# HABITAT USE BY BREEDING BIRDS ON CITY OF

# BOULDER OPEN SPACE, 1984

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.

1 February, 1985

Western Ecosystems, Inc.
1292 Ceres Drive
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## INTRODUCTION

The preservation of 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, this study was initiated to obtain the data required for preservation of avian habitats. Objectives of this study 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 ($40^{o}5'$ to $39^{o}55'$N and $105^{o}19'$ to $105^{o}8'$W) surrounding the City of Boulder, Boulder County, Colorado. Elevations ranged from 1545m (5070 ft) on the Ertl Parcel to 2283m (7490 ft) on the Campbell property, a difference of 738m (2420 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.

## 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 five 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., 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 two or more homogeneous habitats forming the ecotone.

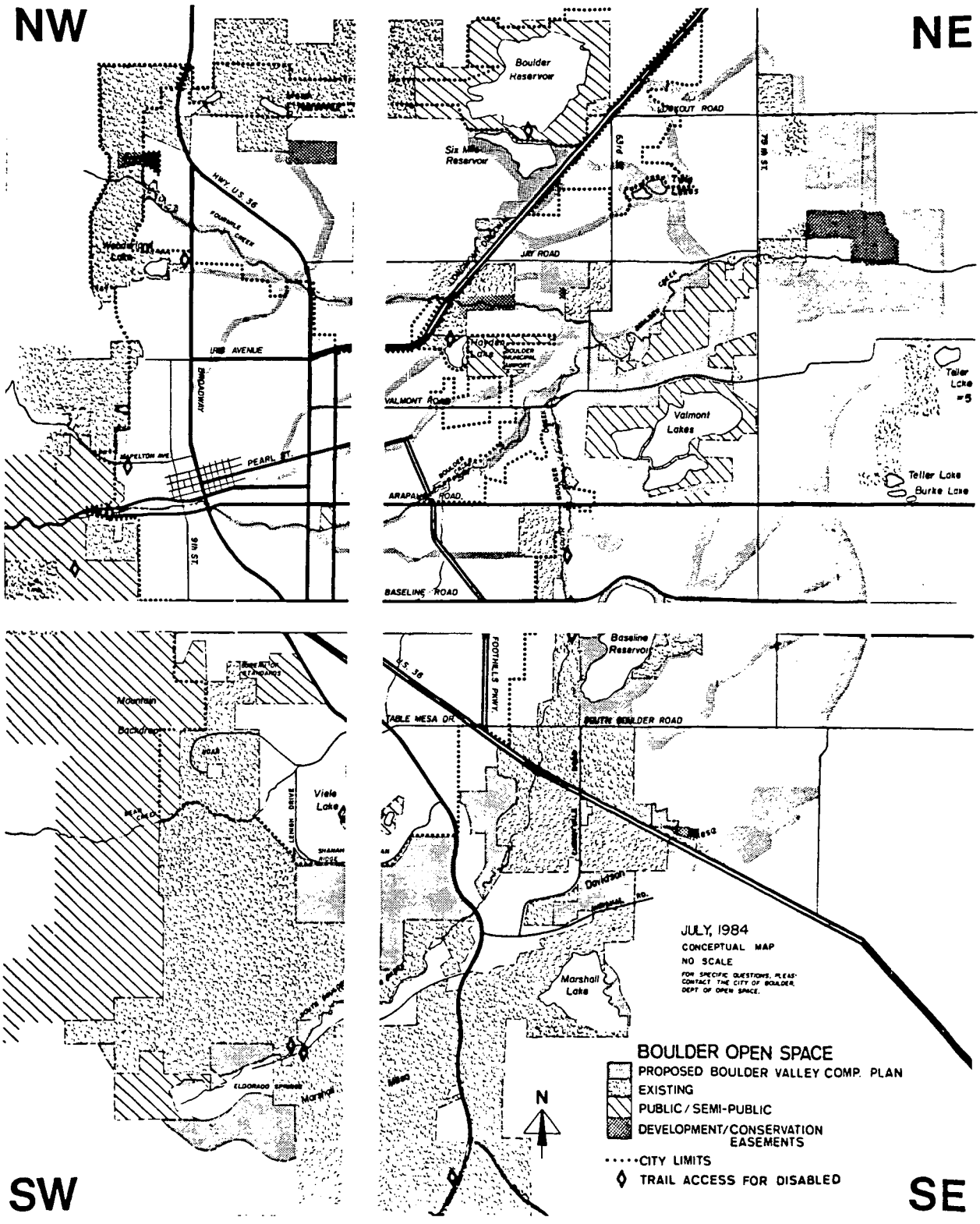


Figure 1. 1984 City of Boulder Open Space map. Refer to Plates 1-4 for detailed maps of the SE, NE, NW, and SW quadrants, respectively, illustrating parcels, habitat types, and locations of study plots.

Table 1. Areal coverage of habitat types on City of Boulder Open Space, April - May, 1984.

| 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.

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

Table 1. Continued.

| PARCEL | ACREAGE | ACREAGE OF HABITAT TYPES[a] G | C | A/G | MS | AG | R | D | W | B | L&P | CL | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tippet | 22.00 | 21.00 | | | | | 1.00 | | | | | | |
| Wells | 774.00 | 136.40 | 568.70 | | 29.60 | | 9.10 | | | | | | |
| Abbey | 160.00 | 48.20 | 111.30 | | | | 0.50 | | | | | | |
| McStain | 17.00 | 8.70 | 8.30 | | | | | | | | | | |
| Brammier | 23.00 | 1.50 | 21.50 | | | | | | | | | | |
| Debacher | 157.00 | 9.50 | 140.30 | | 4.70 | | | | | | | 2.5 | |
| Culberson | 158.00 | 7.50 | 139.40 | | 11.10 | | | | | | | | |
| Frasier Farms | 123.00 | 64.50 | 42.50 | | 16.00 | | | | | | | | |
| Stengel | 425.00 | 363.80 | 45.90 | | 15.30 | | | | | | | | |
| Dunn 1 | 450.00 | 227.20 | 86.40 | 4.70 | 117.40 | | 12.30 | 2.0 | | | | | |
| McCann (W) | 20.00 | | 17.40 | | 0.25 | | | | | | | 2.4 | |
| McCann | 160.00 | 5.40 | 91.50 | | 63.10 | | | | | | | | |
| McCann (SE) | 6.30 | | 4.60 | | 1.70 | | | | | | | | |
| Barute | 106.00 | | 102.60 | | | | | | | | | 2.4 | 1.0 |
| Campbell | 80.00 | | 73.00 | | | | | | | | | 7.0 | |
| Dunn 2 | 280.00 | 269.00 | | | 4.50 | | 5.0 | | | | 1.50 | | |
| Stengel 2 | 307.00 | 77.50 | 156.50 | 31.30 | 36.70 | | 2.5 | | | 2.3 | 0.25 | | |
| TOTALS[c] | | | | | | | | | | | | | |
| ACRES | 11,474.75 | 4,994.1 | 2,436.2 | 2,349.8 | 522.4 | 436.7 | 315.6 | 135.1 | 91.0 | 78.4 | 69.6 | 15.1 | 1.0 |
| HECTARES | 4,645.65 | 2.021.8 | 986.3 | 951.3 | 211.5 | 176.8 | 127.8 | 54.7 | 36.8 | 31.7 | 28.2 | 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 The sum of habitat type areas does not equal total Open Space area due to rounding and measurement errors. Combined acreage errors account for 0.19% (21.85 acres) of total Open space acreage.

## BREEDING BIRD SURVEYS

Eight, permanent 100x200m (2ha=4.94 acre) breeding bird plots (strip-transects, Emlen 1971, Eberhardt 1978) were randomly established in each of the five 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 eight 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 five times between 16 May and 28 June (Rep. 1: 16-18 May; Rep. 2: 27-29 May; Rep. 3: 7-9 June; Rep. 4: 20-22 June; Rep. 5: 26-28 June), the peak of the 1984 breeding season. Observers tranversed 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 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 eight plots per habitat where

$$\text{plot mean} = \bar{X}_{i=1}^{k} = \sum_{i=1}^{5} n/5 \qquad \text{and habitat mean} = \sum_{i=1}^{8} \bar{X}/8$$

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 five 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 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; four plots were established in each of the two groups.

## WATERFOWL SURVEYS

Waterfowl surveys were conducted on Boulder Open Space between 25 June and 11 July when most young would have left the nest, but before they could fly and leave the area. On 25 June we surveyed the following wetlands: Boulder Valley Ranch Reservoir, Mesa Reservoir, Wonderland Lake, the pond on the Burke 1 property, 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). On 27 June we surveyed the four 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 on 25 June 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 seven remaining wetlands were resurveyed on 2, 6, 9, and 11 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. Each site was then searched for evidence of breeding in 1984. 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 of areas in which repeated sightings occurred. Occurence 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) for breeders and all species (breeders and transients) combined. Differences among the five 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. Tests of significance were at $\alpha = 0.05$ unless stated otherwise. Data were screened for normality prior to testing; no transformations were required.

## RESULTS AND DISCUSSION

### BIRDS PRESENT ON OPEN SPACE

One-hundred-twenty breeding species and 145 breeders and transients were observed in the six major Open Space habitats during the 1984 breeding season (Table 2). The greatest number of breeding species occurred in riparian habitats (58) followed by mountain shrub and conifer habitats (53 in each), agricultural grasslands (38), grasslands (24), and lakes and ponds (20). The low number of species associated with lakes and ponds may appear misleading until one recognizes that many species using this habitat are migrants which do not remain in the area to breed. This point is illustrated by a comparison of the number of breeding and total species associated with lakes and ponds (Table 2). Thirteen (39%) of the 33 species observed on lakes and ponds were transients, the highest percentage of transients on any habitat. The combined number of breeding and transient species using habitats was similar to the relation for breeding species (Table 2).

The 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; scientific names are in Table 3) and/or are difficult to detect (e.g., Northern Pygmy Owl).

### BREEDING BIRD DENSITIES AND POPULATION ESTIMATES.

Thirty-seven breeding species were observed in conifer habitats during the plot counts. American Robins, Mourning Doves, Chipping Sparrows, Red Crossbills, Rufous-sided Towhees, and Western Wood Pewees were the most abundant species and together accounted for 55.4% of the population in this habitat (Table 4). Mean breeding density in conifer habitat was $6.53 \pm 1.50$ birds/ha (Table 4). The population of birds in this habitat was $6,440.7 \pm 1,479.5$.

Riparian habitats contained more breeding species (52) at higher mean densities ($10.4 \pm 3.49$ birds/ha) than other Open Space habitats (Table 5). The total riparian population was $1,709.9 \pm 574.7$ birds. Red-winged Blackbirds, European Starlings,

Table 2. Species of birds observed on Boulder Open Space, 19 April - 3 August 1984. Phylogenetic order and common names follow AOU (1983).

| Species | Habitat Type[a] | | | | | |
|---|---|---|---|---|---|---|
| | AG | G | R | MS | C | L&P |
| Pied-billed Grebe | | | | | | B[b] |
| Double-crested Cormorant | | | | | | T[b] |
| American Bittern | | | | | | B |
| Great Blue Heron | | T | B | | | B |
| Black-crowned Night-Heron | | | B | | | B |
| [c]White-faced Ibis | | | | | | T |
| Canada Goose | | B | B | | | B |
| Wood Duck | | | B | | | |
| Mallard | B | | B | B | T | B |
| Blue-winged Teal | B | | B | | | B |
| Cinnamon Teal | | | | | | B |
| [c]Northern Shoveler | | | | | | B |
| Gadwall | | | | | | B |
| [c]Canvasback | | | | | | T |
| [c]Redhead | | | | | | T |
| [c]Ring-necked Duck | | | | | | T |
| [c]Common Goldeneye | | | | | | T |
| [c]Bufflehead | | | | | | T |
| [c]Common Merganser | | | B | B | | |
| Ruddy Duck | | | | | | B |
| Turkey Vulture | B | B | B | B | | |
| [c]Northern Harrier | | T | | T | | |
| Sharp-shinned Hawk | | | | | B | |
| [c]Cooper's Hawk | | | B | | B | |
| [c]Broad-winged Hawk | | | T | | | |
| [c]Swainson's Hawk | | | | | | T |
| Red-tailed Hawk | B | B | B | B | B | |
| [c]Ferruginous Hawk | | T | | | | |
| [c]Golden Eagle | | B | | | | |
| American Kestrel | B | B | | B | | |

Table 2. Continued.

| Species | Habitat Type[a] | | | | | |
|---|---|---|---|---|---|---|
| | AG | G | R | MS | C | L&P |
| Prairie Falcon | B | | | B | B | |
| [c]Chuckar | | | | | B | |
| [c]Ring-necked Pheasant | B | | | | | |
| [c]Blue Grouse | | | | | B | |
| Virginia Rail | B | | | | | |
| Sora | | | B | | | B |
| American Coot | | | | | | B |
| Killdeer | B | | B | | | B |
| Greater Yellowlegs | | | | | | T |
| [c]Lesser Yellowlegs | | | | | | T |
| [c]Solitary Sandpiper | | | T | | | |
| Spotted Sandpiper | | | | | | B |
| [c]Pectoral Sandpiper | | | | | | T |
| Common Snipe | B | | | | | B |
| Wilson's Phalarope | B | | | | | |
| [c]Ring-billed Gull | T | | | | | |
| [c]California Gull | | | | | | T |
| Rock Dove | B | B | | B | B | |
| Mourning Dove | B | B | B | B | B | |
| [c]Black-billed Cuckoo | | | B | | | |
| Barn Owl | | | | B | | |
| Eastern Screech Owl | | | B | | | |
| Great Horned Owl | | | B | B | | |
| Burrowing Owl | B | | | | | |
| Long-eared Owl | | | | B | B | |
| Common Nighthawk | B | B | | B | B | |
| [c]Common Poorwill | | | | | B | |
| White-throated Swift | | | | B | B | |
| Broad-tailed Hummingbird | | B | B | B | B | |
| Belted Kingfisher | | | B | | | B |
| Downy Woodpecker | | | B | | | |
| Hairy Woodpecker | | | | | B | |

Table 2. Continued.

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

Table 2. Continued.

| Species | Habitat Type[a] | | | | | |
|---|---|---|---|---|---|---|
| | AG | G | R | MS | C | L&P |
| Swainson's Thrush | | | T | | | |
| Hermit Thrush | | | | | T | |
| American Robin | B | | B | B | B | |
| Gray Catbird | | | B | B | | |
| Sage Thrasher | | | | T | | |
| Water Pipit | | | | | | T |
| Loggerhead Shrike | | | | B | | |
| European Starling | B | | B | B | | |
| Solitary Vireo | | | T | | B | |
| Warbling Vireo | | | B | | | |
| Red-eyed Vireo | | | B | | | |
| Orange-crowned Warbler | | | T | | | |
| Virginia's Warbler | | | | B | B | |
| Yellow Warbler | | | B | | B | |
| Yellow-rumped Warbler | | | B | | B | |
| McGillivray's Warbler | | | T | B | B | |
| Common Yellowthroat | B | | B | B | | |
| Wilson's Warbler | | | B | B | | |
| Yellow-breasted Chat | | | B | B | | |
| Scarlet Tanager | | | T | | | |
| Western Tanager | | | T | | B | |
| Black-headed Grosbeak | | | | B | B | |
| Blue Grosbeak | | | B | B | | |
| Lazuli Bunting | | | B | B | B | |
| Green-tailed Towhee | | | | B | B | |
| Rufous-sided Towhee | | B | B | B | B | |
| Chipping Sparrow | | | | | B | |
| Brewer's Sparrow | | T | | B | | |
| Vesper Sparrow | B | B | B | B | B | |
| Lark Sparrow | B | B | | | B | |
| Savannah Sparrow | B | | B | | | |
| Grasshopper Sparrow | B | B | | | | |

Table 2. Continued.

| Species | Habitat Type[a] AG | G | R | MS | C | L&P |
|---|---|---|---|---|---|---|
| Song Sparrow | B | | B | | | |
| Lincoln's Sparrow | | | B | B | | |
| White-crowned Sparrow | | | | B | | |
| Dark-eyed Junco | | | | | B | |
| Bobolink | B | | | | | |
| Red-winged Blackbird | B | 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 | |
| Brown-headed Cowbird | B | | B | B | B | |
| Northern Oriole | B | | B | | | |
| Pine Grosbeak | | | | | B | |
| House Finch | B | | B | B | B | |
| Red Crossbill | | T | | | B | |
| Pine Siskin | | | | B | B | |
| Lesser Goldfinch | | | B | | B | |
| American Goldfinch | B | | B | B | | |
| [c]Evening Grosbeak | | | | | B | |
| Total Breeding Species | 38 | 24 | 58 | 53 | 53 | 20 |
| Total Species | 39 | 29 | 66 | 56 | 55 | 33 |

Total Breeding Species in all Habitats = 120

Total Species in all Habitats = 145

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

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

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

Table 3. 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 |
| Phalacrocoracidae | |
| Double-crested Cormorant | Phalacrocorax auritus |
| Ardeidae | |
| American Bittern | Botaurus lentiginosus |
| Great Blue Heron | Adrea herodias |
| Black-crowned Night-Heron | Nycticorax nycticorax |
| Threskiornithidae | |
| White-faced Ibis | Plegadis chihi |
| Anatidae | |
| Canada Goose | Branta canadensis |
| Wood Duck | Aix sponsa |
| Mallard | Anas platyrhynchos |
| Blue-winged Teal | Anas discors |
| Cinnamon Teal | Anas cyanoptera |
| Northern Shoveler | Anas clypeata |
| Gadwall | Anas strepera |
| 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 |
| Accipitridae | |
| Northern Harrier | Circus cyaneus |
| Sharp-shinned Hawk | Accipiter striatus |

Table 3. Continued

| FAMILY / COMMON NAME | SCIENTIFIC NAME |
|---|---|
| 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 |
| 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 |
| Columbidae | |
| Rock Dove | Columba livia |
| Mourning Dove | Zenaida macroura |
| Cuculidae | |
| Black-billed Cuckoo | Coccyzus erythropthalmus |

Table 3. Continued

| FAMILY / COMMON NAME | SCIENTIFIC NAME |
|---|---|
| Tytonidae | |
| Barn Owl | Tyto alba |
| Strigidae | |
| Eastern Screech Owl | Otus asio |
| Great Horned Owl | Bubo virginianus |
| 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 |
| Hammond's Flycatcher | Empidonax hammondii |
| Dusky Flycatcher | Empidonax oberholseri |
| Western Flycatcher | Empidonax difficilis |
| Ash-throated Flycatcher | Myiarchus cinerascens |
| Western Kingbird | Tyrannus verticalis |
| Eastern Kingbird | Tyrannus tyrannus |
| Alaudidae | |
| Horned Lark | Eremophila alpestris |
| Hirundiade | |
| Tree Swallow | Tachycineta bicolor |
| Violet-green Swallow | Tachycineta thalassina |

Table 3. Continued

| FAMILY<br>COMMON NAME | SCIENTIFIC NAME |
|---|---|
| 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 |
| 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 |

Table 3. Continued.

| FAMILY / COMMON NAME | SCIENTIFIC NAME |
|---|---|
| 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 |
| 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 |
| 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 |

Table 3. Continued.

| FAMILY<br>COMMON NAME | SCIENTIFIC NAME |
|---|---|
| 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 |

Table 4. Mean 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/ha ± 90% CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Sharp-shinned Hawk | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Mourning Dove | 1.2 | 1.6 | 2.0 | 0.2 | 4.2 | 2.4 | 0.4 | 0.2 | 0.76 ± 0.58 | 749.6 ± 572.1 |
| Common Nighthawk | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0.038 ± 0.09 | 37.5 ± 88.8 |
| White-throated Swift | 0 | 0 | 0 | 0 | 0 | 0.6 | 0 | 0 | 0.038 ± 0.09 | 37.5 ± 88.8 |
| Broad-tailed Hummingbird | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Hairy Woodpecker | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0 | 0.025 ± 0.039 | 24.7 ± 38.5 |
| Northern Flicker | 0 | 0 | 0.2 | 0 | 0.2 | 0 | 0 | 0.6 | 0.063 ± 0.09 | 62.1 ± 88.8 |
| Unidentified Woodpecker | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Western Wood Pewee | 1.4 | 1.2 | 1.0 | 0.2 | 1.0 | 0.6 | 0.4 | 0.4 | 0.39 ± 0.18 | 384.7 ± 177.5 |
| Hammond's Flycatcher | 0 | 0 | 0.2 | 0 | 0 | 0.4 | 0 | 0 | 0.038 ± 0.063 | 37.5 ± 62.1 |
| Empidonax Flycatcher | 0.2 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.025 ± 0.039 | 24.7 ± 38.5 |
| Barn Swallow | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.038 ± 0.044 | 37.5 ± 43.4 |
| Steller's Jay | 0 | 0 | 0.2 | 0.2 | 0 | 0.2 | 0.6 | 0.6 | 0.11 ± 0.11 | 108.5 ± 108.5 |
| Black-billed Magpie | 0 | 0 | 0.4 | 0.4 | 0 | 0 | 0.4 | 1.0 | 0.14 ± 0.15 | 138.1 ± 147.9 |
| Black-capped Chickadee | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Mountain Chickadee | 1.0 | 0 | 0.4 | 0.4 | 0 | 0.6 | 0.8 | 0.2 | 0.21 ± 0.07 | 207.1 ± 69.0 |
| Red-breasted Nuthatch | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Pygmy Nuthatch | 0 | 0 | 0.2 | 0.2 | 0 | 0.6 | 0 | 0.4 | 0.18 ± 0.10 | 177.5 ± 98.6 |
| Townsend's Solitaire | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.025 ± 0.039 | 24.7 ± 38.5 |
| American Robin | 0.8 | 2.8 | 2.0 | 1.4 | 0.2 | 1.8 | 1.4 | 2.2 | 0.79 ± 0.35 | 779.2 ± 345.2 |
| Solitary Vireo | 0.4 | 0.4 | 0.2 | 0 | 0.8 | 1.0 | 1.6 | 0 | 0.28 ± 0.23 | 276.2 ± 226.9 |
| Virginia's Warbler | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Yellow-rumped Warbler | 0 | 0.2 | 0.2 | 0 | 0 | 0 | 0.2 | 0 | 0.038 ± 0.044 | 37.5 ± 43.4 |
| Western Tanager | 0 | 0 | 3.0 | 0 | 0 | 0.2 | 0.4 | 0.8 | 0.28 ± 0.44 | 276.2 ± 434.0 |
| Black-headed Grosbeak | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.2 | 0.025 ± 0.039 | 24.7 ± 38.5 |
| Lazuli Bunting | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.6 | 0.05 ± 0.09 | 49.3 ± 88.8 |
| Green-tailed Towhee | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0.025 ± 0.06 | 24.7 ± 59.2 |
| Rufous-sided Towhee | 0.6 | 1.0 | 1.4 | 0.6 | 0.2 | 0.8 | 0.6 | 1.2 | 0.40 ± 0.16 | 394.5 ± 157.8 |
| Chipping Sparrow | 2.0 | 2.0 | 1.4 | 2.4 | 1.4 | 1.2 | 0.8 | 0.8 | 0.75 ± 0.25 | 739.7 ± 246.6 |
| Vesper Sparrow | 0 | 3.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.19 ± 0.45 | 187.4 ± 443.8 |
| Lark Sparrow | 0.8 | 3.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.24 ± 0.45 | 236.7 ± 443.8 |
| Dark-eyed Junco | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.6 | 1.0 | 0.13 ± 0.16 | 128.2 ± 157.8 |

Table 4. Continued.

| SPECIES | MEAN PLOT DENSITY (n/2ha)[a] | | | | | | | | MEAN HABITAT DENSITY (n/ha ± 90% CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Unidentified Sparrow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Western Meadowlark | 0 | 0.2 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0.038 ± 0.044 | 37.5 ± 43.4 |
| Brown-headed Cowbird | 0 | 0 | 0 | 0.6 | 0 | 0.6 | 0.4 | 2.2 | 0.24 ± 0.32 | 236.7 ± 315.6 |
| Pine Grosbeak | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| House Finch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Red Crossbill | 2.6 | 1.0 | 1.2 | 1.6 | 1.2 | 0.4 | 0 | 0.4 | 0.53 ± 0.35 | 522.7 ± 345.2 |
| Pine Siskin | 0.2 | 0 | 1.6 | 1.2 | 0 | 1.8 | 0 | 0 | 0.30 ± 0.35 | 295.9 ± 335.3 |
| Lesser Goldfinch | 0 | 1.8 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.125 ± 0.27 | 123.2 ± 266.3 |
| Unidentified Finch | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 12.8 ± 29.6 |
| Total Plot Count | 12.0 | 19.2 | 16.6 | 9.6 | 10.0 | 14.2 | 9.4 | 13.4 | 6.53 ± 1.50 | 6,440.7 ± 1,479.5 |
| Total Birds Observed | 60 | 96 | 83 | 48 | 50 | 71 | 47 | 67 | | |
| Total Species Observed | 15 | 15 | 19 | 13 | 11 | 19 | 17 | 18 | | |

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

[b] Estimates are number of birds ± 90% confidence interval for 986.32 ha (2436.2 acres) of conifer habitat.

Table 5. Mean 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/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Black-crowned Night Heron | 0 | 0 | 0.6 | 0 | 0 | 0 | 0.2 | 0 | 0.05 ± 0.09 | 8.2 ± 14.8 |
| Canada Goose | 0 | 0 | 0 | 0 | 1.6 | 0 | 0 | 0 | 0.10 ± 0.24 | 16.5 ± 39.5 |
| Wood Duck | 0.4 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0.05 ± 0.08 | 8.2 ± 13.2 |
| Mallard | 0.2 | 0.2 | 1.4 | 0.4 | 1.2 | 0.2 | 0 | 0 | 0.23 ± 0.23 | 37.9 ± 37.9 |
| Blue-winged Teal | 0 | 0 | 1.2 | 0 | 0.6 | 0 | 0 | 0 | 0.11 ± 0.19 | 18.1 ± 31.3 |
| Red-tailed Hawk | 0 | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.025 ± 0.06 | 41. ± 9.9 |
| Sora | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0.025 ± 0.06 | 4.1 ± 9.9 |
| Killdeer | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.025 ± 0.039 | 4.1 ± 6.4 |
| Mourning Dove | 0 | 0 | 2.4 | 0.2 | 0 | 0.2 | 0 | 1.2 | 0.25 ± 0.37 | 41.2 ± 60.9 |
| Eastern Screech Owl | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Broad-tailed Hummingbird | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Downy Woodpecker | 0 | 0.2 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0.038 ± 0.063 | 6.3 ± 10.4 |
| Northern Flicker | 1.0 | 1.6 | 0.2 | 0.4 | 0.2 | 1.0 | 0.2 | 0 | 0.23 ± 0.24 | 37.9 ± 39.5 |
| Western Wood Pewee | 1.0 | 0 | 0 | 0.2 | 0 | 0.4 | 0 | 0 | 0.01 ± 0.15 | 16.5 ± 24.7 |
| Eastern Kingbird | 0 | 0 | 0 | 0 | 0 | 0.6 | 0 | 0 | 0.038 ± 0.09 | 6.3 ± 14.8 |
| Northern Rough-winged Swallow | 0.4 | 0 | 0 | 0 | 0 | 0.2 | 1.0 | 0 | 0.10 ± 0.15 | 16.5 ± 24.7 |
| Bank Swallow | 0 | 0 | 1.2 | 0 | 5.4 | 0 | 0 | 0 | 0.41 ± 0.80 | 67.5 ± 131.7 |
| Cliff Swallow | 1.6 | 0 | 0.2 | 0 | 0 | 0 | 0 | 11.2 | 0.81 ± 1.66 | 133.3 ± 273.3 |
| Barn Swallow | 0 | 0.2 | 0.4 | 0 | 1.4 | 0 | 0.4 | 0.4 | 0.18 ± 0.20 | 29.6 ± 32.9 |
| Unidentified Swallow | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Blue Jay | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Black-billed Magpie | 1.0 | 4.8 | 0.4 | 3.2 | 0 | 1.4 | 0.2 | 0.4 | 0.71 ± 0.72 | 116.9 ± 118.5 |
| American Crow | 0 | 0.2 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.025 ± 0.039 | 4.1 ± 6.4 |
| Black-capped Chickadee | 0.2 | 1.0 | 0 | 0.8 | 0 | 0.2 | 0 | 0 | 0.14 ± 0.169 | 23.0 ± 27.8 |
| House Wren | 0.6 | 1.6 | 0 | 0.6 | 0 | 0.6 | 0 | 0 | 0.21 ± 0.237 | 34.6 ± 39.0 |
| American Robin | 0.2 | 1.2 | 1.2 | 0.2 | 0.8 | 0 | 0.2 | 0 | 0.24 ± 0.217 | 39.5 ± 35.7 |
| Gray Catbird | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.6 | 0.05 ± 0.09 | 8.2 ± 14.8 |
| European Starling | 1.8 | 4.2 | 0.2 | 4.4 | 0 | 2.4 | 1.2 | 0.8 | 0.94 ± 0.716 | 154.7 ± 117.9 |
| Warbling Vireo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 2.1 ± 4.9 |

Table 5. Continued.

| SPECIES | MEAN PLOT DENSITY (n/2ha)[a] | | | | | | | | MEAN HABITAT DENSITY (n/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Red-eyed Vireo | 0 | 0 | 1.0 | 0.2 | 0 | 0 | 0 | 0 | 0.075 ± 0.149 | 12.3 ± 24.5 |
| Unidentified Vireo | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Yellow Warbler | 0.6 | 0.4 | 1.0 | 0 | 0 | 0 | 1.2 | 1.6 | 0.30 ± 0.26 | 49.4 ± 42.8 |
| Yellow-rumped Warbler | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0.038 ± 0.09 | 6.3 ± 14.8 |
| McGillivray's Warbler | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.6 | 0.038 ± 0.09 | 6.3 ± 14.8 |
| Common Yellowthroat | 1.0 | 0 | 1.4 | 0.6 | 1.4 | 2.0 | 0 | 0.4 | 0.43 ± 0.306 | 70.8 ± 50.4 |
| Wilson's Warbler | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Unidentified Warbler | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Yellow-breasted Chat | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 1.0 | 0.075 ± 0.149 | 12.3 ± 24.5 |
| Black-headed Grosbeak | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Blue Grosbeak | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Lazuli Bunting | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.8 | 0.063 ± 0.119 | 10.4 ± 19.6 |
| Rufous-sided Towhee | 0 | 0 | 0 | 0 | 0 | 0 | 1.0 | 2.0 | 0.38 ± 0.315 | 62.6 ± 51.9 |
| Vesper Sparrow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Savannah Sparrow | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.1 ± 4.9 |
| Song Sparrow | 0.2 | 0 | 0.4 | 0 | 2.8 | 0.6 | 1.4 | 1.0 | 0.40 ± 0.40 | 65.8 ± 65.8 |
| Lincoln's Sparrow | 0 | 0 | 0.2 | 0 | 0.2 | 0 | 0 | 1.0 | 0.088 ± 0.146 | 14.5 ± 24.0 |
| Red-winged Blackbird | 1.4 | 0.8 | 10.2 | 2.6 | 11.2 | 0.2 | 0 | 0 | 1.65 ± 1.973 | 271.6 ± 324.8 |
| Western Meadowlark | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.05 ± 0.09 | 8.2 ± 14.8 |
| Brewer's Blackbird | 0.6 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0 | 0.063 ± 0.101 | 10.4 ± 16.6 |
| Common Grackle | 1.2 | 0.8 | 3.2 | 4.2 | 0.4 | 0.4 | 0 | 0 | 0.64 ± 0.666 | 105.4 ± 109.6 |
| Brown-headed Cowbird | 0.2 | 0.6 | 1.4 | 0.4 | 0.8 | 1.2 | 0.2 | 1.8 | 0.41 ± 0.25 | 67.5 ± 41.2 |
| Northern Oriole | 0 | 0.2 | 0.8 | 0 | 0 | 0 | 0 | 1.2 | 0.14 ± 0.197 | 23.0 ± 32.4 |
| House Finch | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.2 | 0.025 ± 0.039 | 4.1 ± 6.4 |
| Lesser Goldfinch | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.4 | 0.038 ± 0.063 | 6.3 ± 10.4 |
| Amercian Goldfinch | 0 | 0 | 0.4 | 0.4 | 0.6 | 0.8 | 1.4 | 2.6 | 0.39 ± 0.366 | 64.2 ± 60.2 |
| Unidentified | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0.025 ± 0.06 | 4.1 ± 9.9 |

Table 5. Continued.

| SPECIES | MEAN PLOT DENSITY (n/2ha)[a] | | | | | | | | MEAN HABITAT DENSITY (n/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Total Plot Counts | 14.2 | 18.2 | 30.6 | 20.2 | 28.8 | 13.6 | 10.0 | 30.6 | 10.4 ± 3.49 | 1,709.9 ± 574.7 |
| Total Birds Observed | 71 | 91 | 153 | 101 | 144 | 68 | 50 | 153 | | |
| Total Species Observed | 19 | 16 | 24 | 18 | 15 | 20 | 18 | 25 | | |



a Plots are each 2 hectares (4.94).

b Estimates are number of birds ± 90% confidence interval for 164.61 ha (406.6 acres) of riparian and wetland habitats.

Cliff Swallows, Black-billed Magpies, and Common Grackles were the most abundant species together representing 45.7% of the estimated population.

Forty-three breeding bird species were observed on plots in mountain shrub habitats. Mean breeding density (6.50 $\pm$ 1.25 birds/ha) in mountain shrub was similar to that in conifer habitats (Table 6). The breeding population was estimated at 1,374.6 $\pm$ 264.4 birds with Rufous-sided Towhees, Lazuli Buntings, Black-billed Magpies, and Green-tailed Towhees comprising 52% of the species present (Table 6).

Grassland habitats had the lowest number of breeding species (18) and the lowest mean density (2.43$\pm$ 0.87 birds/ha) for major habitats in the Open Space system (Table 7). The breeding population of 4,913.0 $\pm$ 1,759.0 birds was dominated by Western Meadowlarks and Vesper and Lark sparrows. These three species accounted for 81% of the population; Meadowlarks alone accounted for 55% of the breeding birds.

Thirty breeding species were observed on agricultural grassland plots. Red-winged Blackbirds, Western Meadowlarks, and Cliff and Barn Swallows accounted for 67% of the population, estimated at 5,488.8 $\pm$ 3,035.5 birds (Table 8). Numbers of Red-winged Blackbirds alone represented 44% of the population. Mean habitat density was 5.75 $\pm$ 3.18 birds/ha.

The aforementioned numbers represent mean values of species present on survey plots during the 1984 breeding season. These numbers may vary over the season and between plots depending on habitat quality, species habitat affinities, and breeding activites. Values, which are based on sample statistics, are most accurate for common, widespread species 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 are often concentrated. The 90% confidence interval which follows the density and population estimates simply means that we are 90% confident that the calculated value lies within this interval. For example, there is a 90% probability that the 1984 breeding bird population in Open Space conifer habitat is between 4,961.2 and 7,920.2 birds (6,440.7$\pm$ 1,479.5) (Table 4).

Table 6. Mean 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/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Mallard | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.038 ± 0.09 | 8.0 ± 19.0 |
| American Kestrel | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0.025 ± 0.06 | 5.3 ± 12.7 |
| Prairie Falcon | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Rock Dove | 0 | 0 | 0 | 1.2 | 0 | 0 | 0 | 0 | 0.075 ± 0.18 | 15.9 ± 38.1 |
| Mourning Dove | 0.2 | 0.6 | 0.8 | 0.4 | 0.2 | 0.6 | 0 | 0 | 0.175 ± 0.126 | 37.0 ± 26.6 |
| Great Horned Owl | 0 | 0.2 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0.038 ± 0.063 | 8.0 ± 13.3 |
| White-throated Swift | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0.05 ± 0.08 | 10.6 ± 16.9 |
| Broad-tailed Hummingbird | 0 | 0 | 0 | 0 | 0.8 | 0 | 0 | 2.6 | 0.21 ± 0.39 | 44.4 ± 82.5 |
| Northern Flicker | 0.2 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.025 ± 0.039 | 5.3 ± 8.2 |
| Western Wood Pewee | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Western Flycatcher | 0.4 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.038 ± 0.063 | 8.0 ± 13.3 |
| Empidonax Flycatcher | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Violet-green Swallow | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Northern Rough-winged Swallow | 0 | 0 | 0 | 0.2 | 0 | 0.2 | 0 | 0 | 0.025 ± 0.039 | 5.3 ± 8.2 |
| Barn Swallow | 0 | 0.2 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0.038 ± 0.063 | 8.0 ± 13.3 |
| Steller's Jay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Black-billed Magpie | 1.0 | 0.8 | 1.0 | 2.4 | 0.2 | 0.6 | 1.4 | 0.6 | 0.50 ± 0.28 | 105.7 ± 59.2 |
| Black-capped Chickadee | 0.4 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.038 ± 0.063 | 8.0 ± 13.3 |
| Mountain Chickadee | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.025 ± 0.06 | 5.3 ± 12.7 |
| Rock Wren | 0 | 1.0 | 0 | 0.4 | 0 | 0.4 | 1.2 | 0 | 0.19 ± 0.205 | 40.2 ± 43.4 |
| House Wren | 0.2 | 2.6 | 0.4 | 0.2 | 0 | 0 | 0 | 0 | 0.21 ± 0.377 | 44.4 ± 79.7 |
| American Robin | 0.4 | 0 | 0 | 0 | 0.4 | 0.2 | 0.4 | 0.2 | 0.10 ± 0.078 | 21.1 ± 16.5 |
| Gray Catbird | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| European Starling | 0 | 2.4 | 0 | 2.6 | 0 | 0.8 | 0 | 0 | 0.36 ± 0.48 | 76.1 ± 101.5 |
| Virginia's Warbler | 0.8 | 0 | 0 | 0 | 1.0 | 0 | 0.6 | 0.8 | 0.20 ± 0.187 | 42.3 ± 39.5 |
| Yellow Warbler | 0.2 | 0 | 0.2 | 0 | 0 | 0.2 | 0 | 0 | 0.038 ± 0.044 | 8.0 ± 9.3 |
| McGillivray's Warbler | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Common Yellowthroat | 0 | 0 | 0 | 0.2 | 0 | 0.2 | 0 | 0 | 0.025 ± 0.039 | 5.3 ± 8.2 |
| Wilson's Warbler | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0.038 ± 0.09 | 8.0 ± 19.0 |
| Unidentified Warbler | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0.05 ± 0.08 | 10.6 ± 16.9 |
| Yellow-breasted Chat | 0.4 | 0 | 0 | 0 | 0.6 | 0.4 | 0 | 0.6 | 0.13 ± 0.118 | 27.5 ± 25.0 |

Table 6. Continued.

| SPECIES | MEAN PLOT DENSITY (n/2ha)[a] 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | MEAN HABITAT DENSITY (n/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| Black-headed Grosbeak | 0.2 | 0 | 0.2 | 0 | 0.4 | 0 | 0 | 0.4 | 0.075 ± 0.075 | 15.9 ± 15.9 |
| Blue Grosbeak | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0.025 ± 0.06 | 5.3 ± 12.7 |
| Lazuli Bunting | 1.6 | 1.0 | 2.4 | 0.2 | 2.8 | 1.0 | 1.2 | 3.6 | 0.863 ± 0.47 | 182.5 ± 99.4 |
| Green-tailed Towhee | 2.0 | 0 | 1.4 | 0 | 1.4 | 0 | 0 | 3.0 | 0.49 ± 0.49 | 103.6 ± 103.6 |
| Rufous-sided Towhee | 3.0 | 0.4 | 4.2 | 0.2 | 4.4 | 2.6 | 4.4 | 5.4 | 1.54 ± 0.81 | 325.7 ± 171.3 |
| Brewer's Sparrow | 0 | 0 | 0 | 0 | 0 | 0 | 0.8 | 0 | 0.05 ± 0.12 | 10.6 ± 25.4 |
| Vesper Sparrow | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Lincoln's Sparrow | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.025 ± 0.06 | 5.3 ± 12.7 |
| White-crowned sparrow | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Unidentified Sparrow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.6 | 0.038 ± 0.09 | 8.0 ± 19.0 |
| Red-winged Blackbird | 0.2 | 0 | 0 | 1.2 | 0 | 0 | 0 | 0 | 0.088 ± 0.178 | 18.6 ± 37.6 |
| Western Meadowlark | 0.2 | 0 | 1.2 | 0.6 | 0 | 0.8 | 0.6 | 0 | 0.213 ± 0.189 | 45.0 ± 37.0 |
| Brewer's blackbird | 0 | 0 | 0 | 0.8 | 0 | 0 | 0 | 0 | 0.05 ± 0.12 | 10.6 ± 25.4 |
| Brown-headed Cowbird | 1.2 | 0 | 0.4 | 0 | 0 | 1.0 | 2.0 | 0 | 0.29 ± 0.32 | 61.3 ± 67.7 |
| American Goldfinch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.013 ± 0.03 | 2.7 ± 6.3 |
| Total Plot Counts | 14.4 | 9.6 | 13.4 | 12.2 | 13.2 | 9.4 | 13.0 | 18.8 | 6.50 ± 1.25 | 1,374.6 ± 264.4 |
| Total Birds Observed | 72 | 48 | 67 | 61 | 66 | 47 | 65 | 94 | | |
| Total Species Observed | 21 | 10 | 14 | 18 | 12 | 15 | 10 | 12 | | |

a Plots are each 2 hectares (4.94 acres).

b Estimates are number of birds ± 90% confidence interval for 211.48 ha (522.35 acres) Of mountain shrub habitat.

Table 7. Mean 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/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| American Kestrel | 0.6 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.05 ± 0.09 | 101.1 ± 182.0 |
| Prairie Falcon | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 26.3 ± 60.7 |
| Mourning Dove | 0.4 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0.05 ± 0.08 | 101.1 ± 161.7 |
| Common Nighthawk | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.013 ± 0.03 | 26.3 ± 60.7 |
| Broad-tailed Hummingbird | 0 | 0.2 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.025 ± 0.039 | 50.5 ± 78.9 |
| Western Kingbird | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 26.3 ± 60.7 |
| Northern Rough-winged Swallow | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 26.3 ± 60.7 |
| Cliff Swallow | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.075 ± 0.18 | 151.6 ± 363.9 |
| Barn Swallow | 1.2 | 0 | 0 | 0 | 0.2 | 0.2 | 0 | 0 | 0.10 ± 0.175 | 202.2 ± 353.8 |
| Black-billed Magpie | 0 | 0.6 | 0 | 0.4 | 0.2 | 0 | 0 | 0 | 0.075 ± 0.099 | 151.6 ± 200.2 |
| European Starling | 0 | 0.2 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.025 ± 0.039 | 50.5 ± 78.9 |
| Rufous-sided Towhee | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0.025 ± 0.06 | 50.5 ± 121.3 |
| Vesper Sparrow | 0 | 0.2 | 0.2 | 0 | 2.0 | 4.1 | 0 | 1.2 | 0.48 ± 0.62 | 970.5 ± 1,253.5 |
| Lark Sparrow | 0.2 | 0 | 0.6 | 0 | 0 | 0 | 0 | 1.6 | 0.15 ± 0.24 | 303.3 ± 485.2 |
| Grasshopper Sparrow | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.013 ± 0.03 | 26.3 ± 60.7 |
| Red-winged Blackbird | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.013 ± 0.03 | 26.3 ± 60.7 |
| Western Meadowlark | 2.6 | 1.8 | 3.6 | 2.8 | 3.0 | 2.4 | 2.0 | 3.2 | 1.34 ± 0.26 | 2,709.3 ± 525.7 |
| Brewer's Blackbird | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 26.3 ± 60.7 |
| Total Plot Counts | 6.8 | 3.0 | 4.4 | 2.8 | 6.8 | 7.0 | 2.0 | 6.0 | 2.43 ± 0.87 | 4,913.0 ± 1,759.0 |
| Total Birds Observed | 34 | 15 | 22 | 14 | 34 | 35 | 10 | 30 | | |
| Total Species Observed | 9 | 5 | 3 | 3 | 9 | 4 | 3 | 3 | | |

a Plots are each 2 hectares (4.94 acres).

b Estimates are number of birds ± 90% confidence interval for 2021.82 ha (4994.1 acres) of grassland habitat.

Table 8. Mean 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/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Mallard | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.088 ± 0.178 | 84.0 ± 169.9 |
| Blue-wing Teal | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Virginia Rail | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Killdeer | 0 | 0 | 0.4 | 1.6 | 0 | 0 | 0.2 | 0.8 | 0.188 ± 0.24 | 179.5 ± 229.1 |
| Common Snipe | 0 | 0 | 0 | 0.2 | 0.4 | 1.0 | 0 | 1.2 | 0.175 ± 0.21 | 167.0 ± 200.5 |
| Wilson's Phalarope | 0.2 | 0 | 0 | 0 | 0 | 1.6 | 0 | 0.6 | 0.15 ± 0.24 | 143.2 ± 229.1 |
| Mourning Dove | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.4 | 0 | 0.038 ± 0.063 | 36.3 ± 60.1 |
| Common Nighthawk | 0 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0.2 | 0.038 ± 0.063 | 36.3 ± 60.1 |
| Northern Flicker | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Horned Lark | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0.038 ± 0.09 | 36.3 ± 60.1 |
| Tree Swallow | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Violet-green Swallow | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Northern Rough-winged Swallow | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Cliff Swallow | 0.4 | 0.6 | 0 | 0.2 | 1.4 | 0 | 1.2 | 0.2 | 0.25 ± 0.226 | 238.6 ± 215.7 |
| Barn Swallow | 0.6 | 0.2 | 0 | 0.2 | 0.2 | 0.8 | 0.4 | 1.4 | 0.24 ± 0.192 | 229.1 ± 183.3 |
| Black-billed Magpie | 0.8 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.063 ± 0.119 | 60.1 ± 113.6 |
| American Robin | 0.2 | 0 | 0 | 0 | 0.2 | 1.0 | 0 | 0.6 | 0.125 ± 0.155 | 119.3 ± 148.0 |
| European Starling | 0.4 | 0.2 | 0 | 0 | 0 | 0 | 0 | 1.2 | 0.113 ± 0.178 | 107.9 ± 169.9 |
| Vesper Sparrow | 0 | 0 | 0.4 | 2.0 | 0 | 0 | 0 | 0 | 0.15 ± 0.297 | 143.2 ± 283.5 |
| Lark Sparrow | 0 | 0 | 0.4 | 0.4 | 0 | 0 | 0 | 0 | 0.05 ± 0.08 | 47.7 ± 76.4 |
| Savannah Sparrow | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Grasshopper Sparrow | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Song Sparrow | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Unidentified Sparrow | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Bobolink | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0.125 ± 0.239 | 119.3 ± 228.1 |
| Red-winged Blackbird | 11.8 | 1.0 | 0.8 | 0.4 | 1.2 | 17.8 | 0 | 7.8 | 2.55 ± 2.83 | 2,434.2 ± 2,701.4 |
| Western Meadowlark | 1.0 | 1.2 | 2.8 | 1.8 | 2.2 | 0.4 | 2.6 | 1.2 | 0.83 ± 0.356 | 792.3 ± 339.8 |

Table 8. Continued.

| SPECIES | MEAN PLOT DENSITY (n/2ha)[a] | | | | | | | | MEAN HABITAT DENSITY (n/ha ± 90%CI) | OPEN SPACE POPULATION[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Brewer's Blackbird | 0 | 0 | 0 | 0 | 0.6 | 0.2 | 2.4 | 0.4 | 0.225 ± 0.347 | 214.8 ± 331.2 |
| Common Grackle | 0.2 | 0 | 0 | 0 | 0.2 | 1.6 | 0 | 0.4 | 0.15 ± 0.231 | 143.2 ± 220.5 |
| Brown-headed Cowbird | 0 | 0 | 0 | 0 | 0.4 | 0 | 0.2 | 0 | 0.038 ± 0.063 | 36.3 ± 60.1 |
| American Goldfinch | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0.013 ± 0.03 | 12.4 ± 28.6 |
| Total Plot Counts | 18.8 | 4.4 | 5.8 | 7.0 | 6.8 | 24.8 | 7.8 | 16.6 | 5.75 ± 3.18 | 5,488.8 ± 3,035.5 |
| Total Birds Observed | 94 | 22 | 29 | 35 | 34 | 124 | 39 | 83 | | |
| Total Species Observed | 13 | 11 | 8 | 9 | 9 | 10 | 8 | 14 | | |

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

[b] Estimates are number of birds ± 90% confidence interval for 954.57 (2357.8 acres) of agricultural grassland habitat.

Table 9 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 five 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 9 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. 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 of the Open Space System differed significantly between ($F = 25.53$, $P < 0.0005$) and within ($F = 3.63$, $P < 0.0005$) major habitat types (Appendix A, p. A3). Differences in bird use between habitats are related to the different vegetative and physical attributes which characterize a habitat type and to the relative valué 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 ($Q' = 1.52$, $\alpha = 0.05$, Appendix A, p. A5) except conifer and mountain shrub habitats (Table 10). Species richness was highest in riparian habitats (8.9 species/plot) followed by conifer (6.975), mountain shrub (6.1), agricultural grassland (4.4) and grassland (2.3) habitats (Appendix A, p. A5).

Table 9. Summary of habitat densities and population estimates for breeding birds in major Boulder Open Space habitats.

| SPECIES | MEAN HABITAT DENSITY (n/ha ± 90% CI) C[a] | R[a] | MS[a] | G[a] | AG[a] | L&P[b] | POPULATION[c] |
|---|---|---|---|---|---|---|---|
| Pied-billed Grebe | | | | | | 13 | 13.0 |
| American Bittern | | | | | | 1 | 1.0 |
| Great Blue Heron | | | | | | 6 | 6.0 |
| Black-crowned Night-Heron | | 0.05 ± 0.09 | | | | 4 | 12.2 ± 14.8 |
| Canada Goose | | 0.10 ± 0.24 | | | | 101 | 117.5 ± 39.5 |
| Wood Duck | | 0.05 ± 0.08 | | | | | 8.2 ± 13.2 |
| Mallard | | 0.23 ± 0.23 | 0.038 ± 0.09 | | 0.088 ± 0.178 | 19 | 148.9 ± 226.8 |
| Blue-winged Teal | | 0.11 ± 0.19 | | | 0.013 ± 0.03 | 8 | 38.5 ± 59.9 |
| Cinnamon Teal | | | | | | 4 | 4.0 |
| Northern Shoveler[d] | | | | | | | |
| Gadwall | | | | | | 3 | 3.0 |
| Common Merganser | | | | | | 2[e] | 2.0 |
| Ruddy Duck | | | | | | 3 | 3.0 |
| Turkey Vulture[f] | | | | | | | |
| Sharp-shinned Hawk | 0.013 ± 0.03 | | | | | | 56.8 ± 131.0 |
| Cooper's Hawk[d] | | | | | | | 109.2 ± 262.0 |
| Red-tailed Hawk | | 0.025 ± 0.06 | | | | | |
| Golden Eagle[f] | | | | | | | |
| American Kestrel | | | 0.025 ± 0.06 | 0.05 ± 0.09 | | | 131.0 ± 655.1 |
| Prairie Falcon[f] | | | 0.013 ± 0.03 | 0.013 ± 0.03 | | | 113.54 ± 262.0 |
| Chuckar[d] | | | | | | | |
| Ring-necked Pheasant[d] | | | | | | | |
| Blue Grouse[d] | | | | | | | |
| Virginia Rail | | | | | 0.013 ± 0.03 | | 12.4 ± 28.6 |
| Sora | | 0.025 ± 0.06 | | | | 1 | 5.1 ± 9.9 |
| American Coot | | | | | | 39 | 39.0 |
| Killdeer | | 0.025 ± 0.039 | | | 0.188 ± 0.24 | 23 | 206.6 ± 235.5 |
| Spotted Sandpiper | | | | | | 5 | 5.0 |
| Common Snipe | | | | | 0.175 ± 0.21 | 2 | 169.0 ± 200.5 |
| Wilson's Phalarope | | | | | 0.15 ± 0.24 | | 143.2 ± 229.1 |
| Rock Dove | | | 0.075 ± 0.18 | | | | 15.9 ± 38.1 |

Table 9. Continued.

| SPECIES | MEAN HABITAT DENSITY (n/ha ± 90% CI) C[a] | R[a] | MS[a] | G[a] | AG[a] | L&P[b] | POPULATION[c] |
|---|---|---|---|---|---|---|---|
| Mourning Dove | 0.76 ± 0.58 | 0.25 ± 0.37 | 0.175 ± 0.126 | 0.05 ± 0.08 | 0.038 ± 0.063 | | 965.2 ± 881.4 |
| Barn Owl | | | | | | | 2.0 |
| Eastern Screech Owl | | | 0.013 ± 0.03 | | | | 2.1 ± 4.9 |
| Great Horned Owl | | | 0.038 ± 0.063 | | | | 8.0 ± 13.3 |
| Burrowing Owl | | | | | | | 4.0 |
| Long-eared Owl | | | | | | | 2.0 |
| Common Nighthawk | 0.038 ± 0.09 | | | 0.013 ± 0.03 | 0.038 ± 0.063 | | 100.1 ± 209.6 |
| Common Poorwill[d] | | | | | | | |
| White-throated Swift | 0.038 ± 0.09 | | 0.05 ± 0.08 | | | | 48.1 ± 105.7 |
| Broad-tailed Hummingbird | 0.013 ± 0.03 | 0.013 ± 0.03 | 0.21 ± 0.39 | 0.025 ± 0.039 | | | 109.8 ± 195.9 |
| Belted Kingfisher | | | | | | 5 | 5.0 |
| Downy Woodpecker | | 0.038 ± 0.063 | | | | | 6.3 ± 10.4 |
| Hairy Woodpecker | 0.025 ± 0.039 | | | | | | 24.7 ± 38.5 |
| Northern Flicker | 0.063 ± 0.09 | 0.23 ± 0.24 | 0.025 ± 0.039 | | 0.013 ± 0.03 | | 117.7 ± 165.1 |
| Olive-sided Flycatcher[d] | | | | | | | |
| Western Wood Pewee | 0.039 ± 0.18 | 0.10 ± 0.15 | 0.013 ± 0.03 | | | | 403.9 ± 208.5 |
| Hammond's Flycatcher | 0.038 ± 0.063 | | | | | | 37.5 ± 62.1 |
| Dusky Flycatcher[d] | | | | | | | |
| Western Flycatcher | | | 0.038 ± 0.063 | | | | 8.0 ± 13.3 |
| Say's Phoebe[d] | | | | | | | |
| Western Kingbird | | | | 0.013 ± 0.03 | | | 26.3 ± 60.7 |
| Eastern Kingbird | | 0.038 ± 0.09 | | | | | 6.3 ± 14.8 |
| Horned Lark | | | | | 0.038 ± 0.09 | | 36.3 ± 60.1 |
| Tree Swallow | | | | | 0.013 ± 0.03 | | 12.4 ± 28.6 |
| Violet-green Swallow | | | 0.013 ± 0.03 | | 0.013 ± 0.03 | | 15.1 ± 34.9 |
| Northern Rough-winged Swallow | | 0.10 ± 0.15 | 0.025 ± 0.039 | 0.013 ± 0.03 | 0.013 ± 0.03 | | 60.5 ± 122.2 |
| Bank Swallow | | 0.41 ± 0.80 | | | | | 67.5 ± 131.7 |
| Cliff Swallow | | 0.81 ± 1.66 | 0.075 ± 0.18 | 0.25 ± 0.226 | | | 523.5 ± 852.9 |
| Barn Swallow | 0.038 ± 0.044 | 0.18 ± 0.20 | 0.038 ± 0.063 | 0.10 ± 0.175 | 0.24 ± 0.192 | | 506.4 ± 626.7 |

Table 9. Continued.

| SPECIES | MEAN HABITAT DENSITY (n/ha ± 90% CI) C[a] | R[a] | MS[a] | G[a] | AG[a] | L&P[b] | POPULATION[c] |
|---|---|---|---|---|---|---|---|
| Steller's Jay | 0.11 ± 0.11 | | 0.013 ± 0.03 | | | | 111.2 ± 114.8 |
| Blue Jay | | 0.013 ± 0.03 | | | | | 2.1 ± 4.9 |
| Scrub Jay[d] | | | | | | | |
| Black-billed Magpie | 0.14 ± 0.15 | 0.71 ± 0.72 | 0.50 ± 0.28 | 0.075 ± 0.099 | 0.063 ± 0.119 | | 572.4 ± 639.4 |
| American Crow | | 0.025 ± 0.039 | | | | | 4.1 ± 6.4 |
| Common Raven[d] | | | | | | | |
| Black-capped Chickadee | 0.013 ± 0.03 | 0.14 ± 0.169 | 0.038 ± 0.063 | | | | 43.8 ± 70.7 |
| Mountain Chickadee | 0.21 ± 0.07 | | 0.025 ± 0.06 | | | | 212.4 ± 81.7 |
| Bushtit[d] | | | | | | | |
| Red-breasted Nuthatch | 0.013 ± 0.03 | | | | | | 12.8 ± 29.6 |
| Pygmy Nuthatch | 0.18 ± 0.10 | | | | | | 177.5 ± 98.6 |
| American Dipper[d] | | | | | | | |
| Rock Wren | | | 0.19 ± 0.205 | | | | 40.2 ± 43.4 |
| House Wren | | 0.21 ± 0.237 | 0.21 ± 0.377 | | | | 79.0 ± 118.7 |
| Townsend's Solitaire | 0.025 ± 0.039 | | | | | | 24.7 ± 38.5 |
| American Robin | 0.79 ± 0.35 | 0.24 ± 0.217 | 0.10 ± 0.078 | | 0.125 ± 0.155 | | 959.1 ± 545.4 |
| Gray Catbird | | 0.05 ± 0.09 | 0.013 ± 0.03 | | | | 10.9 ± 21.1 |
| Loggerhead Shrike[d] | | | | | | | |
| European Starling | | 0.94 ± 0.716 | 0.36 ± 0.48 | 0.025 ± 0.039 | 0.113 ± 0.178 | | 389.2 ± 468.2 |
| Solitary Vireo | 0.28 ± 0.23 | | | | | | 276.2 ± 226.9 |
| Warbling Vireo | | 0.013 ± 0.03 | | | | | 2.1 ± 4.9 |
| Red-eyed Vireo | | 0.075 ± 0.149 | | | | | 12.3 ± 24.5 |
| Virginia's Warbler | 0.013 ± 0.03 | | 0.20 ± 0.187 | | | | 55.1 ± 69.1 |
| Yellow Warbler | | 0.30 ± 0.26 | 0.038 ± 0.044 | | | | 57.4 ± 52.1 |
| Yellow-rumped Warbler | 0.038 ± 0.044 | 0.038 ± 0.09 | | | | | 43.8 ± 58.2 |
| McGillivray's Warbler | | 0.038 ± 0.09 | 0.013 ± 0.03 | | | | 9.0 ± 21.1 |
| Common Yellowthroat | | 0.43 ± 0.306 | 0.025 ± 0.039 | | | | 76.1 ± 58.6 |
| Wilson's Warbler | | 0.013 ± 0.03 | 0.038 ± 0.09 | | | | 10.1 ± 23.9 |
| Yellow-breasted Chat | | 0.075 ± 0.149 | 0.13 ± 0.118 | | | | 39.8 ± 49.5 |
| Western Tanager | 0.28 ± 0.44 | | | | | | 276.2 ± 434.0 |

Table 9. Continued.

| SPECIES | MEAN HABITAT DENSITY (n/ha ± 90% CI) | | | | | | |
|---|---|---|---|---|---|---|---|
| | C[a] | R[a] | MS[a] | G[a] | AG[a] | L&P[b] | POPULATION[c] |
| Black-headed Grosbeak | 0.025 ± 0.039 | 0.013 ± 0.03 | 0.075 ± 0.075 | | | | 42.7 ± 59.3 |
| Blue Grosbeak | | 0.013 ± 0.03 | 0.025 ± 0.06 | | | | 7.4 ± 17.6 |
| Lazuli Bunting | 0.05 ± 0.09 | 0.063 ± 0.119 | 0.863 ± 0.47 | | | | 242.2 ± 207.8 |
| Green-tailed Towhee | 0.025 ± 0.06 | | 0.49 ± 0.49 | | | | 128.3 ± 162.8 |
| Rufous-sided Towhee | 0.4 ± 0.16 | 0.38 ± 0.315 | 1.54 ± 0.81 | 0.025± 0.06 | | | 833.3 ± 502.3 |
| Chipping Sparrow | 0.75 ± 0.25 | | | | | | 739.7 ± 246.6 |
| Brewer's Sparrow | | | 0.05 ± 0.12 | | | | 10.6 ± 25.4 |
| Vesper Sparrow | 0.19 ± 0.45 | 0.013 ± 0.03 | 0.013 ± 0.03 | 0.48 ± 0.62 | 0.15 ± 0.297 | | 1,305.9 ± 1,992.0 |
| Lark Sparrow | 0.24 ± 0.45 | | | 0.15 ± 0.24 | 0.05 ± 0.08 | | 587.7 ± 1,005.4 |
| Savannah Sparrow | | 0.013 ± 0.03 | | | 0.013 ± 0.03 | | 14.5 ± 33.5 |
| Grasshopper Sparrow | | | | 0.013 ± 0.03 | 0.013 ± 0.03 | | 38.7 ± 89.3 |
| Song Sparrow | | 0.40 ± 0.40 | | | 0.013 ± 0.03 | | 78.2 ± 94.9 |
| Lincoln's Sparrow | | 0.088 ± 0.146 | 0.025 ± 0.06 | | | | 19.8 ± 36.7 |
| White-crowned Sparrow | | | 0.013 ± 0.03 | | | | 2.7 ± 6.3 |
| Dark-eyed Junco | 0.13 ± 0.16 | | | | | | 128.2 ± 157.8 |
| Bobolink | | | | | 0.125 ± 0.239 | | 119.3 ± 228.1 |
| Red-winged Blackbird | | 1.65 ± 1.973 | 0.088 ± 0.178 | 0.013 ± 0.03 | 2.55 ± 2.83 | | 2,750.7 ± 3,124.5 |
| Western Meadowlark | 0.038 ± 0.044 | 0.05 ± 0.09 | 0.213 ± 0.189 | 1.34 ± 0.26 | 0.83 ± 0.356 | | 3,592.3 ± 960.7 |
| Yellow-headed Blackbird | | | | | | | 35 |
| Brewer's Blackbird | | 0.063 ± 0.101 | 0.05 ± 0.12 | 0.013 ± 0.03 | 0.225 ± 0.347 | | 262.1 ± 433.9 |
| Common Grackle | | 0.64 ± 0.666 | | | 0.15 ± 0.231 | | 248.6 ± 330.1 |
| Brown-headed Cowbird | 0.24 ± 0.32 | 0.41 ± 0.25 | 0.29 ± 0.32 | | 0.038 ± 0.063 | | 401.8 ± 484.6 |
| Northern Oriole | | 0.14 ± 0.197 | | | | | 23.0 ± 32.4 |
| Pine Grosbeak | 0.013 ± 0.03 | | | | | | 12.8 ± 29.6 |
| House Finch | 0.013 ± 0.03 | 0.025 ± 0.039 | | | | | 16.9 ± 36.0 |
| Red Crossbill | 0.53 ± 0.35 | | | | | | 522.7 ± 345.2 |
| Pine Siskin | 0.30 ± 0.34 | | | | | | 295.9 ± 335.3 |
| Lesser Goldfinch | 0.125 ± 0.27 | 0.038 ± 0.063 | | | | | 129.5 ± 236.7 |
| American Goldfinch | | 0.39 ± 0.366 | 0.013 ± 0.03 | | 0.013 ± 0.03 | | 79.3 ± 95.1 |

Table 9. Continued.

| SPECIES | MEAN HABITAT DENSITY (n/ha ± 90% CI) C[a] | R[a] | MS[a] | G[a] | AG[a] | L&P[b] | POPULATION[c] |
|---|---|---|---|---|---|---|---|
| Evening Grosbeak[d] Combined Unidentified Species | 0.063 ± 0.063 | 0.063 ± 0.063 | 0.075 ± 0.099 | | 0.013 ± 0.03 | | 100.8 ± 122.0 |

a Estimates based on 8, 2 ha plots per habitat type 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 on 4,366.98 ha (10,786.65 acres) occupied by the 6 major habitat types and wetland (a subset of riparian habitat) 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 A female nested in the cliff on the Ertl property and produced 8 chicks.

f No pairs nested on Open Space in 1985.

Table 10. Student-Newman-Keuls test results for 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; at $\alpha = 0.05$) or not significantly different (NS).

BREEDING SPECIES RICHNESS

| | R | C | MS | G | AG |
|---|---|---|---|---|---|
| R | | S | S | S | S |
| C | | | NS | S | S |
| MS | | | | S | S |
| G | | | | | S |
| AG | | | | | |

BREEDING SPECIES DENSITY

| | R | C | MS | S | AG |
|---|---|---|---|---|---|
| R | | S | S | S | S |
| C | | | NS | S | NS |
| MS | | | | S | NS |
| G | | | | | S |
| AG | | | | | |

Density of breeding birds also differed between ($F = 8.45$, $P < 0.0005$) and within ($F = 7.81$, $P < 0.0005$) major habitat types (Appendix A, p. A8). SNK test results indicate breeding densities in conifer habitat did not differ from those in agricultural grassland or mountain shrub habitats and that densities in mountain shrub and agricultural grassland habitats were similar (Table 10). Density comparisons between all other habitat type combinations differed significantly (Table 10). Breeding density was highest in riparian habitats (20.7 birds/plot) followed by conifer (13.05), mountain shrub (13.0), agricultural grassland (11.55) and grassland (4.9) habitats (Appendix A. p. A 10).

The statistical similarities between 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 were located in mountain shrub habitat on the Ertl property. Data obtained from these were compared with that from six other mountain shrub plots in Open Space. ANOVA results indicate a borderline result ($F = 1.97$, $0.10 < P < 0.05$) which we conservatively interpret as no significant difference in breeding species richness between the eight mountain shrub plots on Open Space (Appendix A, p. A11). LSD test results ($LSD = 2.037$ $\alpha = 0.05$ ) yield a similar conclusion (Appendix A, p. A12). The two Ertl plots do not differ from each other ($P < 0.05$); MS4, the West Ertl plot, does not differ from any other plot ($P < 0.05$), and MS2, the East Ertl plot, differs ($P \leq 0.05$) only from MS1, the Shadow Canyon plot, which had the highest richness value ($7.8 \pm 0.37$ species/plot) for mountain shrub plots. The mean richness value for the eight mountain shrub plots was $6.13 \pm 0.25$ species/plot; the values for the East and West Ertl plots were $4.8 \pm 1.16$ and $6.0 \pm 0.71$ species/plot, respectively.

Breeding species density differed between the eight mountain shrub plots ($F = 2.90$, $P < 0.025$). ANOVA results and plot statistics are in Appendix A (p. A14). LSD test results (Appendix A, p. A15) indicate the East and West Ertl plots do not differ from each other ($P < 0.05$); however, both differ ($P \leq 0.05$) from the South McCann plot (MS8) which had the highest mountain shrub plot density (18.8 $\pm$ 1.59 birds/plot). Plot MS6 located in Shadow Canyon's alluvial fan, also differed from MS8. Both Ertl plots (MS2 = 9.6 $\pm$ 1.94, MS4 = 12.2 $\pm$ 2.46) were slightly below the mean mountain shrub plot density (13.0 $\pm$0.71).

Two riparian bird plots located in the Cottonwood Grove permitted a comparison with other riparian plots in the system. ANOVA results and plot statistics are in Appendix A(p. A16). Species richness of breeding birds differed among riparian plots ($F=4.41$, $P < 0.0025$). Mean richness for all riparian plots was 8.9 $\pm$ 0.43 species/plot; values for the North (R2) and South (R4) Cottonwood Grove plots were slightly lower (R2 = 8.2 $\pm$ 0.58, R4 = 7.0 $\pm$ 0.55). The Cottonwood Grove plots did not differ from each other, however, both plots differed from plots R3 and R8 (Appendix A, p. A17).

Breeding species density differed among riparian plots ($F = 8.96$, $P < 0.0005$, Appendix A, p. A18). Densities for the North (18.2 $\pm$ 1.39 birds/plot) and South (20.2 $\pm$2.52 birds/plot) Cottonwood Grove plots were similar to the mean riparian value (20.78 $\pm$ 1.52 birds/plot). The Cottonwood Grove plots did not differ from each other, however, both plots were significantly (LSD = 7.931 $\alpha = 0.05$) higher than plot R7, and lower than plots R3, R5, and R8 (Appendix A, p. A19).

In summation, avian use of the two mountain shrub plots on the Ertl parcel and the two riparian plots in the Cottonwood Grove are slightly below the mean values for their respective habitats. Although the bird plots and conclusions drawn about the relative quality of the Cottonwood Grove are representative of that parcel, the mountain shrub habitat was 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 similar species composition to shrub stands in foothills situations. 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 nesting habitat provided in the cliff face in close proximity to Boulder Creek (Starlings, Rock Doves, Rock Wrens, Kestrels, Great Horned Owls, Barn Owls, and Common Mergansers nested in the Ertl cliff in 1984), 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.

Tests between irrigated (I) and nonirrigated agricultural grassland plots indicate that species richness is similar, but higher on irrigated plots and that bird density on irrigated plots is several times greater than on nonirrigated plots (Table 11, Appendix A, p. A20-A23).

Breeding species richness differed between the eight agricultural grassland plots ($F=3.63$, $P<0.01$). The plots supporting the three highest species richness values (P1,P8, and P6) were all irrigated. However, with the exception of plots P1 (I, S=6.4) vs. P2(S=3.0), P1 (I) vs. P3 (S=3.0), and P2 vs. P8 (I, S=6.2) (Table 11), differences between irrigated and nonirrigated plots were not significant (Appendix A, p. 21).

Difference between irrigated and nonirrigated plots were even more clear cut in terms of breeding species density (Table 11). Density differed between the eight agricultural grassland plots ($F=16.86$, $P<0.0005$)(Appendix A, p. A22). The three plots supporting the highest species richness values also had, by far, the greatest density values (Appendix A, p. A23). These plots, P6, P1, and P8 had a combined mean of 20.2 birds/plot (S=4.47) compared to 6.36 birds/plot (S=1.31) for the five other agricultural grassland plots (including irrigated P5).

In both species richness and density, P5(I) appears more similar to nonirrigated plots. 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,

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

SPECIES RICHNESS

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

[a] Irrigated plot.

and 8 was 11.8, 17.8, and 7.8 birds/plot, respectively, compared to 1.2 birds/plot for P5, and 0.85 birds/plot for the four nonirrigated plots combined (see Table 8). Without Red-winged Blackbird density values in plots 1, 6, and 8, the total plot densities would be 7.0, 7.4, and 8.8 birds/plot, respectively, values slightly higher, but similar to the mean of 6.36 birds/plot for the other five 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 associated with more mesic situations. 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

Twenty-two transients, representing seven species, were observed during plot counts. Four of the seven species (Ash-throated Flycatcher, Swainson's Thrush, Hermit Thrush, and Scarlet Tanager) are not considered breeders on Open Space, although the Thrushes may breed in higher elevation conifer habitat in the Boulder Mountain Parks. Because transients represented only 0.87% of all birds observed during plot counts, results of tests for total species (breeders and transients) are identical to those of breeders (Table 12). Raw data and statistical results for total species are in Appendix A (p. A24-A35).

## WATERFOWL AND SHOREBIRDS

Survey results of Open Space lakes and ponds are listed in Tables 13 and 14 in order of decreasing productivity. The most productive wetland was Cowdrey Reservoir No. 2. Four species were observed with young and at least 72 different chicks were observed. Two clutches of Mallards and one of Ruddy Duck were observed. It was not possible to determine the number of clutches for the Pied-billed Grebe and American Coot since the young mix freely and could not be associated with

Table 12. Student-Newman-Keuls test results for total bird (breeders and transients) 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; at $\alpha = 0.05$) or not significantly different (NS).

TOTAL SPECIES RICHNESS

| | R | C | MS | G | AG |
|---|---|---|---|---|---|
| R | | S | S | S | S |
| C | | | NS | S | S |
| MS | | | | S | S |
| G | | | | | S |
| AG | | | | | |

TOTAL SPECIES DENSITY

| | R | C | MS | G | AG |
|---|---|---|---|---|---|
| R | | S | S | S | S |
| C | | | NS | S | NS |
| MS | | | | S | NS |
| G | | | | | S |
| AG | | | | | |

Table 13. Waterfowl and shorebirds observed on surveys of Boulder Open Space ponds and lakes, 1984.

| SPECIES | | SURVEY DATE 25 June | 2 July | 6 July | 9 July | 11 July |
|---|---|---|---|---|---|---|
| Cowdrey Reservoir No. 2 | | | | | | |
| Pied-billed Grebe | adults | 4 | 8 | 9 | 9 | 8 |
| | chicks | 4 | 13 | 10 | 7 | 5 |
| Great Blue Heron | | | | | | 1 |
| Mallard | adults | 3 | 12 | 9 | 11 | 11 |
| | males | 1 | 9 | 4 | 7 | 3 |
| | females | 2 | 3 | 5 | 4 | 8 |
| | chicks | 9(1)[a] | 9(1) | 9(1) | 18(2) | 11(2) |
| Blue-winged Teal | adults | 2 | 3 | 2 | 3 | 6 |
| | males | 1 | 2 | | | |
| | females | 1 | 1 | | | |
| Cinnamon Teal | adults | 4 | 2 | 4 | 2 | |
| | males | 2 | 1 | 2 | | |
| | females | 2 | 1 | 2 | | |
| Unid. Teal | | | | | 7 | 8 |
| Gadwall | | | 1 | | | |
| Ruddy Duck | adults | 2 | | | 3 | 3 |
| | males | 2 | | | 3 | 3 |
| | females | | | | 2 | 2 |
| | chicks | | | | | 6(1) |
| American Coot | adults | 25 | 34 | 29 | 35 | 33 |
| | chicks | 14 | 16 | 33 | 44 | 24 |
| Killdeer | | 2 | 4 | 2 | | 2 |
| Totals | | 69 | 102 | 108 | 139 | 118 |
| Wonderland Lake | | | | | | |
| Canada Goose[b] | | 44 | 43 | 43 | 43 | 42 |
| Mallard | adults | | 1 | | 1 | 1 |
| | chicks | | 7(1) | | 7(1) | 7(1) |
| Killdeer | | 4 | 12 | 3 | 6 | 1 |
| Spotted Sandpiper | | | 1 | | | |
| Totals | | 48 | 64 | 46 | 57 | 51 |

Table 13. Continued

| SPECIES | | SURVEY DATE 25 June | 2 July | 6 July | 9 July | 11 July |
|---|---|---|---|---|---|---|
| Teller Lake | | | | | | |
| Pied-billed Grebe | adults | 3 | 3 | 4 | 2 | 2 |
| | chicks | 2 | 2 | | 5 | 3 |
| Double-crested Cormorant | | 1 | | | | |
| Great Blue Heron | | 1 | | 1 | 1 | 2 |
| Black-crowned Night-Heron | | | | 1 | | |
| Canada Goose | adults | | 20 | 4 | 8 | 6 |
| | chicks | | 14 | | 5 | 11 |
| Mallard | adults | 3 | | | | |
| | chicks | 9(1) | | | | |
| Blue-winged Teal | | 2 | 3 | | | 1 |
| Gadwall | | | | 2 | | |
| American Coot | adults | 3 | 3 | 3 | 4 | 4 |
| | chicks | | | | 3 | 2 |
| Greater Yellowlegs | | | | 1 | | |
| Common Snipe | | | 1 | | | |
| Totals | | 24 | 46 | 16 | 28 | 31 |
| Short-Milne | | | | | | |
| Great Blue Heron | | | 2 | 1 | | 3 |
| Black-crowned Night-Heron | | 2[c] | | | | 2 |
| Canada Goose | adults | 2 | 10 | 6 | 50 | |
| | chicks | 3 | | 17 | | |
| Mallard | | | | | 1 | 1 |
| Sora | | | | 1 | | |
| Killdeer | | 3 | 1 | 4 | 2 | 4 |
| Spotted Sandpiper | | | | 3 | 1 | 1 |
| Belted Kingfisher | | | | 5 | 2 | 3 |
| Totals | | 10 | 13 | 37 | 56 | 14 |

Table 13. Continued

| SPECIES | | SURVEY DATE 25 June | 2 July | 6 July | 9 July | 11 July |
|---|---|---|---|---|---|---|
| Flatirons Vista Reservoir | | | | | | |
| Great Blue Heron | | | | 1 | | |
| Mallard | adults | 2 | 3 | | 6 | 4[d] |
| | males | 1 | 2 | | 2 | |
| | females | 1 | 1 | | | |
| | chicks | | | | | 8 |
| Totals | | 4 | 6 | 1 | 8 | 12 |
| Marshall Lake | | | | | | |
| Great Blue Heron | | 1 | | | | |
| Mallard | | | | | | 1[e] |
| Killdeer | | 3 | | 1 | 1 | |
| Gull (prob. Ring-billed) | | | 1 | | | 59 |
| Totals | | 4 | 1 | 1 | 1 | 60 |
| Ranger Pond | | | | | | |
| Black-crowned Night-Heron | | 1 | | | | |
| Mallard | adults | 1 | | | 1 | 1 |
| Killdeer | | | 1 | 3 | 2 | |
| Spotted Sandpiper | | | | 2 | | |
| Totals | | 2 | 1 | 5 | 4 | 2 |
| Boulder Valley Ranch Reservoir | | | | | | |
| Great Blue Heron | | | | 1 | | |
| American Bittern | | | 1+ | 1+ | | |
| Mallard | | | 1 | | 1 | |
| Gadwall | | | | | | 1 |
| Killdeer | | 2 | 3 | 3 | 1 | 1 |
| Common Snipe | | | | | 2 | |
| Totals | | 2 | 5 | 5 | 4 | 2 |

Table 13. Continued

| SPECIES | SURVEY DATE 25 June | 2 July | 6 July | 9 July | 11 July |
|---|---|---|---|---|---|
| Hogan Pond | | | | | |
| Mallard[f] | 10 | 2 | 6 | | 13 |
| Blue-winged Teal | | 1 | 1 | 1 | 1 |
| Killdeer | | 2 | 1 | 3 | 2 |
| Totals | 10 | 5 | 8 | 4 | 16 |
| Church Pond | | | | | |
| Black-crowned Night-Heron | 1 | | | | |

[a] Number in parentheses is the number of broods observed.

[b] On 19 May, 17 adult and 27 young Canada Geese were observed on Wonderland Lake

[c] First survey on Short-Milne property was made on 27 June.

[d] No Mallards seen on 11 July, observations made on 15 July.

[e] Mallard duck flushed from a nest containing seven eggs.

[f] Some of these may have been domestic birds.

Table 14. Maximum observed waterbird productivity on Boulder Open Space ponds and lakes, 1984.

| WATER BODY<br>SPECIES | MAXIMUM PRODUCTIVITY |
|---|---|
| Cowdrey Reservoir No. 2[a] | |
| Pied-billed Grebe | 13 |
| Mallard | |
| Ruddy Duck | 6 |
| American Coot | 35 |
| Total | 72 |
| Wonderland Lake | |
| Canada Goose | 27 |
| Mallard | 7 |
| Total | 34 |
| Teller Lake | |
| Pied-billed Grebe | 5 |
| Canada Goose | 14 |
| Mallard | 9 |
| American Coot | 3 |
| Total | 31 |
| Short-Milne | |
| Canada Goose | 17 |
| Flatirons Vista Reservoir | |
| Mallard | 8 |
| Marshall Lake | |
| Mallard | 7 |
| Ranger Pond | |
| Mallard | 1 |

[a] Count made on entire reservoir, not just on Open Space part (see Plate 1).

specific adults. The Pied-billed Grebe young probably represented a minimum of four clutches. In addition there were still 2 Grebes on nests at the end of the survey period, thus a minimum of six pairs probably nested. The American Coot young probably represent a minimum of ten clutches. Two Coots were still incubating at the end of the study period and thus a minimum of 12 pairs of American Coots is estimated to have bred.

Cowdrey Reservoir No. 2 is at least twice as productive as any of the other wetlands surveyed (Table 14). The reservoir is isolated from human activity and almost completely surrounded with marsh vegetation, with a well developed cattail marsh on its east end. Because of its value to wildlife, Cowdrey Reservoir No. 2 should be seriously considered for incorporation into the Open Space System.

Teller Lake had at least one pair each of Pied-billed Grebe, Mallard, and American Coot breeding on it. The young Canada Geese observed represent about four pairs of adults. The geese may have bred on Teller Lake or on one of four private ponds to the south.

Only 17 young Canadian Geese were observed on the ponds to the south of the Short-Milne property, however, we observed several pairs of Canada Geese along Boulder Creek on the Short-Milne property during breeding-bird surveys. In addition we observed Mallards and Blue-winged Teal along the creek acting as if their nests were nearby. We estimate that up to a dozen pair of Canada Geese and a few pair each of Mallard and Blue-winged Teal bred on the Short-Milne property adjacent to Boulder Creek.

On 19 May, 17 adult and 27 young Canada Geese were found on Wonderland Lake. This indicates about six breeding pair used the lake. By the beginning of the waterfowl surveys the young could not be separated from the adults. The three goose nesting platforms located around the west end of the lake were not used in 1984. The platforms appear accessible to raccoon (Procyon lotor) predation.

At least one and possible two pair of Mallards bred on Flatirons Vista Reservoir and one pair each were found on Marshall Lake and Ranger Pond.

A female Common Merganser with 7 chicks was observed on Boulder Creek adjacent in the Kaufman Parcel on 25 May. A female Common Merganser was observed on and around the White Rocks cliff on the Ertl property during the breeding bird and raptor surveys of 16, 27, and 29 May. She acted as if she were nesting nearby, probably in a hole in the cliff face. This cliff is over 1 km downstream of where the 25 May observation was made indicating two pair of Common Mergansers nested. Common Mergansers usually nest in tree cavities, however, in areas where these are lacking, they may nest in cliffs or on the ground (Bellrose 1980). We have found no other evidence that Common Mergansers nest in Boulder County. The nearest breeding record is from Granby Lake.

American Bitterns were heard moving about and giving warning calls in the cat-tail marsh at the north end of Boulder Valley Ranch Reservoir. They probably were nesting. The species commonly nests at Sawhill Ponds.

The Great Blue Herons and Black-crowned Night-Herons observed were foraging in the wetlands where they were observed. These birds forage widely during the breeding season and were probably from the heron colony on 95th Street. The Double-crested Cormorant seen on Teller Lake on 25 June may have been a late migrant or from the breeding colony at Panama Reservoir.

Pied-billed Grebes, American Coots, Killdeer, Spotted Sandpiper, Common Snipe and Belted Kingfishers nest throughout the county in suitable habitat. Other species of shorebirds are commonly found during migration.

We observed young waterfowl of five species, on Open space lakes and ponds. Pied-billed Grebe, Canada Goose, Mallard, Ruddy Duck, and American Coot (Table 14). The Mallard was the most widespread species with young found on six of the seven wetlands. The Canada Goose was the second most widespread species with young found on three of the wetlands. However, since the Canada Goose breeds quite early and the young were grown and dispersed by the beginning of this study the observed productivity is probably underestimated. The Pied-billed Grebe and American Coot were both found on two wetlands while the Ruddy Duck was found only on Cowdrey Reservoir No. 2.

## RAPTORS

We found evidence that 15 pairs of five species (Red-tailed Hawk, American Kestrel, Common Barn Owl, Great Horned Owl, and Burrowing Owl) nested on City of Boulder Open Space and evidence that 12 pairs of six species (Red-tailed Hawk, Golden Eagle, Prairie Falcon, Common Barn Owl, Great Horned Owl, and Long-eared Owl) nested near Open Space for a total of 27 pairs of eight species nesting on or near Open Space in 1984 (Table 15). At least five other species (Turkey Vulture, Northern Harrier, Sharp-shinned Hawk, Cooper's Hawk, and Eastern Screech Owl) are suspected to nest on or near Open Space.

The most common nesting species are the American Kestrel with six known and four suspected nests and the Great Horned Owl with six known nests. Four Red-tailed Hawk nests were found with three more nests observed or suspected on or near Open Space.

Red-tailed Hawks and Great Horned Owls nested in large trees, Golden Eagles and Prairie Falcons nested on cliff faces, American Kestrels and Common Barn Owl nested in holes in trees or cliffs, Burrowing Owls nested in prairie dog towns, and Long-eared Owls nested in heavy vegetation. The habitat feature common to all of these species 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 15. Breeding raptors on City of Boulder Open Space, 1984.

| Species | Breeding Observations |
|---|---|
| Turkey Vulture[a] | Suspected to nest. |
| Northern Harrier[a] | Nested on Mountain Parks land near Boulder Reservoir in 1983. |
| 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 and on the McCann parcels. Two pairs 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 three pairs nested in the foothils near Open Space. |
| American Kestrel | At least ten 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 Mountain Parks adjacent to Open Space. |
| Common Barn Owl | One nest in White Rocks and another near the Minnitrista parcel. |
| Eastern Screech Owl | May have nested on or near Burke 2 and Kaufman parcels. A pair raised three young in north Boulder. |
| Great Horned Owl | Nested on Boulder Valley Ranch; near Cottonwood Grove; and on the East Rudd, McKensie, and THP parcels. One nest at Sawhill Ponds. |
| Burrowing Owl | Two pairs nested on Boulder Valley Ranch. |
| Long-eared Owl | Nested near White Rocks and in Skunk Canyon. |
| Other Owls[a] | Flammulated, Northern Pygmy-, and Northern Saw-whet Owls may nest, but there are no confirmed records. |

[a] No evidence of nesting on or near City of Boulder Open Space in 1984.

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

Northern Harrier

Henderson (1909) reported the Northern Harrier as a common summer resident of the plains and mountains in Boulder County. On the other hand, 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 reports sightings thoughout the year, most often during migration and winter and 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 two young with both parents on 25 August.

We saw one bird flying over White Rocks during a breeding bird survey. It appears that the species has decreased markedly since 1937 and now seldom breeds in Boulder county.

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 two sightings of the species, both on the southwestern part of City of Boulder Open Space (Fig. 3). There is abundant habitat for the species in the foothills. Since the species is quite secretive we suspect it is more common than reports indicate.

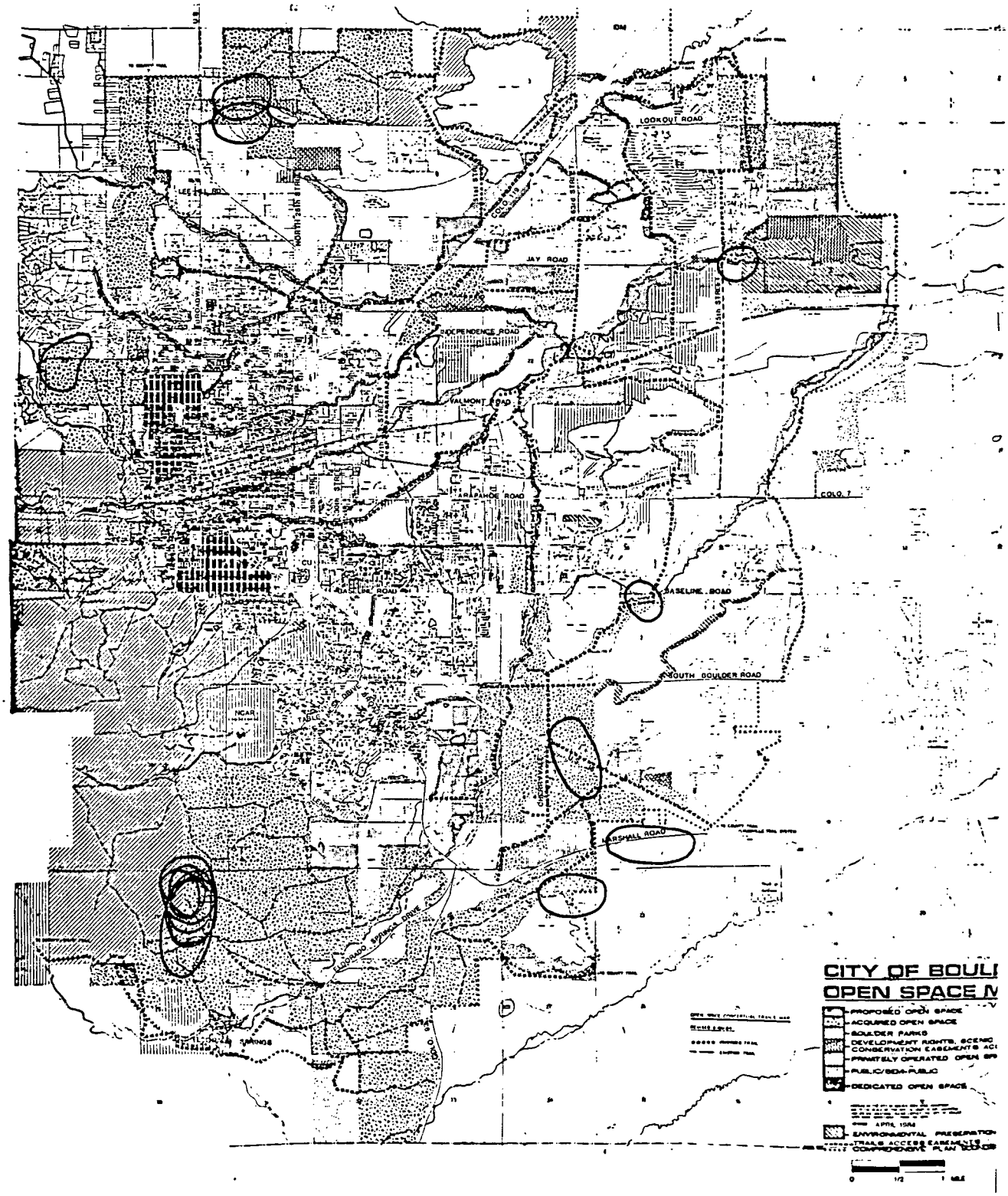


Figure 2. Locations of Turkey Vulture observations made during study (n=15).

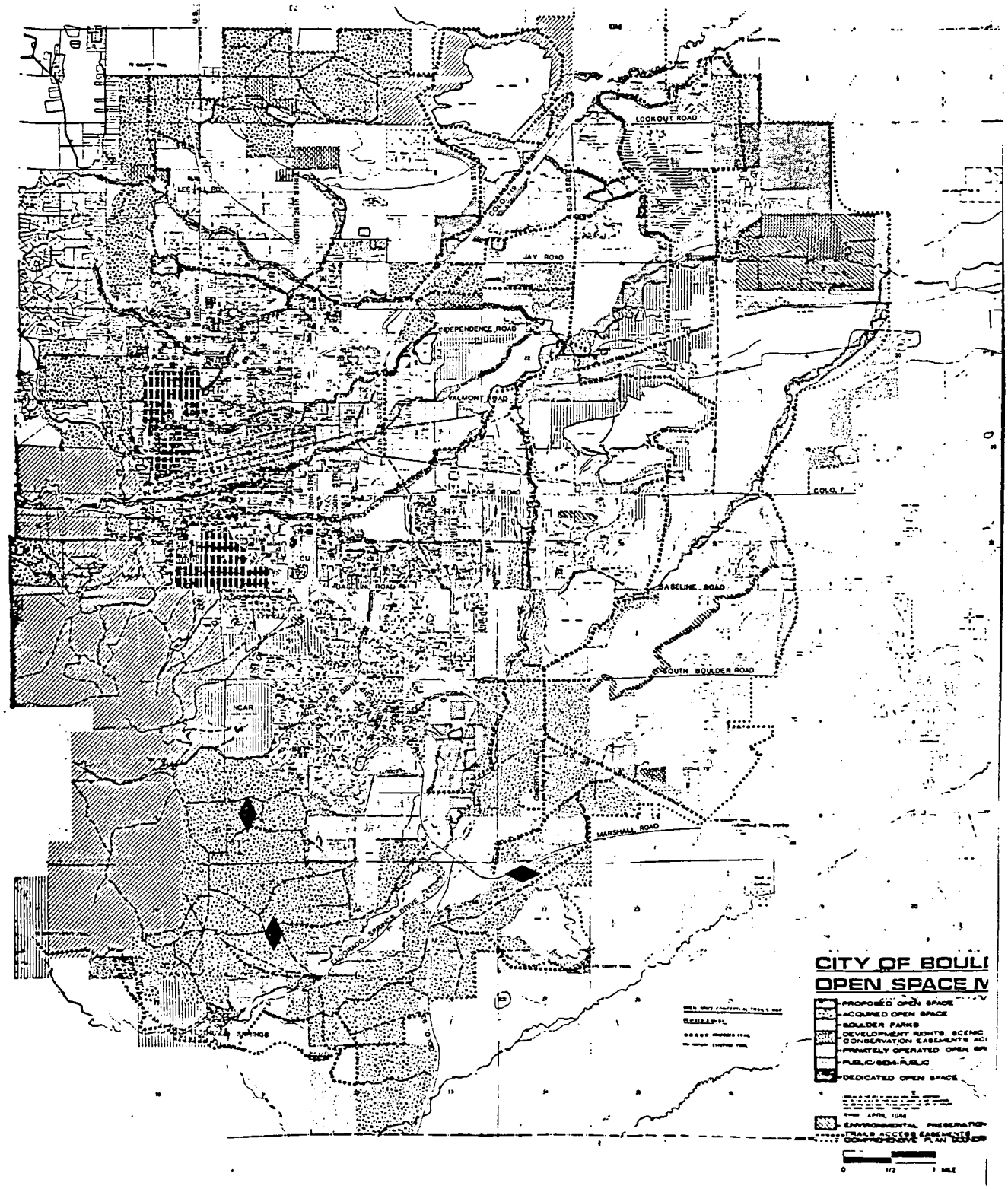


Figure 3. Sites of Sharp-shinned (♦,n=2) and Cooper's Hawk (◆,n=1) observations made during study.

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.

BASWI records show the species is reported in low numbers throughout the year with somewhat greater numbers during migration.

We had one sighting of a Cooper's Hawk just north of Marshall Mesa (Fig. 3). 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 three sightings of Swainson's Hawks, all presumably migrants.

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.

We had 61 sightings of this species during our field work (Fig. 4). We observed two active nests of this species on City of Boulder Open Space and one adjacent to Open Space. On 5 June we found a Red-tailed Hawk nest with one chick in a cottonwood tree along Farmer's Ditch on Boulder Valley Ranch. This chick and the

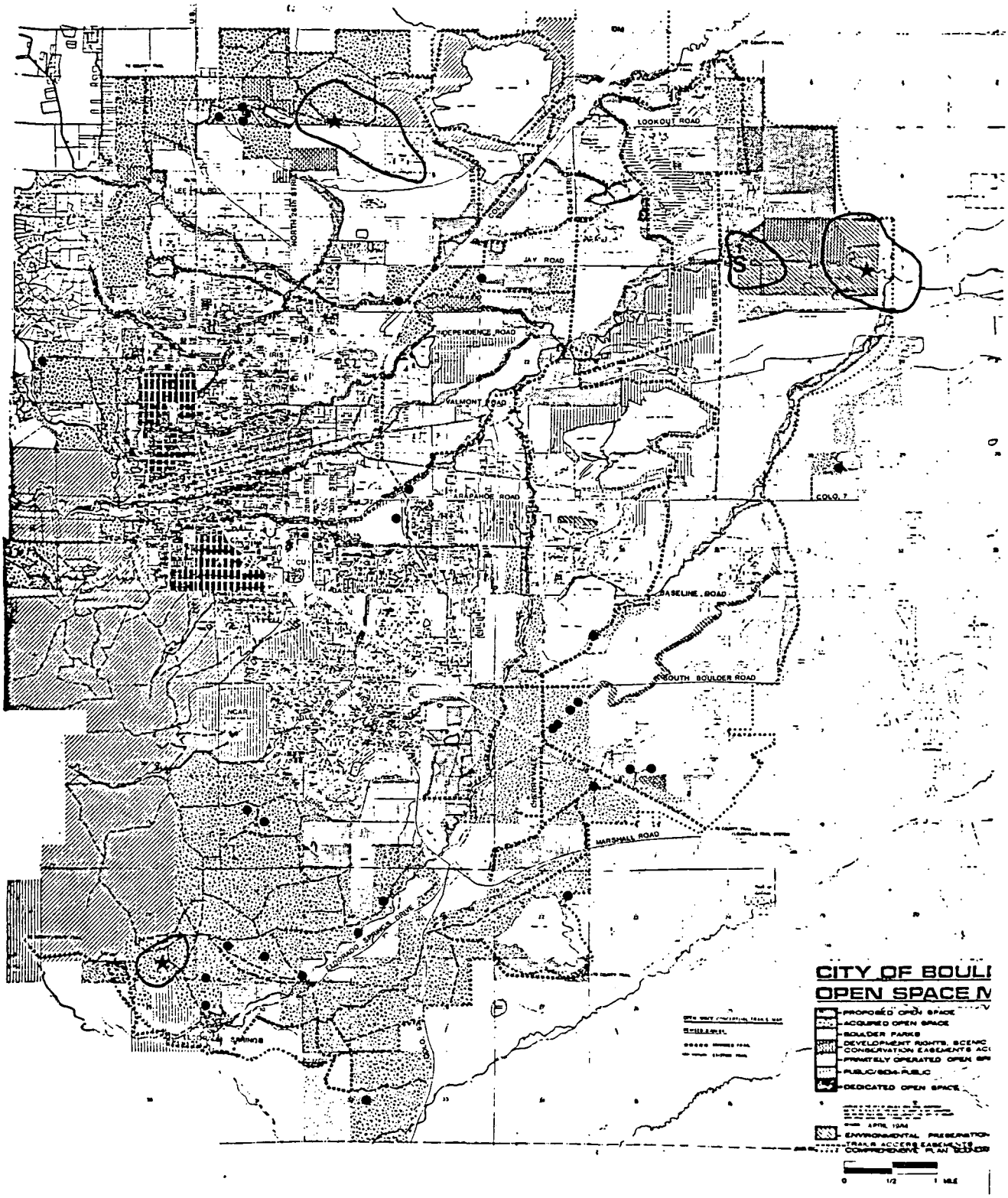


Figure 4. Locations of 1984 Red-tailed Hawk nests (★) and observations ( • ,n=61). Observation area around nests (circle) is area is which the nesting pair was observed.

parent birds were observed several times over the following weeks and the chick had fledged by 2 July. We last saw the young bird with both parents on 19 July. This nest was used in 1982 and 1983 (Steve Jones pers. comm.). On 26 June Mike Figgs, Center for Mountain Bird Ecology, showed us an active Red-tailed Hawk nest just south of the Matron Rock on the McCann Parcel. Two young were seen on the nest. On 3 July we found a flying immature bird near the nest site. A pair of Red-tails nested near this site in 1982 and 1983 (Mike Figgs pers. comm.).

We had several sightings of a pair of Red-tailed Hawks on or near the Kaufmann parcel during breeding bird surveys. The birds acted as if a nest were nearby, but we were unable to find it. Martha Weiser (pers. comm.) saw birds repeatedly at what she thought was a nest on the Kaufmann parcel. On 29 May we found an active Red-tailed Hawk nest on land owned by the Ertl family just south of Boulder Creek, about 0.5 mi east of White Rocks. We were unable to determine the number of chicks in the nest, but on 24 July we saw two immature Red-tailed Hawks at White Rocks which we assume came from this nest. Another pair of Red-tails nested on the Weiser property west of White Rocks (Martha Weiser pers. comm.).

It is suspected that a pair of Red-tailed Hawks nested along Dowdy Draw, but we found no nest. We observed an adult in the area on 28 May and saw an immature bird on Flatirons Vista on 29 June that might have come from the suspected nest. We found what appeared to be an inactive Red-tailed Hawk nest along South Boulder Creek west of the Open Space Ranger Station. We also saw Red-tails several times on the VanVleet Ranch and suspect that an undetected nest was in the area.

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 two active nests in the foothills near Boulder, in 1978.

The BASWI reports moderate to low numbers of sightings of this species throughout the year. The number of sightings appear to be highest during spring and fall migration. We had three Golden Eagle sightings during this study (Fig. 5).

Mike Figgs and Nancy Lederer, Center for Mountain Bird Ecology, have been monitoring the status of Golden Eagle nests in the Boulder area and have provided a summary of their recent observations (Appendix B). There are four nesting sites or groups of nesting sites that have been used in recent years. The histories of these sites are given in Appendix B. One nest site (GE-1e) is on City of Boulder Open Space and may have been used in 1978. Sites GE-2 and GE-3 are on Boulder Mountain Park land. Site GE-4 is to the north near the mouth of Left Hand Canyon. At least 3 young were fledged from these nests in 1984.

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 79 sightings of this species on City of Boulder Open Space during this study (Fig. 6). We found six active nests and four probable nests scattered throughout Open Space (Fig 6). 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.

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 nine sightings of the species between 1978 and 1984.

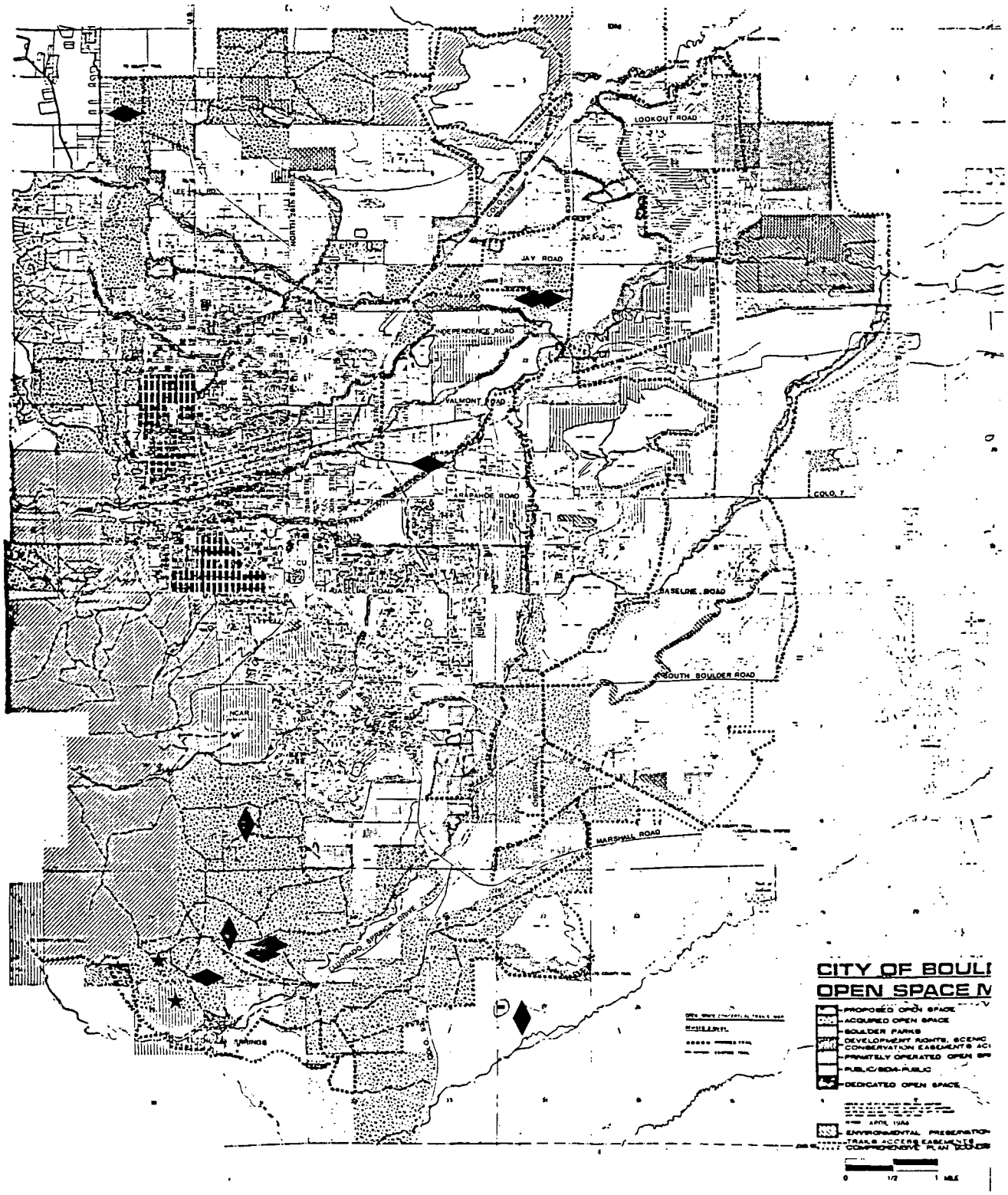


Figure 5. Locations of inactive Golden Eagle nests (★) and 1984 observations (n=3, ◆) and 1984 Prairie Falcon observations (n=7, ◆).

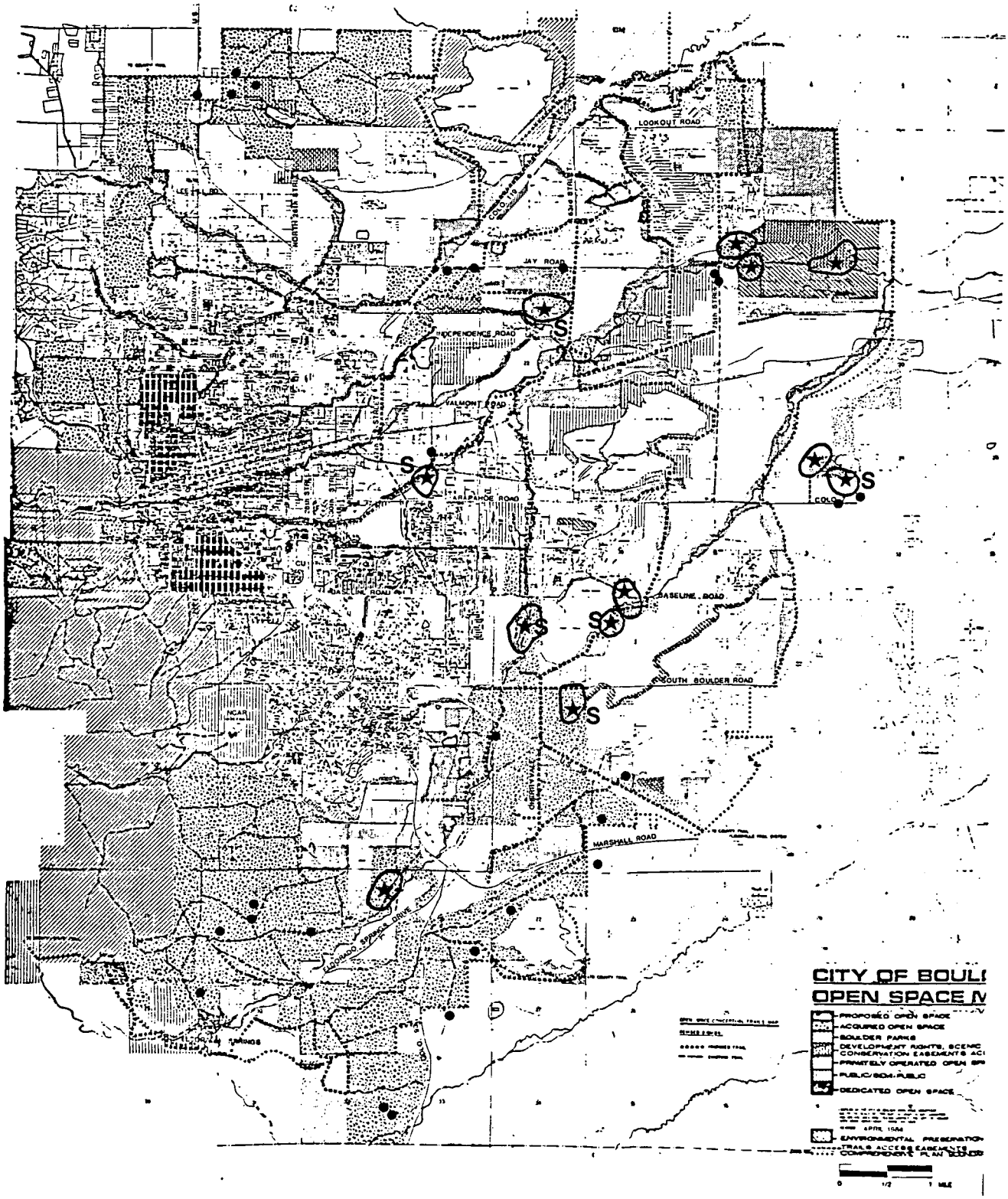


Figure 6. Locations of American Kestrel nests (★), suspected nests (★S), and observations ( ● ,n=79).

French (1951) reported a nest with four 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.

The Center for Mountain Bird Ecology has been monitoring this species in the Boulder area and reports five active nests sites in 1984 (see Appendix B). None of these nests are on City of Boulder Open Space, but four of them are located immediately adjacent to it in the Mountain Parks and the birds use Open Space for foraging. One of these sites is the one found by French (1951). At least seven young were produced from these nests in 1984.

We had seven sightings of Prairie Falcons during this study (Fig. 5). Some of these were near the known nest sites. The species was seen three times hunting over the prairie dog town on the Andrus Parcel, south of Jay Road. Another bird was seen on Boulder Creek near and over the Cottonwood Grove.

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. We found evidence of target shooting in the prairie dog town, which should be controlled to prevent disturbance to or destruction of the birds using the area.

Common Barn Owl

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

Breeding at White Rocks was first suspected in 1941 (Jollie 1945) and seven 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. comm.). Barn Owls were found nesting in 1983 and 1984 along Boulder and Whiterock Ditch, just east of the Minitrista Parcel (Tod Decelli pers. comm.)(Fig. 7). 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 on 15 July and on 24 July saw two adults and at least one young bird there (Fig. 7). A large pile of fresh Barn Owl pellets was found under the nest hole. 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.

We had four sightings of Eastern Screech-Owls on City of Boulder Open Space during this study (Fig. 8). Three birds were found by Steve Jones on 9 July in cottonwoods at the north end of the Burke 2parcel. We found one bird in the Kaufmann Parcel. We also observed a pair with three flying young in the 800-block of Juniper Street. Screech Owls have been seen regularly in that neighborhood for at least the last two 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.)

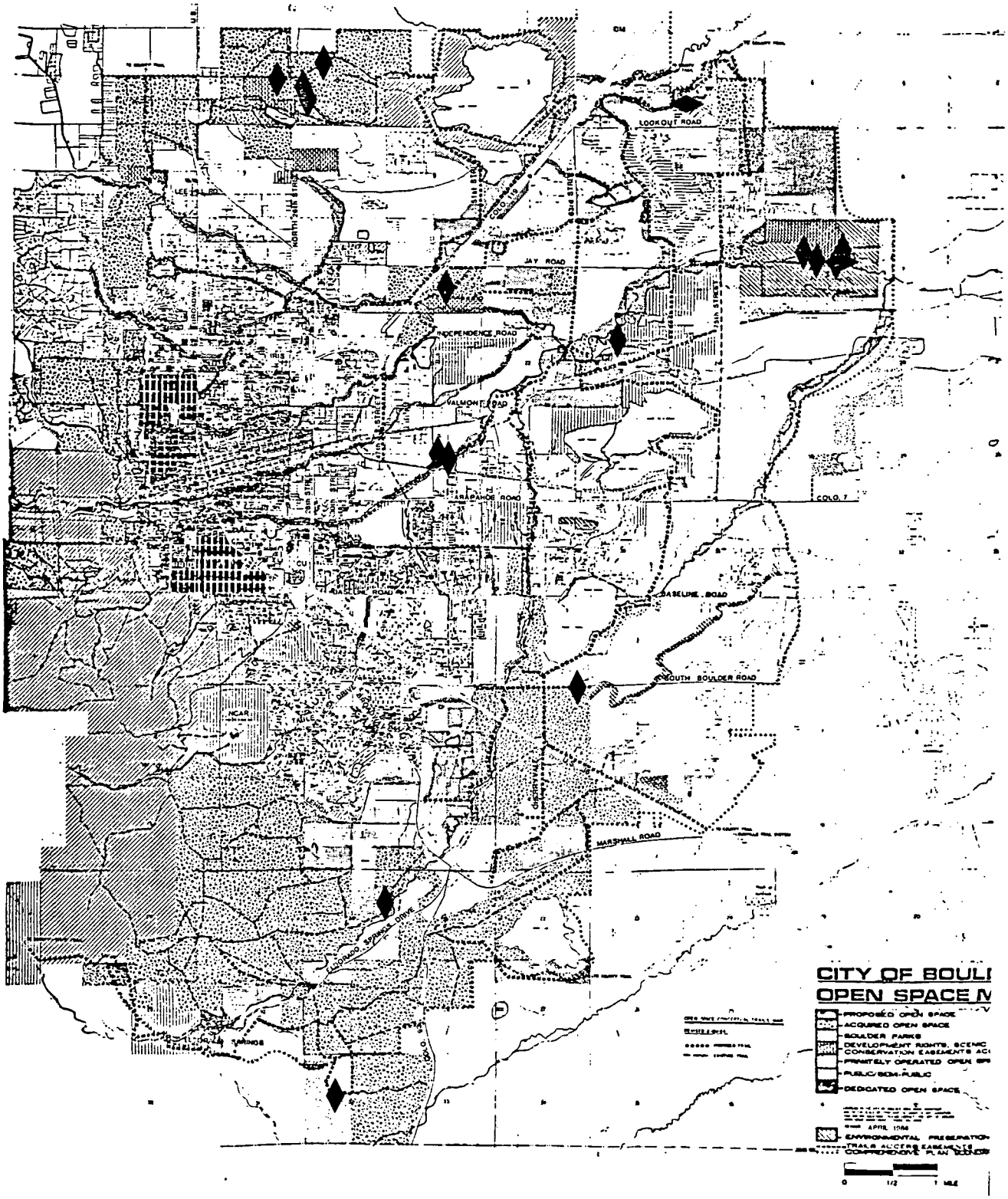


Figure 7. Locations of 1984 Barn Owl nests (◆,n=2) and Great Horned Owl observations (◆,n=27).

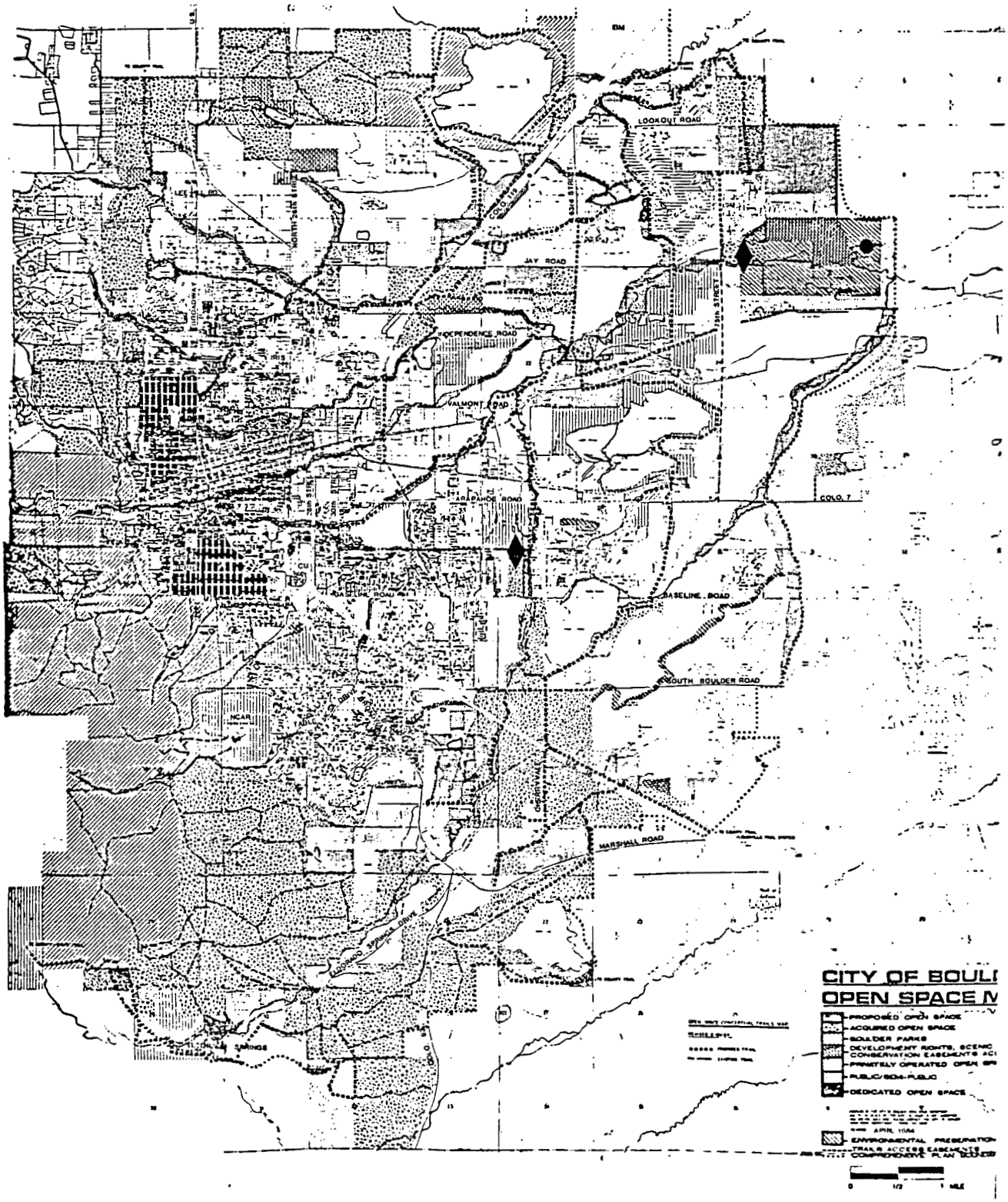


Figure 8. Locations of Eastern Screech Owl (♦,n=4) and Long-eared Owl (●,n=8) observations.

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 had 27 sightings of Great Horned Owls during this study (Fig. 7). We found nests or recently fledged young at Boulder Valley Ranch (along Farmer's Ditch), on the western end of the East Rudd Parcel, adjacent to Cottonwood Grove, at White Rocks, on the McKensie Parcel, and along South Boulder Creek on the western THP Parcel. We found a total of 10 to 12 young birds. A nest at Sawhill Ponds produced one young (Steve Jones pers. comm.).

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 all the 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.

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 three 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 Base Line 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. comm. ). In 1983 a pair raised five young on Boulder Parks land just north of Boulder Reservoir (Steve Jones pers. comm.). 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. comm.).

We searched through the 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 (Figs. 9 and 10). Two pair nested and were monitored by Steve Jones, Deb Amerman, and us through July. Each nest produced four young, but predators appeared to have killed two owlets from the western nest between 10 and 14 July; two were still present on 19 July.

Zarn (1974) reports 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 before the beginning of this study (Fig. 8). A bird was still present on 29 May, but we could not find a nest. On 29 June we found three fledged young and one adult at the site. By 24 July the birds were no longer present. Another pair of Long-eared Owls with five young was found in Skunk Canyon by Steve Jones. An immature bird was seen at Sawhill Ponds on 28 June by Steve Jones.

Other Owls

Flammulated Owls, Northern Pygmy-Owls, and Northern Saw-whet Owls are residents of Boulder County (Henderson 1909, Betts 1913, Alexander 1937) but they are seldom recorded and their status in unknown. The Boreal Owl is also known from the County (BASWI). These species are small, secretive, and difficult to find

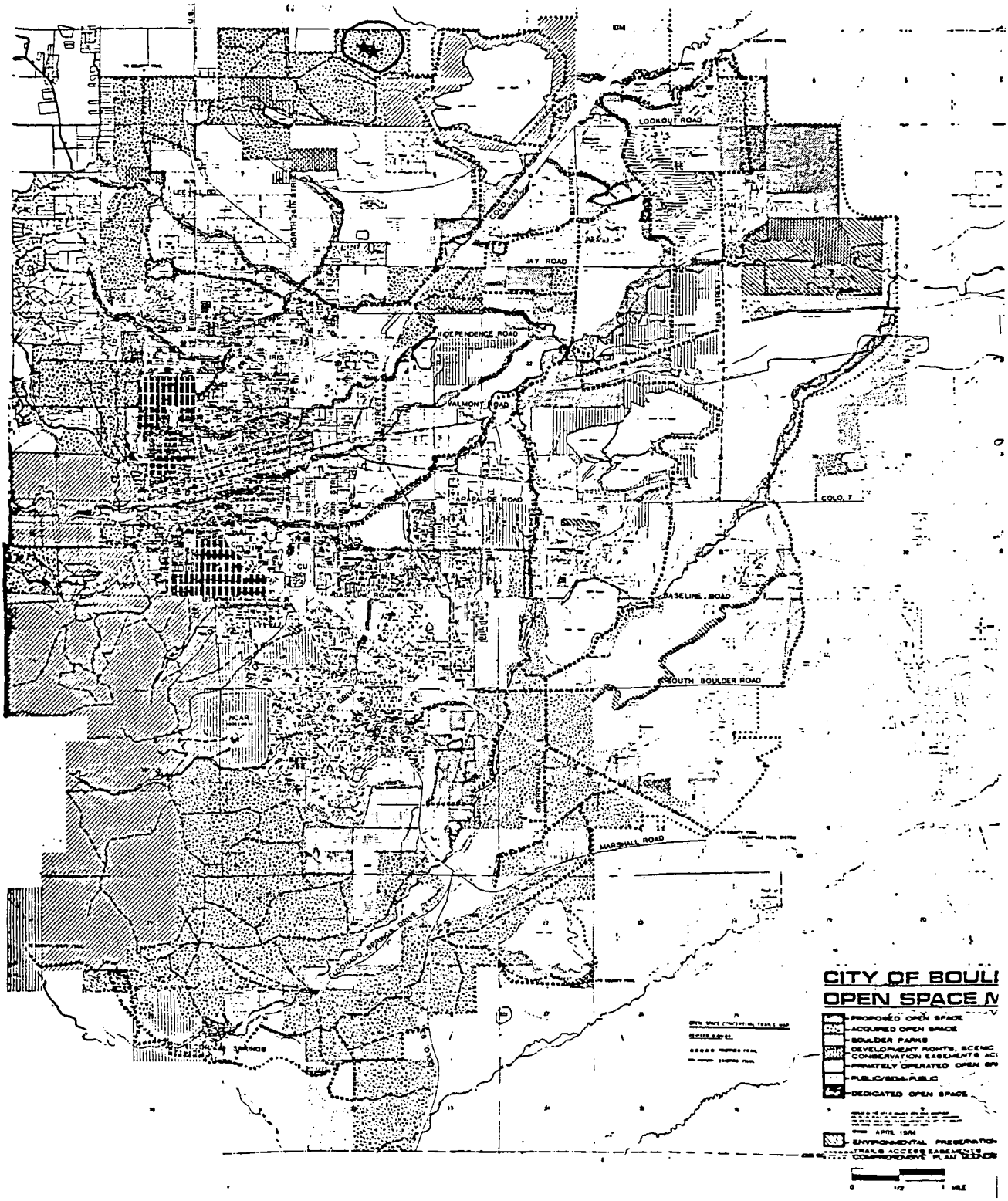


Figure 9. Location of Burrowing Owl nest burrows (★) and observation area (circled, n=48).

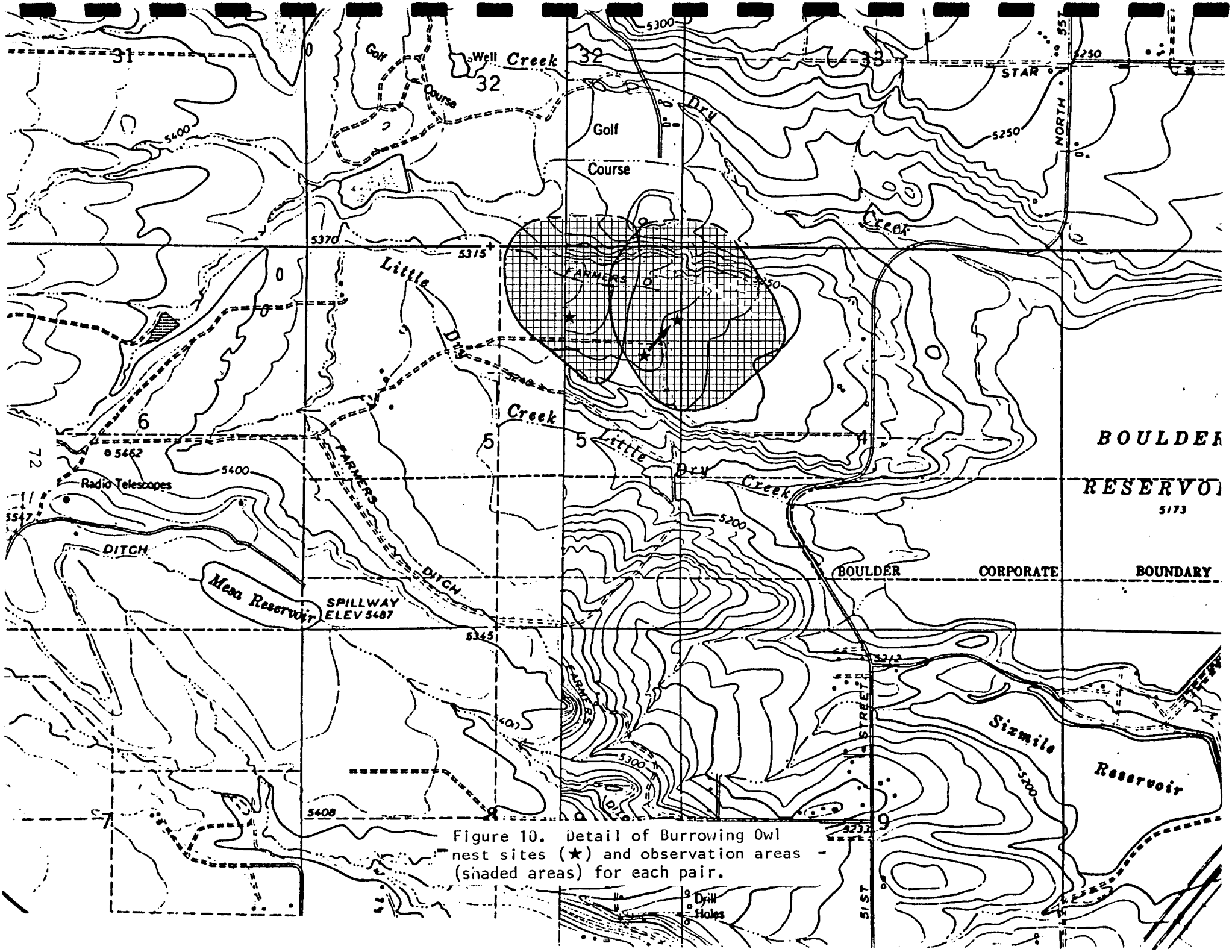


Figure 10. Detail of Burrowing Owl nest sites (★) and observation areas (shaded areas) for each pair.

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. We saw a Northern Pygmy Owl in the drainage just south of Fern Canyon, high on Shanahan Ridge in March before the study's inception.

## 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 seven 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 by well-meaning citizens from part of 11 plots. We found the remains of two fires, assorted beverage containers, and discarded fishing tackle and its packaging along the shore of Marshall Lake. Pieces of clay pigeons were found on one of the Yunker plots, indicating that someone had been trap shooting on Open Space.

Dogs were seen several times on four 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 three 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 and Grasshopper Sparrows), the effects of human activity on most breeding species are 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 interactions. Nests are generally inconspicuous and inaccessible to humans. However, human disturbance is of special management concern for uncommon species nesting in only one or two fields. For these species, if management goals are to maintain their local numbers, any disturbance is too much.

In this study we examined three groups of birds: raptors, waterfowl and shorebirds, and other birds. Raptors are the group most likely disturbed by human activity. These birds are of high public interest, they and their nests are large and often obvious, and they occur in relatively low numbers. Disturbances can range from nest desertion early in incubation to nestlings leaving nests prematurely and damaging growing feathers and breaking bones (Fyfe and Olendorff 1976).

Breeding waterfowl are generally tolerant of human activity, particularly Canada Geese. Waterbodies producing most of the waterfowl in the Boulder Area (e.g., Valmont Lakes, Sawhill/Walden Ponds, Cowdrey Reservoir, Teller Lake, Wonderland Lake) have low to high levels of human disturbance.

Management recommendations for these groups and for individual species are discussed below.

## 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.

Whether the Bobolink has always occurred in the western states in small numbers or whether it moved westward with the white man is uncertain. In any case, it occurs in the West in small scattered populations usually associated with irrigation. We found the species on two Open Space parcels, Burke 2 and Church. We found both sexes on the Burke 2 Parcel and are certain that they were breeding there. According to local birdwatchers, Bobolinks have been found in this field for several years. The eastern populations were drastically reduced early in the century because of market hunting, extermination at rice fields, and because of changes in hay-cutting practices (Bent 1958). Bobolinks require tall grass for nesting and are attracted to hayfields. Young do not leave the nest until July and haying earlier than mid- to late July is fatal to them.

We recommend that haying be delayed in the Burke 2 Parcel until mid- to late July to ensure fledging of Bobolink young. Flusher bars should be required on mowing machines to reduce mortality to Bobolinks and waterfowl that nest on Burke 2. We also recommend that the distribution, nesting density, and fledging dates of Bobolinks on Open Space, be further studied.

The distribution of the western race of the Grasshopper Sparrow is spotty (Bent 1968). They prefer prairie grasses for nesting and do not appear locally until the grass is tall enough to conceal them. Eggs are found in Colorado in July and August (Bailey and Niedrach 1965). Grasshopper Sparrows tend to breed in small colonies and local populations fluctuate considerably from year to year in spite of the apparent availability of suitable habitat. This phenomenon is observed even in the east where the species is more abundant. The reasons for it are unknown.

We suspect that Grasshopper Sparrows are more common and regular in the Boulder area than generally believed and that they are often missed by birdwatchers because they appear much later than most breeding species and nest in areas of low interest. We found Grasshopper Sparrows in several areas scattered throughout Open Space, but they were most abundant on Marshall Mesa. We recommend that a more intensive search be made to determine the distribution of this species on Open Space, and that grazing be controlled on favored areas to ensure that the tall grass required for breeding is available each year.

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.

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% of the 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 five or six 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 five 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.

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 two-and-a-half 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 Parcel in spite of 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 breeding season. Maintaining water in the reservoir would add an important waterbird habitat to Open Space and we recommend this be done.

## Long-range Management

The composition and size of the breeding-bird populations determined during this study are representative for the 1984 breeding season. However, since bird populations may fluctuate widely from year to year long-range management plans can best be designed when estimates of normal limits of such fluctuations are known. We recommend that surveys identical to those made during the "wet" 1984 breeding season be repeated for two more years to obtain an estimate of natural fluctuations. A similar set of surveys should then be repeated in about ten years to assess the effects of management programs and changes in habitat composition.

City of Boulder Open Space is only part of the publically owned land in Boulder County. Management policies on Boulder Mountain Parks and Boulder County Open

Space could strongly affect the results of management plans on City of Boulder Open space. We recommend that city and county personnel responsible for the management of natural habitat develop policies to coordinate their management plans. To do this the type of baseline data being gathered on City of Boulder Open Space must also be gathered on the other areas.

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APPENDIX A. Raw data and statistical test results.

Raw data printout for species richness of breeding birds sampled in riparian (R), conifer (C), and mountain shrub (M), habitats on City of Boulder Open Space, Spring, 1984. Raw breeding species richness data for grassland and agricultural grassland habitats are identical for total species richness data and are listed on that printout.

RAW DATA PRINTOUT. Date: 09/26/84

| TR1 | BR2 | BR3 | BR4 | BR5 | BR6 | TR7 | BR8 |
|---|---|---|---|---|---|---|---|
| 5.00 | 9.00 | 15.00 | 7.00 | 6.00 | 6.00 | 5.00 | 14.00 |
| 9.00 | 7.00 | 11.00 | 8.00 | 11.00 | 11.00 | 6.00 | 11.00 |
| 5.00 | 8.00 | 13.00 | 8.00 | 9.00 | 12.00 | 8.00 | 11.00 |
| 9.00 | 10.00 | 13.00 | 7.00 | 8.00 | 10.00 | 9.00 | 9.00 |
| 11.00 | 7.00 | 8.00 | 5.00 | 9.00 | 6.00 | 6.00 | 14.00 |

File names:

| | | |
|---|---|---|
| 1 | TR1 | S |
| 2 | BR2 | S |
| 3 | BR3 | S |
| 4 | BR4 | S |
| 5 | BR5 | S |
| 6 | BR6 | S |
| 7 | TR7 | S |
| 8 | BR8 | S |

RAW DATA PRINTOUT. Date: 09/26/84

| TC1 | TC2 | BC3 | TC4 | TC5 | TC6 | TC7 | TC8 |
|---|---|---|---|---|---|---|---|
| 6.00 | 8.00 | 4.00 | 4.00 | 5.00 | 8.00 | 7.00 | 5.00 |
| 6.00 | 7.00 | 10.00 | 6.00 | 4.00 | 7.00 | 7.00 | 6.00 |
| 7.00 | 6.00 | 7.00 | 5.00 | 5.00 | 8.00 | 7.00 | 8.00 |
| 8.00 | 8.00 | 8.00 | 6.00 | 4.00 | 10.00 | 5.00 | 8.00 |
| 7.00 | 10.00 | 10.00 | 4.00 | 6.00 | 10.00 | 6.00 | 12.00 |

File names:

| | | |
|---|---|---|
| 1 | TC1 | S |
| 2 | TC2 | S |
| 3 | BC3 | S |
| 4 | TC4 | S |
| 5 | TC5 | S |
| 6 | TC6 | S |
| 7 | TC7 | S |
| 8 | TC8 | S |

RAW DATA PRINTOUT. Date: 09/26/84

| TM1 | BM2 | TM3 | TM4 | TM5 | TM6 | TM7 | TM8 |
|---|---|---|---|---|---|---|---|
| 7.00 | 2.00 | 7.00 | 5.00 | 5.00 | 6.00 | 4.00 | 6.00 |
| 9.00 | 7.00 | 7.00 | 7.00 | 5.00 | 6.00 | 6.00 | 7.00 |
| 8.00 | 4.00 | 8.00 | 4.00 | 8.00 | 7.00 | 6.00 | 8.00 |
| 8.00 | 8.00 | 5.00 | 6.00 | 5.00 | 3.00 | 6.00 | 7.00 |
| 7.00 | 3.00 | 7.00 | 8.00 | 6.00 | 6.00 | 6.00 | 5.00 |

File names:

| | |
|---|---|
| 1 | TM1 S |
| 2 | BM2 S |
| 3 | TM3 S |
| 4 | TM4 S |
| 5 | TM5 S |
| 6 | TM6 S |
| 7 | TM7 S |
| 8 | TM8 S |

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

09/26/84

2-level NESTED ANOVA  Program NANOVA2

BREEDING SPECIES -- RICHNESS (S).

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| GROUPS | 995.150 | 4 | 248.788 | 25.53 | 59.3% |
| SUBGPS | 341.125 | 35 | 9.746 | 3.63 | 14.0% |
| ERROR | 429.600 | 160 | 2.685 | | 26.7% |
| TOTAL | 1,765.875 | 199 | | | |

Transformation code = 0

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) and in plots (subgroups 1-8) within habitats.

GROUP BREAKDOWNS:

| | | | |
|---|---|---|---|
| Group No. 1: | Mean+/-SE(n) = | 8.90 +/- 0000.43(40) | CVM = 4.8% |
| Group No. 2: | Mean+/-SE(n) = | 6.88 +/- 0000.31(40) | CVM = 4.5% |
| Group No. 3: | Mean+/-SE(n) = | 6.13 +/- 0000.25(40) | CVM = 4.1% |
| Group No. 4: | Mean+/-SE(n) = | 2.33 +/- 0000.23(40) | CVM = 10.0% |
| Group No. 5: | Mean+/-SE(n) = | 4.40 +/- 0000.31(40) | CVM = 7.1% |

SUBGROUP BREAKDOWNS:

| | | | |
|---|---|---|---|
| TR1.S | Mean+/-SE(n) = | 7.80 +/- 0001.20(05) | CVM = 15.4% |
| BR2.S | Mean+/-SE(n) = | 8.20 +/- 0000.58(05) | CVM = 7.1% |
| BR3.S | Mean+/-SE(n) = | 12.00 +/- 0001.18(05) | CVM = 9.9% |
| BR4.S | Mean+/-SE(n) = | 7.00 +/- 0000.55(05) | CVM = 7.8% |
| BR5.S | Mean+/-SE(n) = | 8.60 +/- 0000.81(05) | CVM = 9.4% |
| BR6.S | Mean+/-SE(n) = | 9.00 +/- 0001.26(05) | CVM = 14.1% |
| TR7.S | Mean+/-SE(n) = | 6.80 +/- 0000.73(05) | CVM = 10.8% |
| BR8.S | Mean+/-SE(n) = | 11.80 +/- 0000.97(05) | CVM = 8.2% |
| TC1.S | Mean+/-SE(n) = | 6.80 +/- 0000.37(05) | CVM = 5.5% |
| TC2.S | Mean+/-SE(n) = | 7.80 +/- 0000.66(05) | CVM = 8.5% |
| BC3.S | Mean+/-SE(n) = | 7.80 +/- 0001.11(05) | CVM = 14.3% |
| TC4.S | Mean+/-SE(n) = | 5.00 +/- 0000.45(05) | CVM = 8.9% |
| TC5.S | Mean+/-SE(n) = | 4.80 +/- 0000.37(05) | CVM = 7.8% |
| TC6.S | Mean+/-SE(n) = | 8.60 +/- 0000.60(05) | CVM = 7.0% |
| TC7.S | Mean+/-SE(n) = | 6.40 +/- 0000.40(05) | CVM = 6.3% |
| TC8.S | Mean+/-SE(n) = | 7.80 +/- 0001.20(05) | CVM = 15.4% |
| TM1.S | Mean+/-SE(n) = | 7.80 +/- 0000.37(05) | CVM = 4.8% |
| BM2.S | Mean+/-SE(n) = | 4.80 +/- 0001.16(05) | CVM = 24.1% |
| TM3.S | Mean+/-SE(n) = | 6.80 +/- 0000.49(05) | CVM = 7.2% |
| TM4.S | Mean+/-SE(n) = | 6.00 +/- 0000.71(05) | CVM = 11.8% |
| TM5.S | Mean+/-SE(n) = | 5.80 +/- 0000.58(05) | CVM = 10.1% |
| TM6.S | Mean+/-SE(n) = | 5.60 +/- 0000.68(05) | CVM = 12.1% |
| TM7.S | Mean+/-SE(n) = | 5.60 +/- 0000.40(05) | CVM = 7.1% |
| TM8.S | Mean+/-SE(n) = | 6.60 +/- 0000.51(05) | CVM = 7.7% |
| TG1.S | Mean+/-SE(n) = | 4.00 +/- 0000.89(05) | CVM = 22.4% |
| TG2.S | Mean+/-SE(n) = | 2.00 +/- 0000.55(05) | CVM = 27.4% |
| TG3.S | Mean+/-SE(n) = | 1.60 +/- 0000.24(05) | CVM = 15.3% |
| TG4.S | Mean+/-SE(n) = | 1.60 +/- 0000.40(05) | CVM = 25.0% |
| TG5.S | Mean+/-SE(n) = | 3.80 +/- 0000.86(05) | CVM = 22.6% |
| TG6.S | Mean+/-SE(n) = | 2.40 +/- 0000.40(05) | CVM = 16.7% |
| TG7.S | Mean+/-SE(n) = | 1.40 +/- 0000.24(05) | CVM = 17.5% |
| TG8.S | Mean+/-SE(n) = | 1.80 +/- 0000.37(05) | CVM = 20.8% |
| TP1.S | Mean+/-SE(n) = | 6.40 +/- 0000.68(05) | CVM = 10.6% |
| TP2.S | Mean+/-SE(n) = | 3.00 +/- 0001.05(05) | CVM = 35.0% |
| TP3.S | Mean+/-SE(n) = | 3.00 +/- 0000.63(05) | CVM = 21.1% |
| TP4.S | Mean+/-SE(n) = | 4.00 +/- 0000.63(05) | CVM = 15.8% |
| TP5.S | Mean+/-SE(n) = | 3.60 +/- 0000.68(05) | CVM = 18.8% |
| TP6.S | Mean+/-SE(n) = | 5.40 +/- 0000.68(05) | CVM = 12.6% |
| TP7.S | Mean+/-SE(n) = | 3.60 +/- 0000.51(05) | CVM = 14.2% |
| TP8.S | Mean+/-SE(n) = | 6.20 +/- 0000.86(05) | CVM = 13.9% |

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

09/26/84

SNK RESULTS

| | Ranked means: | Unranked means: |
|---|---|---|
| 1 | 2.325 | 8.9 |
| 2 | 4.4 6.875 | |
| 3 | 6.125 | 6.125 |
| 4 | 6.875 | 2.325 |
| 5 | 8.9 4.4 | |

5 vs 1 Q' = 13.32
5 vs 2 Q' = 9.12
5 vs 3 Q' = 5.62
5 vs 4 Q' = 4.1
4 vs 1 Q' = 9.22
4 vs 2 Q' = 5.01
4 vs 3 Q' = 1.52
3 vs 1 Q' = 7.7
3 vs 2 Q' = 3.49
2 vs 1 Q' = 4.2

DF = 35

From a table of Critical Q values:
The DF is the row; No. of MEANS is the column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

Raw data printout for density (n/2ha) of breeding birds sampled in riparian (R), conifer (C), and mountain shrub (M) habitats on City of Boulder Open Space, Spring, 1984. Raw density data for breeders in grassland and agricultural grassland habitats is identical to that for total species and are listed in that printout.

RAW DATA PRINTOUT. Date: 09/26/84

| TR1 | BR2 | BR3 | BR4 | BR5 | BR6 | TR7 | BR8 |
|---|---|---|---|---|---|---|---|
| 10.00 | 13.00 | 32.00 | 19.00 | 28.00 | 7.00 | 7.00 | 27.00 |
| 11.00 | 18.00 | 42.00 | 19.00 | 30.00 | 15.00 | 7.00 | 33.00 |
| 12.00 | 20.00 | 33.00 | 17.00 | 36.00 | 17.00 | 16.00 | 19.00 |
| 14.00 | 21.00 | 27.00 | 16.00 | 27.00 | 18.00 | 12.00 | 46.00 |
| 24.00 | 19.00 | 19.00 | 30.00 | 23.00 | 11.00 | 8.00 | 28.00 |

File names:

| | |
|---|---|
| 1 | TR1 D |
| 2 | BR2 D |
| 3 | BR3 D |
| 4 | BR4 D |
| 5 | BR5 D |
| 6 | BR6 D |
| 7 | TR7 D |
| 8 | BR8 D |

RAW DATA PRINTOUT. Date: 09/26/84

| TC1 | TC2 | BC3 | TC4 | TC5 | TC6 | TC7 | TC8 |
|---|---|---|---|---|---|---|---|
| 13.00 | 18.00 | 7.00 | 11.00 | 10.00 | 14.00 | 9.00 | 8.00 |
| 7.00 | 25.00 | 29.00 | 12.00 | 9.00 | 10.00 | 11.00 | 10.00 |
| 8.00 | 17.00 | 13.00 | 7.00 | 7.00 | 12.00 | 9.00 | 11.00 |
| 14.00 | 15.00 | 14.00 | 12.00 | 11.00 | 19.00 | 10.00 | 17.00 |
| 18.00 | 21.00 | 20.00 | 6.00 | 13.00 | 16.00 | 8.00 | 21.00 |

File names:

| | |
|---|---|
| 1 | TC1 D |
| 2 | TC2 D |
| 3 | BC3 D |
| 4 | TC4 D |
| 5 | TC5 D |
| 6 | TC6 D |
| 7 | TC7 D |
| 8 | TC8 D |

RAW DATA PRINTOUT. Date: 09/26/84

| TM1 | BM2 | TM3 | TM4 | TM5 | TM6 | TM7 | |
|---|---|---|---|---|---|---|---|
| 12.00 | 3.00 | 13.00 | 10.00 | 19.00 | 11.00 | 20.00 | 24. |
| 20.00 | 13.00 | 13.00 | 13.00 | 12.00 | 10.00 | 13.00 | 20. |
| 12.00 | 9.00 | 15.00 | 4.00 | 12.00 | 10.00 | 10.00 | 16. |
| 17.00 | 14.00 | 11.00 | 16.00 | 9.00 | 4.00 | 12.00 | 19. |
| 11.00 | 9.00 | 15.00 | 18.00 | 14.00 | 12.00 | 10.00 | 15. |

File names:

| | |
|---|---|
| 1 | TM1 D |
| 2 | BM2 D |
| 3 | TM3 D |
| 4 | TM4 D |
| 5 | TM5 D |
| 6 | TM6 D |
| 7 | TM7 D |
| 8 | TM8 D |

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

09/26/84

2-level NESTED ANOVA  Program NANOVA2

BREEDING SPECIES -- DENSITY (N/2HA).

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| GROUPS | 5,102.820 | 4 | 1,275.705 | 8.45 | 38.1% |
| SUBGPS | 5,284.775 | 35 | 150.994 | 7.81 | 35.7% |
| ERROR | 3,093.600 | 160 | 19.335 | | 26.2% |
| TOTAL | 13,481.195 | 199 | | | |

Transformation code = 0

Means, standard errors, and coefficients of variation of the mean for breeding species density (n/2ha) in habitats (group 1 = riparian = R; group 2 = conifer = C; group 3 = mountain shrub = m; group 4 = grassland = G; group 5 = agricultural grassland = P) and in plots (subgroups 1-8) within habitats.

GROUP BREAKDOWNS:

| | | | | |
|---|---|---|---|---|
| Group No. | 1: | Mean+/-SE(n) = | 20.78 +/- 0001.52(40) | CVM = 7.3% |
| Group No. | 2: | Mean+/-SE(n) = | 13.05 +/- 0000.83(40) | CVM = 6.4% |
| Group No. | 3: | Mean+/-SE(n) = | 13.00 +/- 0000.71(40) | CVM = 5.5% |
| Group No. | 4: | Mean+/-SE(n) = | 4.90 +/- 0000.47(40) | CVM = 9.5% |
| Group No. | 5: | Mean+/-SE(n) = | 11.55 +/- 0001.29(40) | CVM = 11.1% |

SUBGROUP BREAKDOWNS:

| | | | |
|---|---|---|---|
| TR1.D | Mean+/-SE(n) = | 14.20 +/- 0002.54(05) | CVM = 17.9% |
| BR2.D | Mean+/-SE(n) = | 18.20 +/- 0001.39(05) | CVM = 7.7% |
| BR3.D | Mean+/-SE(n) = | 30.60 +/- 0003.78(05) | CVM = 12.3% |
| BR4.D | Mean+/-SE(n) = | 20.20 +/- 0002.52(05) | CVM = 12.5% |
| BR5.D | Mean+/-SE(n) = | 28.80 +/- 0002.13(05) | CVM = 7.4% |
| BR6.D | Mean+/-SE(n) = | 13.60 +/- 0002.04(05) | CVM = 15.0% |
| TR7.D | Mean+/-SE(n) = | 10.00 +/- 0001.76(05) | CVM = 17.6% |
| BR8.D | Mean+/-SE(n) = | 30.60 +/- 0004.46(05) | CVM = 14.6% |
| TC1.D | Mean+/-SE(n) = | 12.00 +/- 0002.02(05) | CVM = 16.9% |
| TC2.D | Mean+/-SE(n) = | 19.20 +/- 0001.74(05) | CVM = 9.1% |
| BC3.D | Mean+/-SE(n) = | 16.60 +/- 0003.72(05) | CVM = 22.4% |
| TC4.D | Mean+/-SE(n) = | 9.60 +/- 0001.29(05) | CVM = 13.4% |
| TC5.D | Mean+/-SE(n) = | 10.00 +/- 0001.00(05) | CVM = 10.0% |
| TC6.D | Mean+/-SE(n) = | 14.20 +/- 0001.56(05) | CVM = 11.0% |
| TC7.D | Mean+/-SE(n) = | 9.40 +/- 0000.51(05) | CVM = 5.4% |
| TC8.D | Mean+/-SE(n) = | 13.40 +/- 0002.42(05) | CVM = 18.1% |
| TM1.D | Mean+/-SE(n) = | 14.40 +/- 0001.75(05) | CVM = 12.1% |
| BM2.D | Mean+/-SE(n) = | 9.60 +/- 0001.94(05) | CVM = 20.2% |
| TM3.D | Mean+/-SE(n) = | 13.40 +/- 0000.75(05) | CVM = 5.6% |
| TM4.D | Mean+/-SE(n) = | 12.20 +/- 0002.46(05) | CVM = 20.1% |
| TM5.D | Mean+/-SE(n) = | 13.20 +/- 0001.66(05) | CVM = 12.5% |
| TM6.D | Mean+/-SE(n) = | 9.40 +/- 0001.40(05) | CVM = 14.9% |
| TM7.D | Mean+/-SE(n) = | 13.00 +/- 0001.84(05) | CVM = 14.2% |
| TM8.D | Mean+/-SE(n) = | 18.80 +/- 0001.59(05) | CVM = 8.5% |
| TG1.D | Mean+/-SE(n) = | 6.80 +/- 0001.69(05) | CVM = 24.8% |
| TG2.D | Mean+/-SE(n) = | 3.00 +/- 0000.71(05) | CVM = 23.6% |
| TG3.D | Mean+/-SE(n) = | 4.40 +/- 0000.75(05) | CVM = 17.0% |
| TG4.D | Mean+/-SE(n) = | 2.80 +/- 0000.73(05) | CVM = 26.2% |
| TG5.D | Mean+/-SE(n) = | 6.80 +/- 0000.58(05) | CVM = 8.6% |
| TG6.D | Mean+/-SE(n) = | 7.00 +/- 0000.71(05) | CVM = 10.1% |
| TG7.D | Mean+/-SE(n) = | 2.40 +/- 0000.68(05) | CVM = 28.3% |
| TG8.D | Mean+/-SE(n) = | 6.00 +/- 0002.12(05) | CVM = 35.4% |
| TP1.D | Mean+/-SE(n) = | 18.80 +/- 0000.97(05) | CVM = 5.2% |
| TP2.D | Mean+/-SE(n) = | 4.40 +/- 0001.29(05) | CVM = 29.3% |
| TP3.D | Mean+/-SE(n) = | 5.80 +/- 0000.97(05) | CVM = 16.7% |
| TP4.D | Mean+/-SE(n) = | 7.00 +/- 0001.48(05) | CVM = 21.2% |
| TP5.D | Mean+/-SE(n) = | 6.80 +/- 0001.66(05) | CVM = 24.3% |
| TP6.D | Mean+/-SE(n) = | 25.20 +/- 0003.04(05) | CVM = 12.1% |
| TP7.D | Mean+/-SE(n) = | 7.80 +/- 0001.66(05) | CVM = 21.2% |
| TP8.D | Mean+/-SE(n) = | 16.60 +/- 0002.66(05) | CVM = 16.0% |

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

09/26/84

SNK RESULTS

| | Ranked means: | Unranked means: |
|---|---|---|
| 1 | 4.9 20.775 | |
| 2 | 11.55 | 13.05 |
| 3 | 13 13 | |
| 4 | 13.05 | 4.9 |
| 5 | 20.775 | 11.55 |

| | | | |
|---|---|---|---|
| 5 | vs 1 | Q' = | 8.17 |
| 5 | vs 2 | Q' = | 4.75 |
| 5 | vs 3 | Q' = | 4 |
| 5 | vs 4 | Q' = | 3.98 |
| 4 | vs 1 | Q' = | 4.19 |
| 4 | vs 2 | Q' = | .77 |
| 4 | vs 3 | Q' = | .03 |
| 3 | vs 1 | Q' = | 4.17 |
| 3 | vs 2 | Q' = | .75 |
| 2 | vs 1 | Q' = | 3.42 |

DF = 35

From a table of Critical Q values:
The DF is the row; No. of MEANS is the column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

One-Way analysis of variance results testing for differences in breeding species richness between two mountain shrub plots on the Ertl parcel (BM2.S and TM4.S) and the six other mountain shrub plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

09/26/84

1-WAY ANALYSIS OF VARIANCE Program ANOVA

BREEDING SPECIES -- RICHNESS; ERTL VS NONERTL, MT. SHRUB.

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| AMONG GROUPS | 29.58 | 7 | 4.23 | 1.97 | 16.2% |
| WITHIN GROUPS | 68.80 | 32 | 2.15 | | 83.8% |
| TOTAL | 98.38 | 39 | | | |

Transformation code = 0

| | | | |
|---|---|---|---|
| TM1.S | M+/-SE(n)= | 7.80 +/- 00000.37(05) | CVM = 4.8% |
| BM2.S | M+/-SE(n)= | 4.80 +/- 00001.16(05) | CVM = 24.1% |
| TM3.S | M+/-SE(n)= | 6.80 +/- 00000.49(05) | CVM = 7.2% |
| TM4.S | M+/-SE(n)= | 6.00 +/- 00000.71(05) | CVM = 11.8% |
| TM5.S | M+/-SE(n)= | 5.80 +/- 00000.58(05) | CVM = 10.1% |
| TM6.S | M+/-SE(n)= | 5.60 +/- 00000.68(05) | CVM = 12.1% |
| TM7.S | M+/-SE(n)= | 5.60 +/- 00000.40(05) | CVM = 7.1% |
| TM8.S | M+/-SE(n)= | 6.60 +/- 00000.51(05) | CVM = 7.7% |

Student - Newman - Keuls and least significant difference test results (LSD at $\alpha$ = 0.05 and $\alpha$ =0.01) for breeding species richness between two mountain shrub plots on the Ertl parcel (ranked means 1 and 5; unranked means file names BM2.S and TM4.S) and the six other mountain shrub plots on Open Space.

SNK RESULTS

| | Ranked means: | Unranked means: | File names: |
|---|---|---|---|
| 1 | 4.8000 | 7.8000 | TM1.S |
| 2 | 5.6000 | 4.8000 | BM2.S |
| 3 | 5.6000 | 6.8000 | TM3.S |
| 4 | 5.8000 | 6.0000 | TM4.S |
| 5 | 6.0000 | 5.8000 | TM5.S |
| 6 | 6.6000 | 5.6000 | TM6.S |
| 7 | 6.8000 | 5.6000 | TM7.S |
| 8 | 7.8000 | 6.6000 | TM8.S |

8 vs 1 Q' = 4.57
8 vs 2 Q' = 3.35
8 vs 3 Q' = 3.35
8 vs 4 Q' = 3.05
8 vs 5 Q' = 2.74
8 vs 6 Q' = 1.83
8 vs 7 Q' = 1.52
7 vs 1 Q' = 3.05
7 vs 2 Q' = 1.83
7 vs 3 Q' = 1.83
7 vs 4 Q' = 1.52
7 vs 5 Q' = 1.22
7 vs 6 Q' = .3
6 vs 1 Q' = 2.74
6 vs 2 Q' = 1.52
6 vs 3 Q' = 1.52
6 vs 4 Q' = 1.22
6 vs 5 Q' = .91
5 vs 1 Q' = 1.83
5 vs 2 Q' = .61
5 vs 3 Q' = .61
5 vs 4 Q' = .3
4 vs 1 Q' = 1.52
4 vs 2 Q' = .3
4 vs 3 Q' = .3
3 vs 1 Q' = 1.22
3 vs 2 Q' = 0
2 vs 1 Q' = 1.22

Error DF = 32

From a table of Critical Q values:
Error DF is the row; No. of MEANS is column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

LSD = 1.889 t-value = 2.037

LSD = 1.571 t-value = 1.694

One-way analysis of variance results testing for differences in breeding species density between two mountain shrub plots on the Ertl parcel (BM2.D and TM4.D) and the six other mountain shrub plots on Open Space. Means, standard errors, and coefficients of variation of the mean are provided below test results.

09/26/84

1-WAY ANALYSIS OF VARIANCE Program ANOVA

BREEDING SPECIES -- DENSITY (N/2HA); ERTL VS NONERTL, MT. SHRUB.

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| AMONG GROUPS | 304.80 | 7 | 43.54 | 2.90 | 27.5% |
| WITHIN GROUPS | 481.20 | 32 | 15.04 | | 72.5% |
| TOTAL | 786.00 | 39 | | | |

Transformation code = 0

| | | | |
|---|---|---|---|
| TM1.D | M+/-SE(n)= | 14.40 +/- 00001.75(05) | CVM = 12.1% |
| BM2.D | M+/-SE(n)= | 9.60 +/- 00001.94(05) | CVM = 20.2% |
| TM3.D | M+/-SE(n)= | 13.40 +/- 00000.75(05) | CVM = 5.6% |
| TM4.D | M+/-SE(n)= | 12.20 +/- 00002.46(05) | CVM = 20.1% |
| TM5.D | M+/-SE(n)= | 13.20 +/- 00001.66(05) | CVM = 12.5% |
| TM6.D | M+/-SE(n)= | 9.40 +/- 00001.40(05) | CVM = 14.9% |
| TM7.D | M+/-SE(n)= | 13.00 +/- 00001.84(05) | CVM = 14.2% |
| TM8.D | M+/-SE(n)= | 18.80 +/- 00001.59(05) | CVM = 8.5% |

Student - Newman - Keuls and least significant difference test results (LSD at $\alpha$ = 0.05 and $\alpha$ = 0.01) for breeding species density (n/2ha) between two mountain shrub plots on the Ertl parcel (ranked means 2 and 3; unranked means file names BM2.D and TM4.D) and the six other mountain shrub plots on Open Space.

SNK RESULTS

| | Ranked means: | Unranked means: | File names: |
|---|---|---|---|
| 1 | 9.4000 | 14.4000 | TM1.D |
| 2 | 9.6000 | 9.6000 | BM2.D |
| 3 | 12.2000 | 13.4000 | TM3.D |
| 4 | 13.0000 | 12.2000 | TM4.D |
| 5 | 13.2000 | 13.2000 | TM5.D |
| 6 | 13.4000 | 9.4000 | TM6.D |
| 7 | 14.4000 | 13.0000 | TM7.D |
| 8 | 18.8000 | 18.8000 | TM8.D |

| | | |
|---|---|---|
| 8 vs 1 | Q' = | 5.42 |
| 8 vs 2 | Q' = | 5.3 |
| 8 vs 3 | Q' = | 3.81 |
| 8 vs 4 | Q' = | 3.34 |
| 8 vs 5 | Q' = | 3.23 |
| 8 vs 6 | Q' = | 3.11 |
| 8 vs 7 | Q' = | 2.54 |
| 7 vs 1 | Q' = | 2.88 |
| 7 vs 2 | Q' = | 2.77 |
| 7 vs 3 | Q' = | 1.27 |
| 7 vs 4 | Q' = | .81 |
| 7 vs 5 | Q' = | .69 |
| 7 vs 6 | Q' = | .58 |
| 6 vs 1 | Q' = | 2.31 |
| 6 vs 2 | Q' = | 2.19 |
| 6 vs 3 | Q' = | .69 |
| 6 vs 4 | Q' = | .23 |
| 6 vs 5 | Q' = | .12 |
| 5 vs 1 | Q' = | 2.19 |
| 5 vs 2 | Q' = | 2.08 |
| 5 vs 3 | Q' = | .58 |
| 5 vs 4 | Q' = | .12 |
| 4 vs 1 | Q' = | 2.08 |
| 4 vs 2 | Q' = | 1.96 |
| 4 vs 3 | Q' = | .46 |
| 3 vs 1 | Q' = | 1.61 |
| 3 vs 2 | Q' = | 1.5 |
| 2 vs 1 | Q' = | .12 |

Error DF = 32

From a table of Critical Q values:
Error DF is the row; No. of MEANS is column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

LSD = 4.996 t-value = 2.037

LSD = 4.155 t-value = 1.694

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

09/26/84

1-WAY ANALYSIS OF VARIANCE Program ANOVA

BREEDING SPECIES -- RICHNESS (S); COTTONWOOD GROVE VS OTHER RIPARIAN.

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| AMONG GROUPS | 139.20 | 7 | 19.89 | 4.41 | 40.5% |
| WITHIN GROUPS | 144.40 | 32 | 4.51 | | 59.5% |
| TOTAL | 283.60 | 39 | | | |

Transformation code = 0

| | | | |
|---|---|---|---|
| TR1.S | M+/-SE(n)= | 7.80 +/- 00001.20(05) | CVM = 15.4% |
| BR2.S | M+/-SE(n)= | 8.20 +/- 00000.58(05) | CVM = 7.1% |
| BR3.S | M+/-SE(n)= | 12.00 +/- 00001.18(05) | CVM = 9.9% |
| BR4.S | M+/-SE(n)= | 7.00 +/- 00000.55(05) | CVM = 7.8% |
| BR5.S | M+/-SE(n)= | 8.60 +/- 00000.81(05) | CVM = 9.4% |
| BR6.S | M+/-SE(n)= | 9.00 +/- 00001.26(05) | CVM = 14.1% |
| TR7.S | M+/-SE(n)= | 6.80 +/- 00000.73(05) | CVM = 10.8% |
| BR8.S | M+/-SE(n)= | 11.80 +/- 00000.97(05) | CVM = 8.2% |

Student - Newman - Keuls and least significant difference test results (LSD at $\alpha$ =0.05 and $\alpha$ = 0.10) for breeding species richness between two riparian plots in the Cottonwood Grove (ranked means 4 and 2; unranked means file names BR2.5 and BR 4.5) and the six other riparian plots on Open Space.

SNK RESULTS

| | Ranked means: | Unranked means: | File names: |
|---|---|---|---|
| 1 | 6.8000 | 7.8000 | TR1.S |
| 2 | 7.0000 | 8.2000 | BR2.S |
| 3 | 7.8000 | 12.0000 | BR3.S |
| 4 | 8.2000 | 7.0000 | BR4.S |
| 5 | 8.6000 | 8.6000 | BR5.S |
| 6 | 9.0000 | 9.0000 | BR6.S |
| 7 | 11.8000 | 6.8000 | TR7.S |
| 8 | 12.0000 | 11.8000 | BR8.S |

8 vs 1 Q' = 5.47
8 vs 2 Q' = 5.26
8 vs 3 Q' = 4.42
8 vs 4 Q' = 4
8 vs 5 Q' = 3.58
8 vs 6 Q' = 3.16
8 vs 7 Q' = .21
7 vs 1 Q' = 5.26
7 vs 2 Q' = 5.05
7 vs 3 Q' = 4.21
7 vs 4 Q' = 3.79
7 vs 5 Q' = 3.37
7 vs 6 Q' = 2.95
6 vs 1 Q' = 2.32
6 vs 2 Q' = 2.11
6 vs 3 Q' = 1.26
6 vs 4 Q' = .84
6 vs 5 Q' = .42
5 vs 1 Q' = 1.89
5 vs 2 Q' = 1.68
5 vs 3 Q' = .84
5 vs 4 Q' = .42
4 vs 1 Q' = 1.47
4 vs 2 Q' = 1.26
4 vs 3 Q' = .42
3 vs 1 Q' = 1.05
3 vs 2 Q' = .84
2 vs 1 Q' = .21

Error DF = 32

From a table of Critical Q values:
Error DF is the row; No. of MEANS is column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

LSD = 2.737 t-value = 2.037

LSD = 2.276 t-value = 1.694

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

09/26/84

1-WAY ANALYSIS OF VARIANCE Program ANOVA

BREEDING SPECIES -- DENSITY (N/2HA); COTTONWOOD GROVE VS OTHER RIPARIAN.

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| AMONG GROUPS | 2,376.18 | 7 | 339.45 | 8.96 | 61.4% |
| WITHIN GROUPS | 1,212.80 | 32 | 37.90 | | 38.6% |
| TOTAL | 3,588.98 | 39 | | | |

Transformation code = 0

| | | | |
|---|---|---|---|
| TR1.D | M+/-SE(n)= | 14.20 +/- 00002.54(05) | CVM = 17.9% |
| BR2.D | M+/-SE(n)= | 18.20 +/- 00001.39(05) | CVM = 7.7% |
| BR3.D | M+/-SE(n)= | 30.60 +/- 00003.78(05) | CVM = 12.3% |
| BR4.D | M+/-SE(n)= | 20.20 +/- 00002.52(05) | CVM = 12.5% |
| BR5.D | M+/-SE(n)= | 28.80 +/- 00002.13(05) | CVM = 7.4% |
| BR6.D | M+/-SE(n)= | 13.60 +/- 00002.04(05) | CVM = 15.0% |
| TR7.D | M+/-SE(n)= | 10.00 +/- 00001.76(05) | CVM = 17.6% |
| BR8.D | M+/-SE(n)= | 30.60 +/- 00004.46(05) | CVM = 14.6% |

Student - Newman - Keuls and least significant difference test results (LSD at = 0.05 and =0.10) for breeding species density between two riparian plots in the Cottonwood Grove (ranked means 4 and 5; unranked means file names BR2.D and BR4.D) and the six other riparian plots on Open Space.

SNK RESULTS

| | Ranked means: | Unranked means: | File names: |
|---|---|---|---|
| 1 | 10.0000 | 14.2000 | TR1.D |
| 2 | 13.6000 | 18.2000 | BR2.D |
| 3 | 14.2000 | 30.6000 | BR3.D |
| 4 | 18.2000 | 20.2000 | BR4.D |
| 5 | 20.2000 | 28.8000 | BR5.D |
| 6 | 28.8000 | 13.6000 | BR6.D |
| 7 | 30.6000 | 10.0000 | TR7.D |
| 8 | 30.6000 | 30.6000 | BR8.D |

8 vs 1 Q' = 7.48
8 vs 2 Q' = 6.17
8 vs 3 Q' = 5.96
8 vs 4 Q' = 4.5
8 vs 5 Q' = 3.78
8 vs 6 Q' = .65
8 vs 7 Q' = 0
7 vs 1 Q' = 7.48
7 vs 2 Q' = 6.17
7 vs 3 Q' = 5.96
7 vs 4 Q' = 4.5
7 vs 5 Q' = 3.78
7 vs 6 Q' = .65
6 vs 1 Q' = 6.83
6 vs 2 Q' = 5.52
6 vs 3 Q' = 5.3
6 vs 4 Q' = 3.85
6 vs 5 Q' = 3.12
5 vs 1 Q' = 3.7
5 vs 2 Q' = 2.4
5 vs 3 Q' = 2.18
5 vs 4 Q' = .73
4 vs 1 Q' = 2.98
4 vs 2 Q' = 1.67
4 vs 3 Q' = 1.45
3 vs 1 Q' = 1.53
3 vs 2 Q' = .22
2 vs 1 Q' = 1.31

Error DF = 32

From a table of Critical Q values:
Error DF is the row; No. of MEANS is column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

LSD = 7.931 t-value = 2.037

LSD = 6.596 t-value = 1.694

One-way analysis of variance results testing for differences in breeding species richness between four irrigated (TP1.5, TP5.5, TP6.5 and TP8.5) and four nonirrigated agricultrual grassland plots. Means, standard errors, and coefficients of variation of the mean are provided below test results.

09/26/84

1-WAY ANALYSIS OF VARIANCE Program ANOVA

BREEDING SPECIES -- RICHNESS (S); IRRIGATED VS NONIRRIGATED PASTURE.

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| AMONG GROUPS | 68.00 | 7 | 9.71 | 3.63 | 34.5% |
| WITHIN GROUPS | 85.60 | 32 | 2.68 | | 65.5% |
| TOTAL | 153.60 | 39 | | | |

Transformation code = 0

| | | | |
|---|---|---|---|
| TP1.S | M+/-SE(n) = | 6.40 +/- 00000.68(05) | CVM = 10.6% |
| TP2.S | M+/-SE(n) = | 3.00 +/- 00001.05(05) | CVM = 35.0% |
| TP3.S | M+/-SE(n) = | 3.00 +/- 00000.63(05) | CVM = 21.1% |
| TP4.S | M+/-SE(n) = | 4.00 +/- 00000.63(05) | CVM = 15.8% |
| TP5.S | M+/-SE(n) = | 3.60 +/- 00000.68(05) | CVM = 18.8% |
| TP6.S | M+/-SE(n) = | 5.40 +/- 00000.68(05) | CVM = 12.6% |
| TP7.S | M+/-SE(n) = | 3.60 +/- 00000.51(05) | CVM = 14.2% |
| TP8.S | M+/-SE(n) = | 6.20 +/- 00000.86(05) | CVM = 13.9% |

Student - Newman - Keuls and least significant difference test results (LSD at $\alpha$ =0.05 and $\alpha$ =0.10) for breeding species richness between four irrigated (ranked means 8,3,6, and 7) and four nonirrigated agricultural grassland plots.

SNK RESULTS

| | Ranked means: | Unranked means: | File names: |
|---|---|---|---|
| 1 | 3.0000 | 6.4000 | TP1.S |
| 2 | 3.0000 | 3.0000 | TP2.S |
| 3 | 3.6000 | 3.0000 | TP3.S |
| 4 | 3.6000 | 4.0000 | TP4.S |
| 5 | 4.0000 | 3.6000 | TP5.S |
| 6 | 5.4000 | 5.4000 | TP6.S |
| 7 | 6.2000 | 3.6000 | TP7.S |
| 8 | 6.4000 | 6.2000 | TP8.S |

| | | | |
|---|---|---|---|
| 8 | vs 1 | Q' = | 4.65 |
| 8 | vs 2 | Q' = | 4.65 |
| 8 | vs 3 | Q' = | 3.83 |
| 8 | vs 4 | Q' = | 3.83 |
| 8 | vs 5 | Q' = | 3.28 |
| 8 | vs 6 | Q' = | 1.37 |
| 8 | vs 7 | Q' = | .27 |
| 7 | vs 1 | Q' = | 4.37 |
| 7 | vs 2 | Q' = | 4.37 |
| 7 | vs 3 | Q' = | 3.55 |
| 7 | vs 4 | Q' = | 3.55 |
| 7 | vs 5 | Q' = | 3.01 |
| 7 | vs 6 | Q' = | 1.09 |
| 6 | vs 1 | Q' = | 3.28 |
| 6 | vs 2 | Q' = | 3.28 |
| 6 | vs 3 | Q' = | 2.46 |
| 6 | vs 4 | Q' = | 2.46 |
| 6 | vs 5 | Q' = | 1.91 |
| 5 | vs 1 | Q' = | 1.37 |
| 5 | vs 2 | Q' = | 1.37 |
| 5 | vs 3 | Q' = | .55 |
| 5 | vs 4 | Q' = | .55 |
| 4 | vs 1 | Q' = | .82 |
| 4 | vs 2 | Q' = | .82 |
| 4 | vs 3 | Q' = | 0 |
| 3 | vs 1 | Q' = | .82 |
| 3 | vs 2 | Q' = | .82 |
| 2 | vs 1 | Q' = | 0 |

Error DF = 32

From a table of Critical Q values:
Error DF is the row; No. of MEANS is column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

LSD = 2.107 t-value = 2.037

LSD = 1.752 t-value = 1.694

One-way analysis of variance results testing for differences in breeding species density between four irrigated (TP1.D, TP5.D, TP6.D, and TP8.D) and four nonirrigated agricultural grassland plots. Means, standard errors, and coefficients of variation of the mean are provided below test results.

09/26/84

1-WAY ANALYSIS OF VARIANCE Program ANOVA

BREEDING SPECIES -- DENSITY (N/2HA); IRRIGATED VS. NONIRRIGATEDPASTURE.

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| AMONG GROUPS | 2,029.50 | 7 | 289.93 | 16.86 | 76.0% |
| WITHIN GROUPS | 550.40 | 32 | 17.20 | | 24.0% |
| TOTAL | 2,579.90 | 39 | | | |

Transformation code = 0

| | | | |
|---|---|---|---|
| TP1.D | M+/-SE(n) = | 18.80 +/- 00000.97(05) | CVM = 5.2% |
| TP2.D | M+/-SE(n) = | 4.40 +/- 00001.29(05) | CVM = 29.3% |
| TP3.D | M+/-SE(n) = | 5.80 +/- 00000.97(05) | CVM = 16.7% |
| TP4.D | M+/-SE(n) = | 7.00 +/- 00001.48(05) | CVM = 21.2% |
| TP5.D | M+/-SE(n) = | 6.80 +/- 00001.66(05) | CVM = 24.3% |
| TP6.D | M+/-SE(n) = | 25.20 +/- 00003.04(05) | CVM = 12.1% |
| TP7.D | M+/-SE(n) = | 7.80 +/- 00001.66(05) | CVM = 21.2% |
| TP8.D | M+/-SE(n) = | 16.60 +/- 00002.66(05) | CVM = 16.0% |

Student - Newman - Keuls and least significant difference test results (LSD at $\alpha$ =0.05 and $\alpha$ =0.01) for breeding species density between four irrigated (ranked means 7,3,8 and 6) and four nonirrigated agricultural grassland plots.

SNK RESULTS

| | Ranked means: | Unranked means: | File names: |
|---|---|---|---|
| 1 | 4.4000 | 18.8000 | TP1.D |
| 2 | 5.8000 | 4.4000 | TP2.D |
| 3 | 6.8000 | 5.8000 | TP3.D |
| 4 | 7.0000 | 7.0000 | TP4.D |
| 5 | 7.8000 | 6.8000 | TP5.D |
| 6 | 16.6000 | 25.2000 | TP6.D |
| 7 | 18.8000 | 7.8000 | TP7.D |
| 8 | 25.2000 | 16.6000 | TP8.D |

| | | | |
|---|---|---|---|
| 8 | vs 1 | Q' = | 11.21 |
| 8 | vs 2 | Q' = | 10.46 |
| 8 | vs 3 | Q' = | 9.92 |
| 8 | vs 4 | Q' = | 9.81 |
| 8 | vs 5 | Q' = | 9.38 |
| 8 | vs 6 | Q' = | 4.64 |
| 8 | vs 7 | Q' = | 3.45 |
| 7 | vs 1 | Q' = | 7.76 |
| 7 | vs 2 | Q' = | 7.01 |
| 7 | vs 3 | Q' = | 6.47 |
| 7 | vs 4 | Q' = | 6.36 |
| 7 | vs 5 | Q' = | 5.93 |
| 7 | vs 6 | Q' = | 1.19 |
| 6 | vs 1 | Q' = | 6.58 |
| 6 | vs 2 | Q' = | 5.82 |
| 6 | vs 3 | Q' = | 5.28 |
| 6 | vs 4 | Q' = | 5.18 |
| 6 | vs 5 | Q' = | 4.74 |
| 5 | vs 1 | Q' = | 1.83 |
| 5 | vs 2 | Q' = | 1.08 |
| 5 | vs 3 | Q' = | .54 |
| 5 | vs 4 | Q' = | .43 |
| 4 | vs 1 | Q' = | 1.4 |
| 4 | vs 2 | Q' = | .65 |
| 4 | vs 3 | Q' = | .11 |
| 3 | vs 1 | Q' = | 1.29 |
| 3 | vs 2 | Q' = | .54 |
| 2 | vs 1 | Q' = | .75 |

Error DF = 32

From a table of Critical Q values:
Error DF is the row; No. of MEANS is column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

LSD = 5.343 t-value = 2.037

LSD = 4.443 t-value = 1.694

Total species (breeders and transients) richness raw data printout for birds sampled in riparian (R), conifer (C), mountain shrub (m), grassland (G), and agricultural grassland (P) habitats on City of Boulder Open Space, Spring, 1984.

RAW DATA PRINTOUT. Date: 09/26/84

| TR1 | TR2 | TR3 | TR4 | TR5 | TR6 | TR7 | TR8 |
|---|---|---|---|---|---|---|---|
| 5.00 | 9.00 | 15.00 | 9.00 | 6.00 | 6.00 | 5.00 | 15.00 |
| 9.00 | 8.00 | 12.00 | 9.00 | 12.00 | 12.00 | 6.00 | 11.00 |
| 5.00 | 8.00 | 13.00 | 8.00 | 9.00 | 12.00 | 8.00 | 11.00 |
| 9.00 | 10.00 | 13.00 | 8.00 | 8.00 | 10.00 | 9.00 | 9.00 |
| 11.00 | 7.00 | 9.00 | 5.00 | 9.00 | 6.00 | 6.00 | 14.00 |

File names:

| | |
|---|---|
| 1 | TR1 S |
| 2 | TR2 S |
| 3 | TR3 S |
| 4 | TR4 S |
| 5 | TR5 S |
| 6 | TR6 S |
| 7 | TR7 S |
| 8 | TR8 S |

RAW DATA PRINTOUT. Date: 09/26/84

| TC1 | TC2 | TC3 | TC4 | TC5 | TC6 | TC7 | TC8 |
|---|---|---|---|---|---|---|---|
| 6.00 | 8.00 | 4.00 | 4.00 | 5.00 | 8.00 | 7.00 | 5.00 |
| 6.00 | 7.00 | 11.00 | 6.00 | 4.00 | 7.00 | 7.00 | 6.00 |
| 7.00 | 6.00 | 7.00 | 5.00 | 5.00 | 8.00 | 7.00 | 8.00 |
| 8.00 | 8.00 | 8.00 | 6.00 | 4.00 | 10.00 | 5.00 | 8.00 |
| 7.00 | 10.00 | 10.00 | 4.00 | 6.00 | 10.00 | 6.00 | 12.00 |

File names:

| | |
|---|---|
| 1 | TC1 S |
| 2 | TC2 S |
| 3 | TC3 S |
| 4 | TC4 S |
| 5 | TC5 S |
| 6 | TC6 S |
| 7 | TC7 S |
| 8 | TC8 S |

RAW DATA PRINTOUT. Date: 09/26/84

| TM1 | TM2 | TM3 | TM4 | TM5 | TM6 | TM7 | TM8 |
|---|---|---|---|---|---|---|---|
| 7.00 | 2.00 | 7.00 | 5.00 | 5.00 | 6.00 | 4.00 | 6.00 |
| 9.00 | 7.00 | 7.00 | 7.00 | 5.00 | 6.00 | 6.00 | 7.00 |
| 8.00 | 4.00 | 8.00 | 4.00 | 8.00 | 7.00 | 6.00 | 8.00 |
| 8.00 | 9.00 | 5.00 | 6.00 | 5.00 | 3.00 | 6.00 | 7.00 |
| 7.00 | 3.00 | 7.00 | 8.00 | 6.00 | 6.00 | 6.00 | 5.00 |

File names:

| | | |
|---|---|---|
| 1 | TM1 | S |
| 2 | TM2 | S |
| 3 | TM3 | S |
| 4 | TM4 | S |
| 5 | TM5 | S |
| 6 | TM6 | S |
| 7 | TM7 | S |
| 8 | TM8 | S |

RAW DATA PRINTOUT. Date: 09/26/84

| TG1 | TG2 | TG3 | TG4 | TG5 | TG6 | TG7 | TG8 |
|---|---|---|---|---|---|---|---|
| 3.00 | 4.00 | 1.00 | 1.00 | 2.00 | 2.00 | 1.00 | 2.00 |
| 3.00 | 1.00 | 1.00 | 1.00 | 3.00 | 2.00 | 1.00 | 1.00 |
| 2.00 | 2.00 | 2.00 | 3.00 | 4.00 | 2.00 | 1.00 | 1.00 |
| 7.00 | 2.00 | 2.00 | 2.00 | 7.00 | 4.00 | 2.00 | 3.00 |
| 5.00 | 1.00 | 2.00 | 1.00 | 3.00 | 2.00 | 2.00 | 2.00 |

File names:

| | | |
|---|---|---|
| 1 | TG1 | S |
| 2 | TG2 | S |
| 3 | TG3 | S |
| 4 | TG4 | S |
| 5 | TG5 | S |
| 6 | TG6 | S |
| 7 | TG7 | S |
| 8 | TG8 | S |

RAW DATA PRINTOUT. Date: 09/26/84

| TP1 | TP2 | TP3 | TP4 | TP5 | TP6 | TP7 | TP8 |
|---|---|---|---|---|---|---|---|
| 9.00 | 2.00 | 1.00 | 2.00 | 1.00 | 3.00 | 4.00 | 4.00 |
| 6.00 | 1.00 | 2.00 | 5.00 | 4.00 | 6.00 | 4.00 | 6.00 |
| 5.00 | 7.00 | 4.00 | 5.00 | 4.00 | 7.00 | 2.00 | 5.00 |
| 6.00 | 3.00 | 4.00 | 5.00 | 4.00 | 6.00 | 5.00 | 9.00 |
| 6.00 | 2.00 | 4.00 | 3.00 | 5.00 | 5.00 | 3.00 | 7.00 |

File names:

| | |
|---|---|
| 1 | TP1 S |
| 2 | TP2 S |
| 3 | TP3 S |
| 4 | TP4 S |
| 5 | TP5 S |
| 6 | TP6 S |
| 7 | TP7 S |
| 8 | TP8 S |

Results of two-level nested analysis of variance testing for total species richness differences between and within major Open Space habitats.

09/26/84

2-level NESTED ANOVA  Program NANOVA2

TOTAL SPECIES -- SPECIES RICHNESS (S).

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| GROUPS | 1,063.580 | 4 | 265.895 | 27.04 | 60.2% |
| SUBGPS | 344.175 | 35 | 9.834 | 3.48 | 13.2% |
| ERROR | 452.000 | 160 | 2.825 | | 26.6% |
| TOTAL | 1,859.755 | 199 | | | |

Transformation code = 0

Species richness, means, standard errors, and coefficients of variation of the mean for all species sampled (breeders and transients) in habitats (group 1 = riparian; group 2 = conifer = C; group 3 = mountain shrub = M; group 4 = grassland = G; and group 5 = agricultural grassland = P) and in plots (subgroups 1-8) within habitats.

GROUP BREAKDOWNS:

| | | | |
|---|---|---|---|
| Group No. 1: | Mean+/-SE(n)= | 9.15 +/- 0000.44(40) | CVM = 4.8% |
| Group No. 2: | Mean+/-SE(n)= | 6.90 +/- 0000.32(40) | CVM = 4.6% |
| Group No. 3: | Mean+/-SE(n)= | 6.15 +/- 0000.26(40) | CVM = 4.2% |
| Group No. 4: | Mean+/-SE(n)= | 2.33 +/- 0000.23(40) | CVM = 10.0% |
| Group No. 5: | Mean+/-SE(n)= | 4.40 +/- 0000.31(40) | CVM = 7.1% |

SUBGROUP BREAKDOWNS:

| | | | |
|---|---|---|---|
| TR1.S | Mean+/-SE(n)= | 7.80 +/- 0001.20(05) | CVM = 15.4% |
| TR2.S | Mean+/-SE(n)= | 8.40 +/- 0000.51(05) | CVM = 6.1% |
| TR3.S | Mean+/-SE(n)= | 12.40 +/- 0000.98(05) | CVM = 7.9% |
| TR4.S | Mean+/-SE(n)= | 7.80 +/- 0000.73(05) | CVM = 9.4% |
| TR5.S | Mean+/-SE(n)= | 8.80 +/- 0000.97(05) | CVM = 11.0% |
| TR6.S | Mean+/-SE(n)= | 9.20 +/- 0001.36(05) | CVM = 14.7% |
| TR7.S | Mean+/-SE(n)= | 6.80 +/- 0000.73(05) | CVM = 10.8% |
| TR8.S | Mean+/-SE(n)= | 12.00 +/- 0001.10(05) | CVM = 9.1% |
| TC1.S | Mean+/-SE(n)= | 6.80 +/- 0000.37(05) | CVM = 5.5% |
| TC2.S | Mean+/-SE(n)= | 7.80 +/- 0000.66(05) | CVM = 8.5% |
| TC3.S | Mean+/-SE(n)= | 8.00 +/- 0001.22(05) | CVM = 15.3% |
| TC4.S | Mean+/-SE(n)= | 5.00 +/- 0000.45(05) | CVM = 8.9% |
| TC5.S | Mean+/-SE(n)= | 4.80 +/- 0000.37(05) | CVM = 7.8% |
| TC6.S | Mean+/-SE(n)= | 8.60 +/- 0000.60(05) | CVM = 7.0% |
| TC7.S | Mean+/-SE(n)= | 6.40 +/- 0000.40(05) | CVM = 6.3% |
| TC8.S | Mean+/-SE(n)= | 7.80 +/- 0001.20(05) | CVM = 15.4% |
| TM1.S | Mean+/-SE(n)= | 7.80 +/- 0000.37(05) | CVM = 4.8% |
| TM2.S | Mean+/-SE(n)= | 5.00 +/- 0001.30(05) | CVM = 26.1% |
| TM3.S | Mean+/-SE(n)= | 6.80 +/- 0000.49(05) | CVM = 7.2% |
| TM4.S | Mean+/-SE(n)= | 6.00 +/- 0000.71(05) | CVM = 11.8% |
| TM5.S | Mean+/-SE(n)= | 5.80 +/- 0000.58(05) | CVM = 10.1% |
| TM6.S | Mean+/-SE(n)= | 5.60 +/- 0000.68(05) | CVM = 12.1% |
| TM7.S | Mean+/-SE(n)= | 5.60 +/- 0000.40(05) | CVM = 7.1% |
| TM8.S | Mean+/-SE(n)= | 6.60 +/- 0000.51(05) | CVM = 7.7% |
| TG1.S | Mean+/-SE(n)= | 4.00 +/- 0000.89(05) | CVM = 22.4% |
| TG2.S | Mean+/-SE(n)= | 2.00 +/- 0000.55(05) | CVM = 27.4% |
| TG3.S | Mean+/-SE(n)= | 1.60 +/- 0000.24(05) | CVM = 15.3% |
| TG4.S | Mean+/-SE(n)= | 1.60 +/- 0000.40(05) | CVM = 25.0% |
| TG5.S | Mean+/-SE(n)= | 3.80 +/- 0000.86(05) | CVM = 22.6% |
| TG6.S | Mean+/-SE(n)= | 2.40 +/- 0000.40(05) | CVM = 16.7% |
| TG7.S | Mean+/-SE(n)= | 1.40 +/- 0000.24(05) | CVM = 17.5% |
| TG8.S | Mean+/-SE(n)= | 1.80 +/- 0000.37(05) | CVM = 20.8% |
| TP1.S | Mean+/-SE(n)= | 6.40 +/- 0000.68(05) | CVM = 10.6% |
| TP2.S | Mean+/-SE(n)= | 3.00 +/- 0001.05(05) | CVM = 35.0% |
| TP3.S | Mean+/-SE(n)= | 3.00 +/- 0000.63(05) | CVM = 21.1% |
| TP4.S | Mean+/-SE(n)= | 4.00 +/- 0000.63(05) | CVM = 15.8% |
| TP5.S | Mean+/-SE(n)= | 3.60 +/- 0000.68(05) | CVM = 18.8% |
| TP6.S | Mean+/-SE(n)= | 5.40 +/- 0000.68(05) | CVM = 12.6% |
| TP7.S | Mean+/-SE(n)= | 3.60 +/- 0000.51(05) | CVM = 14.2% |
| TP8.S | Mean+/-SE(n)= | 6.20 +/- 0000.86(05) | CVM = 13.9% |

Student - Newman - Keuls test results for richness of all species (breeders and transients sampled in grassland (group 1), agricultrual grassland (group 2), mountain shrub (group 3), conifer (group 4), and riparian (group 5) habitats.

09/26/84

SNK RESULTS

TOTAL SPECIES -- SPECIES RICHNESS (S).

| | Ranked means: | Unranked means: |
|---|---|---|
| 1 | 2.325 | 9.15 |
| 2 | 4.4 6.9 | |
| 3 | 6.15 | 6.15 |
| 4 | 6.9 2.325 | |
| 5 | 9.15 | 4.4 |

| | | |
|---|---|---|
| 5 vs 1 | Q' = | 13.77 |
| 5 vs 2 | Q' = | 9.58 |
| 5 vs 3 | Q' = | 6.05 |
| 5 vs 4 | Q' = | 4.54 |
| 4 vs 1 | Q' = | 9.23 |
| 4 vs 2 | Q' = | 5.04 |
| 4 vs 3 | Q' = | 1.51 |
| 3 vs 1 | Q' = | 7.71 |
| 3 vs 2 | Q' = | 3.53 |
| 2 vs 1 | Q' = | 4.18 |

DF = 35

From a table of Critical Q values:
The DF is the row; No. of MEANS is the column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

RAW DATA PRINTOUT. Date: 09/26/84

| TM1 | TM2 | TM3 | TM4 | TM5 | TM6 | TM7 | TM8 |
|---|---|---|---|---|---|---|---|
| 12.00 | 3.00 | 13.00 | 10.00 | 19.00 | 11.00 | 20.00 | 24.00 |
| 20.00 | 13.00 | 13.00 | 13.00 | 12.00 | 10.00 | 13.00 | 20.00 |
| 12.00 | 9.00 | 15.00 | 4.00 | 12.00 | 10.00 | 10.00 | 16.00 |
| 17.00 | 15.00 | 11.00 | 16.00 | 9.00 | 4.00 | 12.00 | 19.00 |
| 11.00 | 9.00 | 15.00 | 18.00 | 14.00 | 12.00 | 10.00 | 15.00 |

File names:

| | |
|---|---|
| 1 | TM1 D |
| 2 | TM2 D |
| 3 | TM3 D |
| 4 | TM4 D |
| 5 | TM5 D |
| 6 | TM6 D |
| 7 | TM7 D |
| 8 | TM8 D |

RAW DATA PRINTOUT. Date: 09/26/84

| TG1 | TG2 | TG3 | TG4 | TG5 | TG6 | TG7 | TG8 |
|---|---|---|---|---|---|---|---|
| 6.00 | 5.00 | 5.00 | 2.00 | 6.00 | 7.00 | 1.00 | 5.00 |
| 5.00 | 1.00 | 3.00 | 1.00 | 6.00 | 5.00 | 4.00 | 2.00 |
| 3.00 | 3.00 | 3.00 | 5.00 | 6.00 | 6.00 | 1.00 | 3.00 |
| 13.00 | 4.00 | 4.00 | 4.00 | 9.00 | 9.00 | 2.00 | 14.00 |
| 7.00 | 2.00 | 7.00 | 2.00 | 7.00 | 8.00 | 4.00 | 6.00 |

File names:

| | |
|---|---|
| 1 | TG1 D |
| 2 | TG2 D |
| 3 | TG3 D |
| 4 | TG4 D |
| 5 | TG5 D |
| 6 | TG6 D |
| 7 | TG7 D |
| 8 | TG8 D |

Raw data printout for the density (n/2ha) of all birds (breeders and transients) sampled in riparian (R), conifer (C), mountain shrub (M), grassland (G), and agricultural grassland (P) habitats on City of Boulder Open Space, Spring, 1984.

RAW DATA PRINTOUT. Date: 09/26/84

| TR1 | TR2 | TR3 | TR4 | TR5 | TR6 | TR7 | TR8 |
|---|---|---|---|---|---|---|---|
| 10.00 | 13.00 | 32.00 | 22.00 | 28.00 | 7.00 | 7.00 | 28.00 |
| 11.00 | 20.00 | 48.00 | 20.00 | 31.00 | 18.00 | 7.00 | 33.00 |
| 12.00 | 20.00 | 33.00 | 17.00 | 36.00 | 17.00 | 16.00 | 19.00 |
| 14.00 | 21.00 | 27.00 | 17.00 | 27.00 | 18.00 | 12.00 | 46.00 |
| 24.00 | 19.00 | 20.00 | 30.00 | 23.00 | 11.00 | 8.00 | 28.00 |

File names:

| | |
|---|---|
| 1 | TR1 D |
| 2 | TR2 D |
| 3 | TR3 D |
| 4 | TR4 D |
| 5 | TR5 D |
| 6 | TR6 D |
| 7 | TR7 D |
| 8 | TR8 D |

RAW DATA PRINTOUT. Date: 09/26/84

| TC1 | TC2 | TC3 | TC4 | TC5 | TC6 | TC7 | TC8 |
|---|---|---|---|---|---|---|---|
| 13.00 | 18.00 | 7.00 | 11.00 | 10.00 | 14.00 | 9.00 | 8.00 |
| 7.00 | 25.00 | 30.00 | 12.00 | 9.00 | 10.00 | 11.00 | 10.00 |
| 8.00 | 17.00 | 13.00 | 7.00 | 7.00 | 12.00 | 9.00 | 11.00 |
| 14.00 | 15.00 | 14.00 | 12.00 | 11.00 | 19.00 | 10.00 | 17.00 |
| 18.00 | 21.00 | 20.00 | 6.00 | 13.00 | 16.00 | 8.00 | 21.00 |

File names:

| | |
|---|---|
| 1 | TC1 D |
| 2 | TC2 D |
| 3 | TC3 D |
| 4 | TC4 D |
| 5 | TC5 D |
| 6 | TC6 D |
| 7 | TC7 D |
| 8 | TC8 D |

RAW DATA PRINTOUT.

Date: 09/26/84

| TP1 | TP2 | TP3 | TP4 | TP5 | TP6 | TP7 | TP8 |
|---|---|---|---|---|---|---|---|
| 15.00 | 2.00 | 3.00 | 3.00 | 2.00 | 15.00 | 7.00 | 7.00 |
| 20.00 | 2.00 | 4.00 | 8.00 | 6.00 | 26.00 | 12.00 | 18.00 |
| 20.00 | 9.00 | 8.00 | 6.00 | 5.00 | 23.00 | 3.00 | 16.00 |
| 20.00 | 5.00 | 7.00 | 12.00 | 10.00 | 29.00 | 11.00 | 23.00 |
| 19.00 | 4.00 | 7.00 | 6.00 | 11.00 | 33.00 | 6.00 | 19.00 |

File names:

| | |
|---|---|
| 1 | TP1 D |
| 2 | TP2 D |
| 3 | TP3 D |
| 4 | TP4 D |
| 5 | TP5 D |
| 6 | TP6 D |
| 7 | TP7 D |
| 8 | TP8 D |

Results of two-level nested analysis of variance test examining differences in total species (breeders and transients) density between and within major Open Space habitats.

09/26/84

2-level NESTED ANOVA Program NANOVA2

TOTAL SPECIES -- SPECIES DENSITY (N/2HA).

| SOURCE OF VARIATION | SS | DF | MS | F | VARIANCE COMPONENTS |
|---|---|---|---|---|---|
| GROUPS | 5,419.730 | 4 | 1,354.933 | 8.77 | 38.8% |
| SUBGPS | 5,408.350 | 35 | 154.524 | 7.56 | 34.7% |
| ERROR | 3,272.400 | 160 | 20.453 | | 26.5% |
| TOTAL | 14,100.480 | 199 | | | |

Transformation code = 0

Means, standard errors, and coefficients of variation of the mean for total species (breeders and transients) density (n/2ha) 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) and in plots (subgroups 1-8) within habitats.

GROUP BREAKDOWNS:

| | | | | |
|---|---|---|---|---|
| Group No. | 1: | Mean+/-SE(n)= | 21.25 +/- 0001.57(40) | CVM = 7.4% |
| Group No. | 2: | Mean+/-SE(n)= | 13.08 +/- 0000.85(40) | CVM = 6.5% |
| Group No. | 3: | Mean+/-SE(n)= | 13.03 +/- 0000.71(40) | CVM = 5.5% |
| Group No. | 4: | Mean+/-SE(n)= | 4.90 +/- 0000.47(40) | CVM = 9.5% |
| Group No. | 5: | Mean+/-SE(n)= | 11.55 +/- 0001.29(40) | CVM = 11.1% |

SUBGROUP BREAKDOWNS:

| | | |
|---|---|---|
| TR1.D | Mean+/-SE(n)= | 14.20 +/- 0002.54(05) CVM = 17.9% |
| TR2.D | Mean+/-SE(n)= | 18.60 +/- 0001.44(05) CVM = 7.7% |
| TR3.D | Mean+/-SE(n)= | 32.00 +/- 0004.62(05) CVM = 14.4% |
| TR4.D | Mean+/-SE(n)= | 21.20 +/- 0002.40(05) CVM = 11.3% |
| TR5.D | Mean+/-SE(n)= | 29.00 +/- 0002.17(05) CVM = 7.5% |
| TR6.D | Mean+/-SE(n)= | 14.20 +/- 0002.22(05) CVM = 15.7% |
| TR7.D | Mean+/-SE(n)= | 10.00 +/- 0001.76(05) CVM = 17.6% |
| TR8.D | Mean+/-SE(n)= | 30.80 +/- 0004.42(05) CVM = 14.4% |
| TC1.D | Mean+/-SE(n)= | 12.00 +/- 0002.02(05) CVM = 16.9% |
| TC2.D | Mean+/-SE(n)= | 19.20 +/- 0001.74(05) CVM = 9.1% |
| TC3.D | Mean+/-SE(n)= | 16.80 +/- 0003.89(05) CVM = 23.2% |
| TC4.D | Mean+/-SE(n)= | 9.60 +/- 0001.29(05) CVM = 13.4% |
| TC5.D | Mean+/-SE(n)= | 10.00 +/- 0001.00(05) CVM = 10.0% |
| TC6.D | Mean+/-SE(n)= | 14.20 +/- 0001.56(05) CVM = 11.0% |
| TC7.D | Mean+/-SE(n)= | 9.40 +/- 0000.51(05) CVM = 5.4% |
| TC8.D | Mean+/-SE(n)= | 13.40 +/- 0002.42(05) CVM = 18.1% |
| TM1.D | Mean+/-SE(n)= | 14.40 +/- 0001.75(05) CVM = 12.1% |
| TM2.D | Mean+/-SE(n)= | 9.80 +/- 0002.06(05) CVM = 21.0% |
| TM3.D | Mean+/-SE(n)= | 13.40 +/- 0000.75(05) CVM = 5.6% |
| TM4.D | Mean+/-SE(n)= | 12.20 +/- 0002.46(05) CVM = 20.1% |
| TM5.D | Mean+/-SE(n)= | 13.20 +/- 0001.66(05) CVM = 12.5% |
| TM6.D | Mean+/-SE(n)= | 9.40 +/- 0001.40(05) CVM = 14.9% |
| TM7.D | Mean+/-SE(n)= | 13.00 +/- 0001.84(05) CVM = 14.2% |
| TM8.D | Mean+/-SE(n)= | 18.80 +/- 0001.59(05) CVM = 8.5% |
| TG1.D | Mean+/-SE(n)= | 6.80 +/- 0001.69(05) CVM = 24.8% |
| TG2.D | Mean+/-SE(n)= | 3.00 +/- 0000.71(05) CVM = 23.6% |
| TG3.D | Mean+/-SE(n)= | 4.40 +/- 0000.75(05) CVM = 17.0% |
| TG4.D | Mean+/-SE(n)= | 2.80 +/- 0000.73(05) CVM = 26.2% |
| TG5.D | Mean+/-SE(n)= | 6.80 +/- 0000.58(05) CVM = 8.6% |
| TG6.D | Mean+/-SE(n)= | 7.00 +/- 0000.71(05) CVM = 10.1% |
| TG7.D | Mean+/-SE(n)= | 2.40 +/- 0000.68(05) CVM = 28.3% |
| TG8.D | Mean+/-SE(n)= | 6.00 +/- 0002.12(05) CVM = 35.4% |
| TP1.D | Mean+/-SE(n)= | 18.80 +/- 0000.97(05) CVM = 5.2% |
| TP2.D | Mean+/-SE(n)= | 4.40 +/- 0001.29(05) CVM = 29.3% |
| TP3.D | Mean+/-SE(n)= | 5.80 +/- 0000.97(05) CVM = 16.7% |
| TP4.D | Mean+/-SE(n)= | 7.00 +/- 0001.48(05) CVM = 21.2% |
| TP5.D | Mean+/-SE(n)= | 6.80 +/- 0001.66(05) CVM = 24.3% |
| TP6.D | Mean+/-SE(n)= | 25.20 +/- 0003.04(05) CVM = 12.1% |
| TP7.D | Mean+/-SE(n)= | 7.80 +/- 0001.66(05) CVM = 21.2% |
| TP8.D | Mean+/-SE(n)= | 16.60 +/- 0002.66(05) CVM = 16.0% |

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

09/26/84

SNK RESULTS

TOTAL SPECIES -- DENSITY (N/2HA).

| | Ranked means: | Unranked means: |
|---|---|---|
| 1 | 4.9 21.25 | |
| 2 | 11.55 | 13.075 |
| 3 | 13.025 | 13.025 |
| 4 | 13.075 | 4.9 |
| 5 | 21.25 | 11.55 |

| | | |
|---|---|---|
| 5 vs 1 | Q' = | 8.32 |
| 5 vs 2 | Q' = | 4.94 |
| 5 vs 3 | Q' = | 4.18 |
| 5 vs 4 | Q' = | 4.16 |
| 4 vs 1 | Q' = | 4.16 |
| 4 vs 2 | Q' = | .78 |
| 4 vs 3 | Q' = | .03 |
| 3 vs 1 | Q' = | 4.13 |
| 3 vs 2 | Q' = | .75 |
| 2 vs 1 | Q' = | 3.38 |

DF = 35

From a table of Critical Q values:
The DF is the row; No. of MEANS is the column.
Compare each Q' (top down) with Q table (right left).

If Q' is > Q (table), Reject Ho.

APPENDIX B. Status of raptor nests in Boulder Mountain Parks and vicinity through 1984. By Mike Figgs and Nan Lederer.

## Map Key and Status of Raptor Nests in Boulder Mountain Parks and Vicinity through 1984

### Prairie Falcon

PF-1 Eldorado Mtn. (Mickey Mouse Ears cliff). History: Unknown to investigators*prior to 1983. Recent status: Active 1983 and 1984. Productivity: Unknown. Exact nest site not found. Hunting grounds: Unknown. Other: Popular climbing rock.

PF-2 Shadow Canyon, near "the Maiden" rock formation. History: Reported to be a regularly occupied site (Greg Hayes, pers. comm.). Recent status: Active 1982 and 1984, not field checked in 1983. Productivity: Four young on nest 1984. Hunting grounds: Unknown.

PF-3 Fern Canyon. History: Unknown to investigators prior to 1984. Recent status: Active 1984. Productivity: Three young on nest 1984. Hunting grounds: Unknown.

PF-4 Bear Canyon. History: Unknown to investigators prior to 1983. Recent status: Active 1983 and 1984. Productivity: Unknown. Exact nest site not found. Hunting grounds: Unknown.

PF-5 Third Flatiron. History: Occupied in 1950 (Bailey and Niedrach 1965). Probably regularly occupied since 1950 (Greg Hayes, pers. comm.). Recent status: Active 1982, 1983 and 1984. Productivity: Unknown. Exact nest site not found. Hunting grounds: Unknown. Other: Very popular climbing rock.

### Golden Eagle

GE-1 Eldorado Canyon-Eldorado Mtn. History: Jollie (1943) includes this territory in the Bear Canyon-Skunk Canyon territory; however, he suspected an additional territory centered in the South Draw-Scartop Mtn. area 1-2 miles west of Eldorado Mtn. D'Ostilio (1954) shows an active nest north of Eldorado Canyon (possibly GE-1e). DOW (1978) shows inactive nest on Mickey Mouse Ears cliff (GE-1a or GE-1b). DOW (1978) shows either GE-1d or GE-1e active in 1978. Jollie (1943) indicates GE-1f as an active area. Recent status: GE-1a Active 1983 but abandoned sometime after incubation begun. Inactive in 1984, but pair present, and GE-1c was rebuilt and decorated with green boughs. Productivity: Probably laid eggs 1983 but no young raised. No known productivity in 1984. Hunting grounds: Unknown. Other: Nests GE-1a and GE-1b are on Mickey Mouse Ears cliff, a popular climbing rock. Nest GE-1c is about 300 ft. from the railroad track and is in a popular hiking area. Nest GE-1d is on the Wind Tower in Eldorado Canyon, an extremely popular climbing route; not considered a viable nest

*investigators referred to in this report are Mike Figgs and Nan Lederer.

site.

GE-2 South Boulder Peak. History: Active 1978 (DOW 1978). Unknown to investigators prior to 1984. Recent status: Active 1984. Productivity: Unknown. Hunting grounds: Unknown. Other: Popular hiking area; nest within 100 ft. of summit.

GE-3 Skunk Canyon. History: Gale (Henderson 1907) records an active eagle nest in Bear Canyon in 1889. Jollie (1943) shows nests on Bear Peak and Green Mtn. GE-3b active in 1980 and GE-3a active in 1981 (Steve Jones, pers. comm.). Unknown to investigators prior to 1983. Recent status: Active 1983 and 1984. Productivity: Two young fledged 1983, one young fledged 1984. Hunting grounds: Jollie (1943) mapped the hunting territory for this pair; however, it overlaps with the present territories of GE-1 and GE-2, which he did not recognize as separate territories. Current information (from the investigators and City Parks rangers) shows that this pair hunts the area south of Shanahan Hill to 1/2 mile south of S. Boulder Creek, and east to Marshall Mesa (see map). Other: Moderately popular climbing and hiking area. At present there is difficulty in distinguishing the territories of GE-1, -2, and -3. Both the DOW (1978) and the investigators' records show that there are at least two separate territories, but to date we have not been able to confirm three territories.

GE-4 Lefthand Canyon. History: Gale (Henderson 1907), Jollie (1943), D'Ostilio (1954) 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 1984. Productivity: Two young fledged 1984. Average of 1.1 young fledged per year from 1974 to 1984. Hunting grounds: Jollie (1943) mapped the hunting territory for this pair (see map). Jones (1983) indicates that this pair hunts on Boulder Valley Ranch.

## Red-tailed Hawk

RTH-1 South of Matron rock formation (tree nest). History: Unknown to investigators prior to 1982. Recent status: Active 1982, 1983 and 1984. Productivity: Two young on nest 1984. Hunting grounds: Unknown.

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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.

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. 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.