County, Colorado Univ. Colo. Stud. 10:177-232

Chase, C.A. III, S.J. Bissell, H.E. Kingery, and W.D. Graul. 1982 Colorado bird distribution latilong study. Colo. Field Ornithologists.

Connor, R.N., and J.G. Dickson. 1980. Strip transect sampling for avaian habitat studies. Wildl. Soc. Bull. 8:4-10

Eberhardt, L.L. 1978. Transect methods for population studies. J. Wildl. Manage. 42:1-31

Henderson, J. 1909. An annotated list of the birds of Boulder County, Colorado. Univ. Colo. Stud. 6:219-242

Holitza, J., and J. Krieg. 1981. Birds of Boulder County field check list. Boulder Aud. Soc.

James, S.W. 1983. Status, distribution, and habitat selection of the Grasshopper Sparrow in Morrow County, Oregon. Murrelet 64:51-54.

Kelker, G.H. 1945. Measurement and interpretation of forces that determine populations of managed deer herds. Ph.D. thesis, Univ. Mich., Ann Arbor

Smith, R.L. 1968. Grasshopper Sparrow. pp. 725-745. In: A.C. Bent and collaborators. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparros, and allies. U.S. Natl. Mus. Bull. 237.

Thompson, R.W., and J.G. Strauch, Jr. 1985. Habitat use by breeding birds on City of Boulder Open Space, 1984. Western Ecosystems Inc., Lafayette, Colo.

Whitmore, R.C. 1979. Short-term changes in vegetation structue and its effects on Grasshopper Sparrows in West Virginia. Auk 96:621-625.

Whitmore, R.C. 1981. Structure characteristics of Grasshopper Sparrow habitat. J. Wildl. Manage. 45:811-814.

Wiens, J.A. 1969. An approach to the study of ecological relationships among grassland birds. A.O.U. Mono. 8.

Wiens, J.A., and M.I. Dyer. 1975. Rangeland avifaunas: Their composition, energetics, and role in ecosystems. pp. 146-182. In: D.R. Smith (tech. coord.) Proceedings of the symposium on management of forest and range habitats for nongame birds. USDA For. Serv. Gen. Tech. Rp. WO-1.

Plates 1-4. Detailed maps of Open Space parcels, habitat types, and locations of study plots in the City of Boulder's Open Space System as of 1985. Plates 1,2,3, and 4 detail the SE, NE, NW, and SW quadrants of the system, respectively. Refer to Figure 1 for the locations of the quadrants in the overall Open Space System.