SNAG USE BY CAVITY-NESTING BIRDS IN THE BOULDER MOUNTAIN PARK

Prepared by:

Stephen R. Jones
1197B Bear Mt. Dr.
Boulder, CO 80303
5 December, 1991

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Introduction

Management of Rocky Mountain coniferous forests has often resulted in degradation of habitat for cavity-nesting birds (Mannan and Meslow 1984, Scott and Oldmeyer 1983). Cutting of large trees, removal of snags, and suppression of fires have created even aged forests where few dead trees are available for use by cavity-nesters.

Studies conducted in the Boulder Mountain Park during 1989-90 indicated that snag densities and cavity-nesting bird populations are low throughout much of the Park (Jones 1990, 1989). Mean snag densities on 22, 5-hectare forest plots within the Park were 2.4 snags/ha greater than 25cm DBH. Several studies conducted in Rocky Mountain coniferous forests have concluded that a minimum snag density of at least 5 large snags/ha is necessary to provide suitable habitat for several species of cavity-nesting birds, including hairy woodpecker and Williamson's sapsucker (Cunningham, Balda and Gaud 1980, Thomas et al 1979, Scott 1978, Balda 1975; see Table 5). Cavity-nesting birds comprised only 22% of all individuals seen during breeding bird surveys conducted on the 22 forest plots in the Mountain Park (Jones 1990). This compares with a mean cavity-nester density of 42% (with a range of 32-46%) reported by 8 similar studies conducted in ponderosa pine/Douglas fir forests in Arizona and Colorado (Scott, Whelan, and Svoboda 1975).

Low snag density within the Mountain Park may limit breeding success of many species of cavity-nesting birds. Twenty-one breeding cavity-nesting species have been documented within the Park (Jones 1990). Eight cavity-nesting species (flammulated owl, Lewis's woodpecker, Williamson's sapsucker, hairy woodpecker, brown creeper, western bluebird, mountain bluebird, and European starling) have been designated as species of special interest within the Park (Jones 1990). Two of three known western bluebird nest sites are situated in areas with low snag densities. The last observed Lewis' woodpecker nest within the Park, which was active from 1985-6, was also situated in an area with low snag density (Jones 1989).

I investigated snag use by cavity-nesting birds on 7, 2/ha study plots within the Park. The purpose was to determine: (1) The relationship of snag density to cavity-nester density on each plot (2) characteristics of snags containing excavated nest cavities or active nests (3) optimum snag densities required to support breeding populations of cavity-nesting species.

In addition, a snag creation program was planned during 1991 and will be initiated during 1992. Fifteen to 20 new snags will be created on each of 3 study plots. Use of these snags and existing snags on each plot by cavity-nesting birds will be monitored over the next 12 years.

Study Area

The Boulder Mountain Park is a 24km^2 area of forested mountains to the west of Boulder, extending south to north from

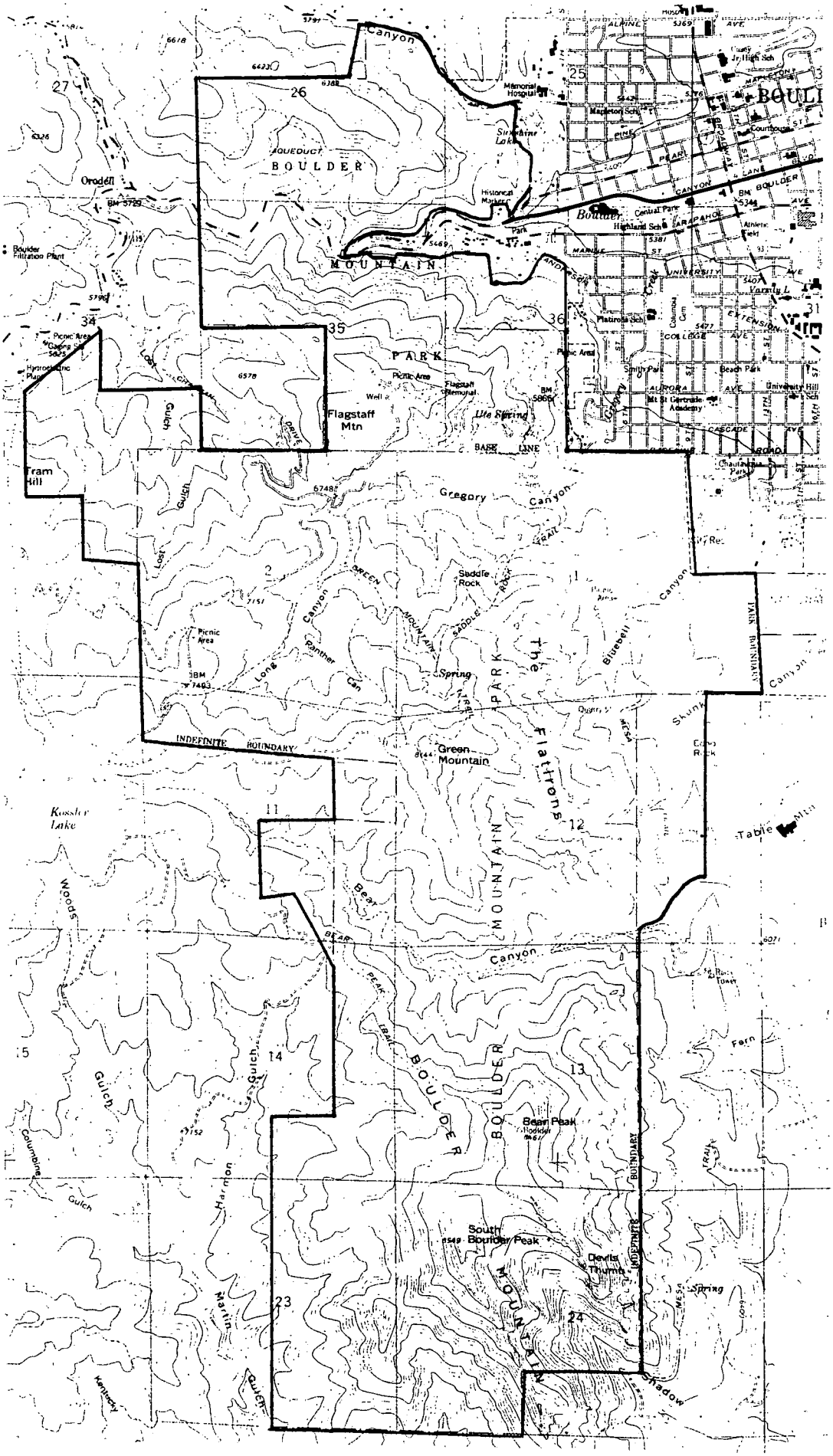


Figure 1. Boulder Mountain Park

Eldorado Springs to Sunshine Canyon (Figure 1). Study plots were located in primarily ponderosa pine/Douglas fir forest at elevations from 1,820m-2,275m. The forest in these areas is predominantly second growth, with a majority of the canopy trees in the 75-150 year age class (Colorado State Forest Service 1982).

All seven study plots are situated within forest stands that were thinned by the Colorado State Forest Service between 1977 and 1982 (Colorado State Forest Service 1982). The thinning was a response to the dense, stunted nature of the forest, which may have stemmed from fire suppression, and to a mountain pine beetle infestation, which had killed many ponderosa pines. Most of the infected ponderosa pines were cut and removed, leaving approximately 1-5 large snags/ha (snags greater than 25cm DBH) throughout the study area (Jones 1990).

Snags within the study area appear to have been created primarily by insect infestation and wind throw. In addition to the mountain pine beetle infestation, a spruce budworm infestation during the 1980's killed many Douglas firs within the study area. Many of the broken top snags within the study area were topped off during a windstorm in spring 1987 (pers. obs.). Snags within Douglas fir stands are clustered, reflecting the impact of the spruce budworm infestation. Snags within ponderosa pine stands are more evenly spaced.

Methods

Six permanent 2ha plots, each measuring 200m x 100m, were established and permanently marked using metal flashing (Figure 2,

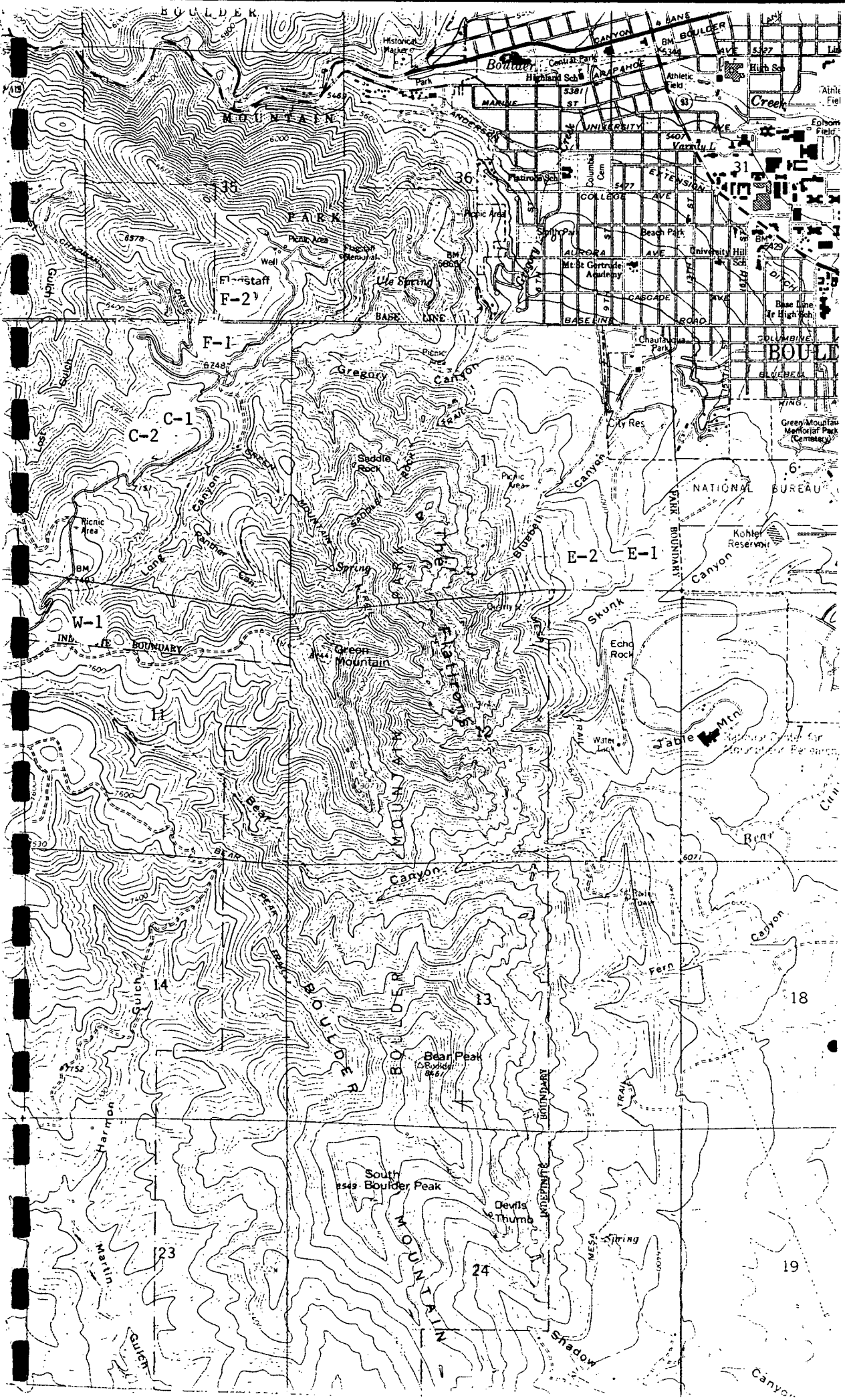


Figure 2. Plot Location

Appendix B). Plots E1 and E2 were located at 1820-1900m on Enchanted Mesa, in ponderosa pine forest (canopy closure is greater than 50%), on a 5-10% east-facing slope. Plots F1 and F2 were located at 2060-2100m on Flagstaff Mountain, in ponderosa pine woodland (canopy closure less than 50%), on a 0-15% south-facing slope. Plots C1 and C2 were located at 2100-2180m in the Cathedral Park area of Flagstaff Mountain, in ponderosa pine/Douglas fir forest, on a 0-25% east-facing slope. A seventh plot (W-1) was established, but not permanently marked, in an area of documented high snag density in ponderosa pine/Douglas fir forest at 2170-2275m on Green Mountain West Ridge, on a 15-25% north-facing slope.

All snags within each plot were mapped, measured, and checked for woodpecker damage and nest cavities. Four breeding bird surveys were conducted on each plot, 20 May-5 July. Surveys were conducted between sunrise and 9:00 a.m., M.S.T. The observer walked slowly the length of the plot stopping every 25m for one minute to look and listen for birds. All birds seen or heard, except young of the year, were counted. The number of birds reported for each plot represents the total number of species seen on all four counts and the highest number of individuals of each species seen on any one count. During each breeding bird survey, all snags within each plot were checked for nesting activity.

For this study snags were defined as all dead or dying trees at least 3m high and 20cm in diameter and with less than 50% live canopy growth. There is no generally agreed upon definition of a snag, but studies have shown that snags smaller than 20cm DBH and 3m high are infrequently used by cavity-nesting birds (Morrison,

Rafael, and Heald 1983, Brush, Anderson, and Ohmart 1983, Miller and Miller 1980).

Results and Discussion

Results of snag inventories and breeding bird surveys on the seven study plots are shown in Tables 1-4. These data suggest the following tentative conclusions about snag use by cavity-nesting birds in the Boulder Mountain Park:

(1) There is a strong correlation between snag density and cavity-nesting bird population density. Cavity-nester density was low (23% or less) on all 5 plots that had fewer than 5 snags/ha.

(2) A minority of snags (probably less than 20%) are suitable for use by cavity-nesting birds. Most snags are either too old and soft or too young and hard to facilitate successful excavation of nest cavities by primary cavity-nesters.

(3) Some areas of the Mountain Park do not contain enough snags to support viable populations of cavity-nesting birds. Four of the seven study plots contained no active nests, and two study plots contained no snags with cavities.

(4) Large, broken top snags with some bark remaining are probably most suitable for use by cavity-nesting birds.

Snag Densities and Breeding Bird Populations

Table 1 shows the relationship of the number of snags on each plot to breeding bird populations on each plot. The Green Mountain West Ridge Plot and Enchanted Mesa Plot No. 2, which had the highest densities of snags, also supported the highest densities of cavity-nesting birds. These plots had more snags with cavities and more snags with active nests than any of the other plots.

Scott, Whelan and Svoboda (1975) summarized the results of eight breeding bird population studies conducted in ponderosa pine/Douglas fir forests in Arizona and Colorado. They reported a mean cavity-nester density in ponderosa pine forests of 45%, with a range of 32-46%. The cavity-nester density on Enchanted Mesa Plot No. 2 (34%) fell within this range. The cavity-nester density on the Green Mountain West Ridge Plot (62%) was much higher. The cavity-nester density on the other 5 plots (0-23%) was lower.

Most of the cavity-nesters seen during breeding bird surveys did not nest within the study plots (68 individuals were seen and only 14 nested). Breeding birds may have foraged within the plots and nested in adjacent areas. Small flocks of pygmy nuthatches, mountain chickadees, and pine siskins were observed foraging on snags in Cathedral Park Plot No. 1, Cathedral Park Plot No. 2 and the West Ridge plot, but none of these birds nested within the plots. The majority of snags in these three plots contained woodpecker drill holes but no cavities. Though snags of this type are not used for nesting, they may provide an important food source for insectivorous cavity-nesters.

Table 1. Snag Densities and Breeding Bird Densities on Study Plots

Plot No.	No. Snags	Snags With Cavities	Nests	Total Species	Total Individuals	% Cavity Nesters
F-1	3	1	0	13	22	18
F-2	2	0	0	5	12	0
C-1	7	0	0	19	35	23
C-2	7	3	1	15	37	11
E-1	9	3	0	9	13	15
E-2	12	6	2	17	38	34
W-1	59	6	4	24	55	67
Total	99	19	7	34	212	32

Snag Characteristics

Table 2 shows characteristics of various types of snags in the seven study plots. Approximately 80% of all snags contained woodpecker drill holes or other evidence of woodpecker damage, but only 20% of all snags contained nest cavities. This is not surprising given that snags may stand for 10 years or more before the wood is soft enough to permit excavation by primary cavity-nesters (Bull 1983). Fifty-two percent of broken top snags contained cavities and 16% contained nests; only 4% of snags without broken tops contained cavities, and only 3% contained nests. Rapid wood decay in broken top snags probably facilitates cavity excavation. In some cases decay may weaken a tree and cause it to break; in others, a healthy tree will snap off and heart rot fungus will work its way into the tree through the wound (Bull 1983, Cunningham, Balda and Gaud 1983).

Fourteen of the 19 snags that contained cavities were larger than 30cm DBH. Fifteen of the 19 trees with cavities contained more than 1 cavity. Seventeen of the 19 snags with cavities retained some of their bark, and 4 retained all of their bark. These data corroborate previously reported observations that large, broken top snags retaining some bark provide optimum nesting habitat for cavity-nesting birds (Cunningham, Balda and Gaud 1980, Mannan et. al. 1980, Scott et. al. 1980).

Nest Site Selection

Table 3 gives structural characteristics of snags containing active nests. Snags with nests tended to be large (30cm DBH or

Table 2. Snag Characteristics

Snag Type	Number	With Woodpecker Damage	With Cavities	With Nests
Douglas fir straight top	63	48	2	1
Douglas-fir broken top	4	4	3	2
Ponderosa Pine straight top	5	5	1	1
Ponderosa Pine broken top	27	22	13	3
Total	99	79	19	7

Table 3. Nest Site Selection

Nest	Location	Tree Type	DBH(cm)	Tree Ht(m)	%Bark[1]	%Crown[2]	Nest Ht.
H. Wood.	Enchanted Mesa-2	Ponderosa (BT)[3]	50	6.5	100	0	5.5
V. Swallow	Enchanted Mesa-2	Ponderosa	60	21.0	20	0	20.0
H. Wren	Cathedral Park-2	D. Fir (BT)	37	3.6	95	0	2.5
W. Bluebird	West Ridge	Ponderosa (BT)	20	8.0	100	0	6.5
H. Wren	West Ridge	D. Fir	55	14.0	80	0	7.5
A. Kestrel	West Ridge	Ponderosa (BT)	30	8.0	30	0	5.5
C. Flicker	West Ridge	D. Fir (BT)	35	7.5	90	0	4.5

[1]Percent of bark remaining on trunk.

[2]Percent of live growth remaining in crown.

[3]Broken top snag.

larger), retained some of their bark, and had broken tops. Mean height for these snags was slightly lower (9.6m) than mean height for all snags on the study plots (10.8m).

Cavity-Nesting Bird Populations

Eleven species of cavity-nesters were observed on the seven plots during breeding bird surveys. Pygmy nuthatches were most numerous, followed by mountain chickadees and house wrens. Among woodpeckers, common flickers were most numerous, followed by Williamson's sapsuckers and hairy woodpeckers.

The Green Mountain West Ridge plot contained all eleven species. The ponderosa pine/Douglas fir forest on the West Ridge plot was infested by spruce budworms between 1985 and 1990, and although few of the recently created snags contain nest cavities, most probably support healthy insect populations. Forty-nine of the 59 snags on the West Ridge plot showed signs of woodpecker drilling or bark scaling.

The contrast is striking between the Green Mountain West Ridge plot, with 24 species, 55 individuals and 67% cavity-nesters and Flagstaff Plot No. 2, with 5 species, 12 individuals, and 0% cavity nesters. The Flagstaff plot is located in a monoculture of stunted ponderosa pines with sparse shrub vegetation and contains only 2 snags. The West Ridge plot is located in a mixed forest of ponderosa pine/Douglas fir with a well developed shrub understory and 59 snags. The difference in snag density on these two plots is probably one of several factors that distinguish a rich avian habitat from a relatively sterile one.

Table 4. Plot Densities of Cavity-Nesting Birds.[1]

Species	E-1	E-2	F-1	F-2	C-1	C-2	W-1	Total
Williamson's Sapsucker					1		3	4
Hairy Woodpecker		2					1	3
Northern Flicker					1		4	5
Violet-Green Swallow		2	2		2		2	8
Mountain Chickadee	1	2	1		2	1	5	12
Red-Breasted Nuthatch	1		1		2	1	2	7
White-Breasted Nuthatch							1	1
Pygmy Nuthatch		5					10	15
Brown Creeper							1	1
House Wren		2				2	5	9
Western Bluebird							3	3

[1]Highest number of individuals of each species seen on any one count.

Management Recommendations

The results of this study reaffirm conclusions reached by several more exhaustive studies conducted in Rocky Mountain coniferous forests. These previous studies are summarized in Table 5.

Scott and Oldmeyer (1983) investigated snag use by cavity-nesting birds in an Arizona ponderosa pine forest before and after a timber harvest. They concluded that cavity-nesting birds were nesting or roosting at "natural levels" in the uncut forest, which contained 7.5 snags/ha. Reduced densities of cavity-nesting birds were noted in areas of the forest where snags had been removed. Nest holes were present in 54% of all snags > 47cm DBH, whereas only 28% of snags < 47cm DBH had nest holes. The majority of nest holes were found in snags that had been dead at least 6 years and with at least 40% bark cover.

Marzluff and Lyon used a multi-variant model to estimate habitat requirements of open nesting birds on 19, 5 hectare plots in western Montana coniferous forest. They observed a strong correlation between snag density and population density of open nesting birds and concluded that at least 60 snags/ha are necessary to provide suitable habitat for sensitive open nesting species. They recommended patchy snag distribution to provide niches for primary and secondary cavity nesters, ground and shrub nesters, and forest interior species. Number of snags > 30cm DBH was an excellent predictor of bird abundance on study plots. This

Table 5. Recommended Snag Densities for Ponderosa Pine/Douglas-fir Forest.

Study	Minimum Snags/ha	Minimum Snag DBH (cm)	Minimum Snag Ht. (m)	Other Considerations
Scott and Oldemeyer (1983) Ponderosa Pine, Arizona	5.8-8.7	47	---	>40% bark
Marzluff and Lyon (1983) Ponderosa/Engelman/sub-alpine fir, Western Montana	60	30	---	Patchy snag distribution
Thomas et. al. (1979) Ponderosa Pine, Eastern Oregon	5.6-17	25	---	Some species need larger snags
Scott, Whelan, and Svoboda (1980) Ponderosa Pine, Colorado	---	47	---	> 40% bark, broken tops
Cunningham, Balda, and Gaud (1980) Ponderosa Pine, Colorado	5.2	33	6	> 40% bark, broken tops, 5-29 year age

conclusion was supported by the Boulder Mountain Park Forest Bird Study (Jones 1989) and by other studies of breeding birds in western coniferous forests (Ffolliott 1983, Mannan 1980).

Thomas et. al. computed snag densities required to support maximum populations of woodpecker species in eastern Oregon ponderosa pine forest. By estimating the home range of each species and the suitability of existing snags for use by each species, they were able to calculate minimum numbers of snags necessary to support maximum populations. They concluded that white-headed woodpeckers needed 5.58 snags/ha > 25.4cm DBH; hairy woodpeckers required 4.46 snags/ha > 25.4cm DBH; and Williamson's sapsuckers required 3.71 snags/ha > 30.5cm DBH.

Scott, Whelan, and Svoboda (1980) examined the characteristics of snags used by cavity-nesting birds in Colorado aspen, ponderosa pine, and sub-alpine forests. They concluded that snag diameter, percentage of bark present, and length of time that snags had been dead were important determinants of nest site selection by cavity-nesting birds. Sixty-five percent of snags dead more than 5 years had holes, whereas only 12% of snags dead 5 years or less had holes. Snags < 47cm DBH were used less frequently than larger snags. Snags used by primary cavity-nesters averaged 90% bark cover, and snags used by secondary cavity-nesters averaged 76% bark cover.

Cunningham, Balda, and Gaud (1980) studied snag use by secondary cavity-nesting birds in Colorado ponderosa pine forest. Results of their investigation led to the following conclusions about the characteristics of desirable snags:

(1) Diameter of snags should be > 33cm.

(2) Total height of snags should be > 6m.

(3) Percent bark cover should be > 40%.

(4) Snags which have broken tops should be saved if they also fit the above criteria.

(5) Ponderosa pine snags in the most frequently used age range of 5-29 years should be saved.

They recommended a minimum snag density of 5.2 snags/ha in mature ponderosa pine forests, with preference given to snags that met their criteria.

There will never be complete agreement on the precise number of snags necessary to support viable populations of cavity-nesting birds in various ecological settings. However, there is significant agreement about desirable characteristics of snags. Cavity-nesting birds consistently select large diameter, broken top snags with at least 40% bark cover. Snags fitting this description and snags containing nest cavities should never be removed during forest thinning operations. Additional snags should be retained, as well, whenever possible. Although there may be some agreement about lower limits of snag density (somewhere around 5-10 large snags/ha), no one has as yet attempted to establish a maximum desirable snag density. Marzluff and Lyon (1983) concluded that a variety of breeding bird species can benefit from snag densities as high as 80-90 snags/ha in Rocky Mountain coniferous forests.

The following guidelines for snag management in the Boulder Mountain Park are synthesized from results of the current study and the studies summarized in Table 5. These guidelines should be

modified as additional information is gathered concerning snag use by cavity-nesting birds in the Mountain Park:

(1) Maintain snag densities of at least 10 snags/ha > 25cm DBH and at least 5 snags/ha > 35cm DBH throughout the Mountain Park.

(2) Retain all snags containing nest cavities.

(3) Retain all snags > 35cm DBH.

(4) Retain broken top snags > 25cm DBH and with at least 40% bark cover.

(5) Create snags as necessary to provide nesting habitat for rare or endangered populations of cavity-nesting birds.

The areas of the Boulder Mountain Park supporting lowest snag densities were generally those areas where forest thinning had taken place (Jones 1990, 1989). In areas where no forest thinning has occurred, natural creation of snags from insect infestation, lightning strikes, and wind throw may be sufficient to maintain adequate snag densities. Artificial creation of snags may be necessary in those areas where too many snags have been removed. Infrequent and judicious culling of dead trees to reduce fire hazard and arrest insect infestations need not conflict with the goal of maintaining suitable habitat for breeding bird populations, so long as the above guidelines are followed.

Cavity-Nesting Species of Special Interest

The term "species of special interest" describes breeding birds in the Boulder Mountain Park that fall into one or more of the following categories:

(1) Extirpated species.

(2) Federal or State endangered or threatened species.

(3) Species undergoing long-term non-cyclical population declines.

(4) Rare species.

(5) Species with isolated or restricted populations.

(6) Species with increasing populations that pose a threat to species in categories 1-5.

Population information for Boulder County was derived from Henderson (1908), Betts (1913), Alexander (1937), The Boulder County Wildlife Inventory (Boulder Audubon Society 1975-91), and the Environmental Resources Element of the Boulder County Comprehensive Plan (Boulder County Parks and Open Space 1988). State and National population data were derived from the American Birds "Blue List" (Tate 1986) and the Colorado Latilong Survey (Kingery 1975).

Eight cavity-nesting species fit the above criteria for species of special interest. Status of these species in the Boulder Mountain Park and management recommendations for each species are given below.

1. Flammulated owl

Status: Isolated or restricted population; 4-6 nesting pairs in the Mountain Park.

Narrative: Flammulated owls are found in isolated foothills canyons containing late successional or old-growth ponderosa pine/Douglas fir forest (Reynolds and Linkhart 1987). They were considered rare in Boulder County until recently (Betts, Henderson, and Alexander), when isolated populations were discovered in the Boulder Mountain Park and in North St. Vrain Canyon (Jones 1991). In the Mountain Park, breeding flammulated owls were found in Long Canyon, Upper Skunk Canyon, Shadow Canyon, and an unnamed canyon west of South Boulder Peak (see Figure 3). These owls nest in areas containing large diameter live ponderosa pines, large diameter snags, and dense shrub vegetation (Jones 1991, 1989: Reynolds and Linkhart 1987). Flammulated owls nest in cavities excavated by woodpeckers in aspen and ponderosa pine. They may require large diameter live trees for roosting (Reynolds and Linkhart 1987).

Management Recommendation: Every effort should be made to avoid cutting of all snags and all trees > 25cm DBH in Long Canyon, Lost Gulch, Shadow Canyon, Upper Skunk Canyon, and the unnamed canyon west of South Boulder Peak. Continued monitoring of flammulated owl populations throughout the Park is recommended.

2. Williamson's Sapsucker

Status: May be declining in Boulder County; estimated Mountain Park population of approximately 8 pairs/100 ha.

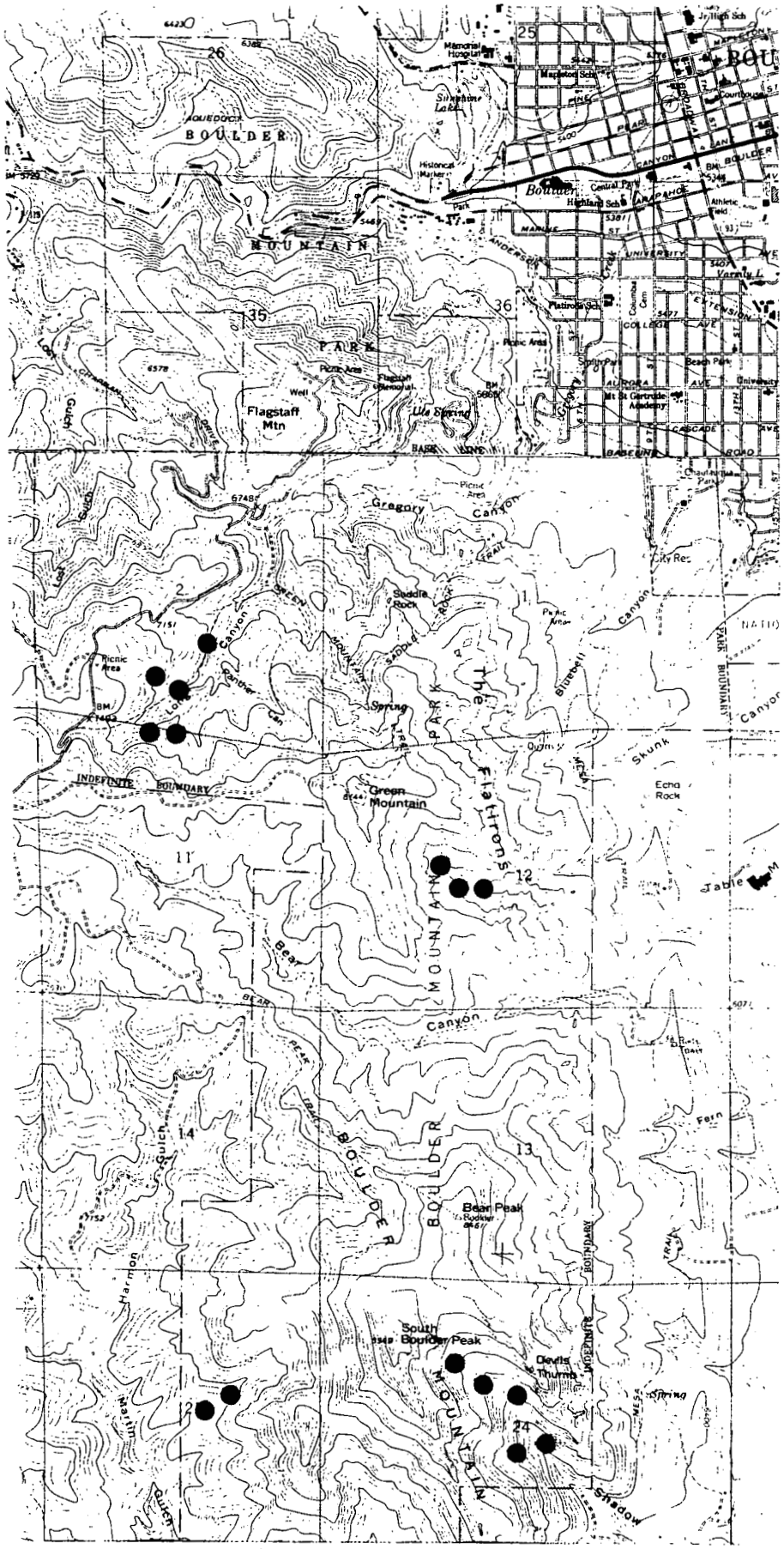


Figure 3. Flammulated Owl Distribution, 1988-91. Each dot represents one singing male during one breeding season.

Narrative: This species nests in Lost Gulch, Long Canyon, on Green Mountain West Ridge, on Bear Peak West Ridge, and in the canyons on the west side of Bear Peak and South Boulder Peak (Figure 4). It can excavate nest cavities in ponderosa pine, lodgepole, Douglas fir, or aspen (Ehrlich et. al. 1988, Crockett and Hansley 1977). It was listed as common by Henderson (1908) and Betts (1913). It is now considered an uncommon summer resident throughout much of its range in Boulder County (Boulder Audubon Society 1975-91). Some observers believe that Williamson's sapsucker populations are stable in Boulder County (Mike Figgs, pers. comm., Hallock 1987).

Management Recommendation: This species would benefit from a policy of retaining large snags in areas of the Boulder Mountain Park above 3,000m (6,600'). As a primary cavity nester, this species creates nesting sites for flammulated owls and other secondary cavity nesters.

3. Lewis's Woodpecker

Status: Declining locally; rare in Boulder Mountain Park; American Birds "Blue List"; last observed nesting in Boulder Mountain Park in 1986.

Narrative: Henderson (1908) and Betts (1913) classified Lewis's woodpecker as a common summer resident in the lower foothills of Boulder County. This species is now confined to a few sites in the county, mostly on the plains (Boulder Audubon Society 1975-91). A pair of Lewis's woodpeckers nested successfully in a large snag on Panorama Point in the Mountain Park in 1985. During

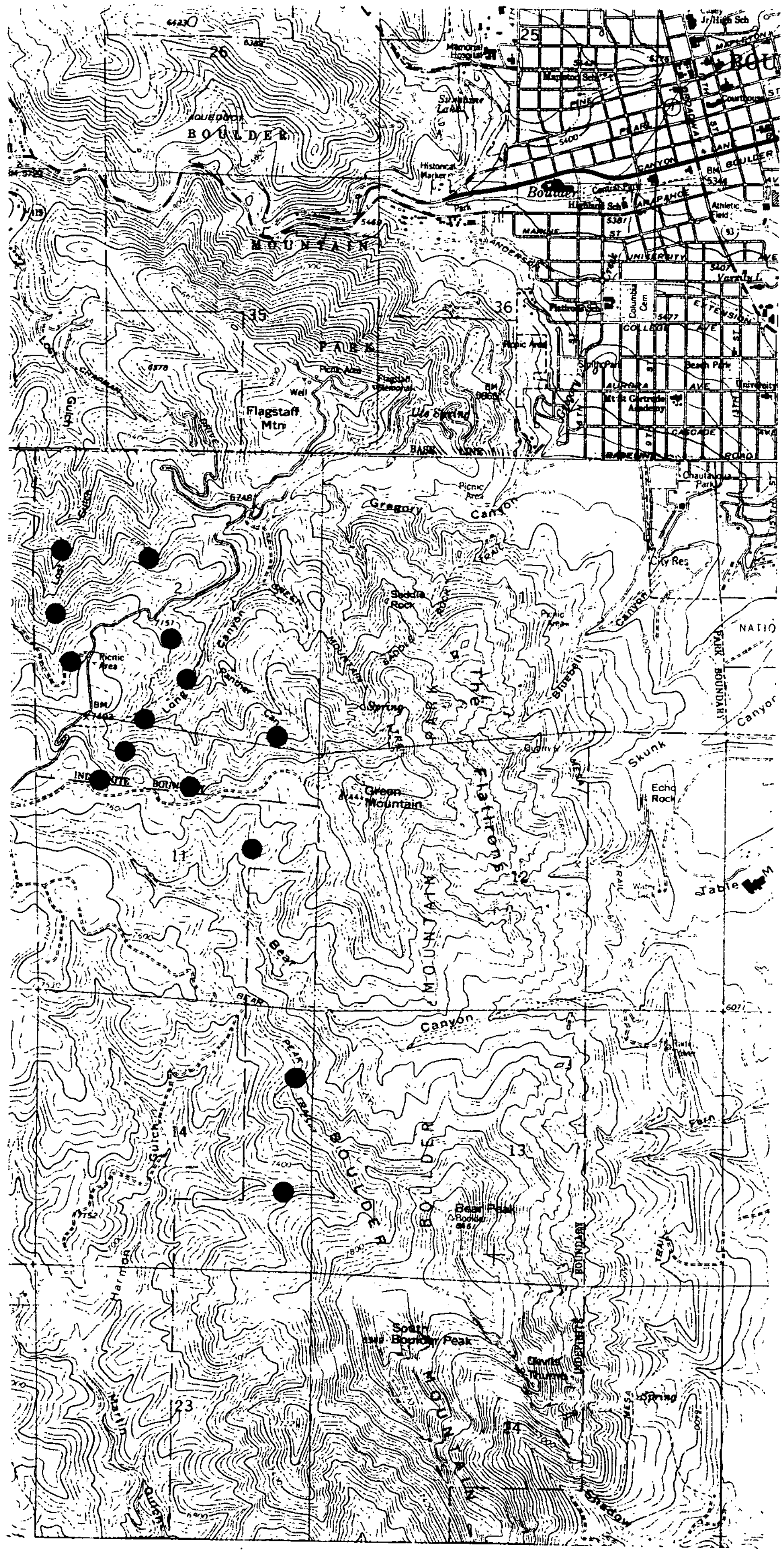


Figure 4. Williamson's Sapsucker Sightings, 1989-91. Each dot represents one territorial male or one pair.

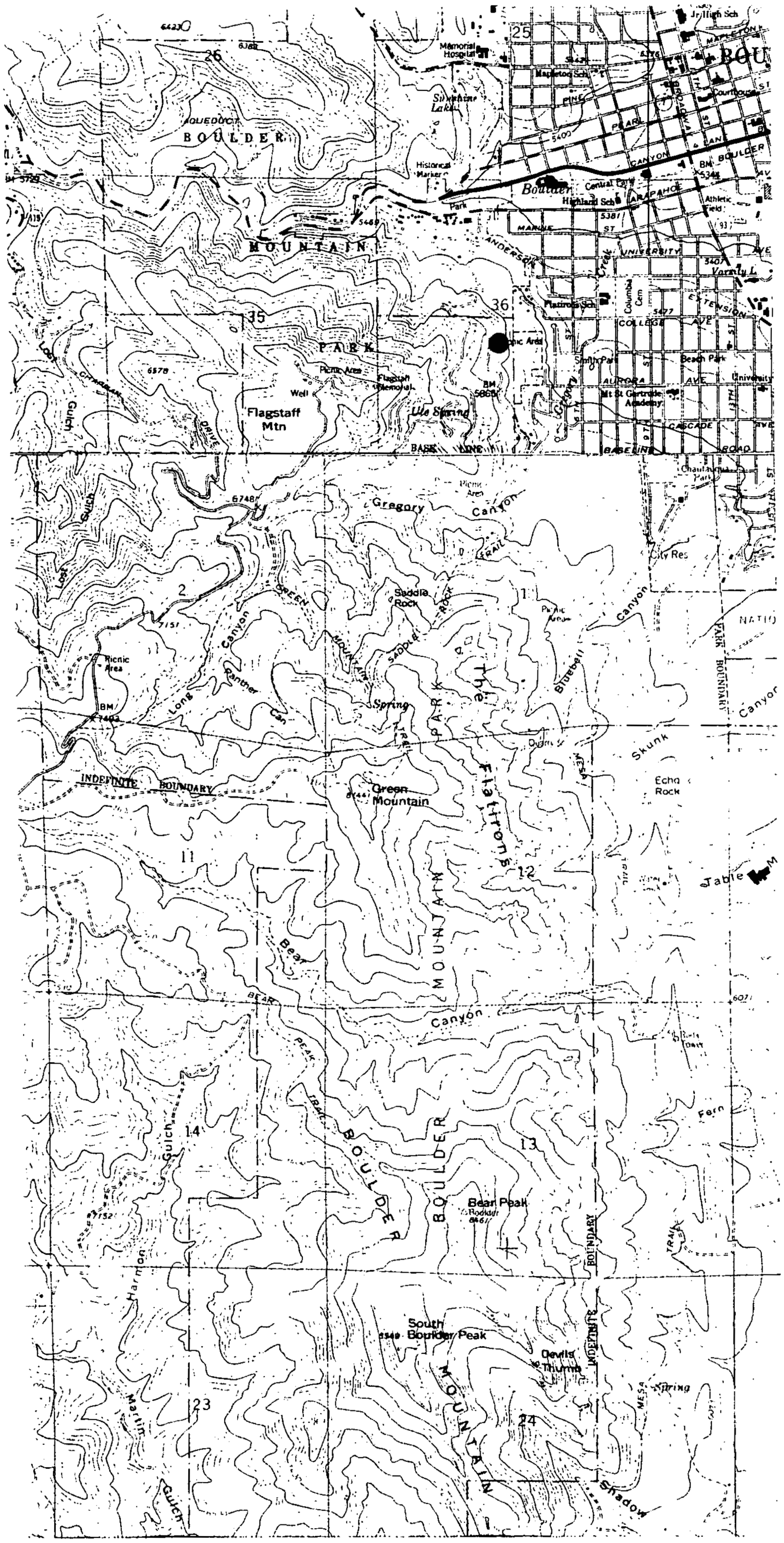


Figure 5. Lewis's Woodpecker Nest Location, 1985-6.

summer, 1986, a nesting attempt at this site failed when a pair of European starlings took over the nest cavity the woodpeckers had been using. This tree fell down during summer, 1987.

Disruption of nesting activity by European starlings has affected Lewis's woodpecker populations throughout North America. Lewis's woodpeckers can nest in pre-excavated cavities in live or dead trees (Short 1982). A search for Lewis's woodpeckers in the Mountain Park throughout the summers of 1989-91 found no active nests.

Management Recommendation: Monitor populations and protect potential nest sites.

4. Hairy Woodpecker

Status: American Birds "Blue List"; estimated population in the Mountain Park of 15 pairs/100 ha (Jones 1990, 1989).

Narrative: Hairy woodpecker populations appear to be steady or increasing in the Mountain Park (Jones 1989). Thomas et. al. (1979) estimated that a minimum of 4.46 snags/ha > 25.4cm DBH are required to maintain maximum populations in eastern Oregon ponderosa pine forests. Hairy woodpeckers preferred large, broken top snags with evidence of heart rot and > 40% bark. In the West nests are usually in dead conifers (Short 1982).

Management Recommendations: Maintain minimum snag densities of 5 snags/ha > 25cm throughout the Mountain Park with preference given to broken top snags and snags with at least 40% bark.

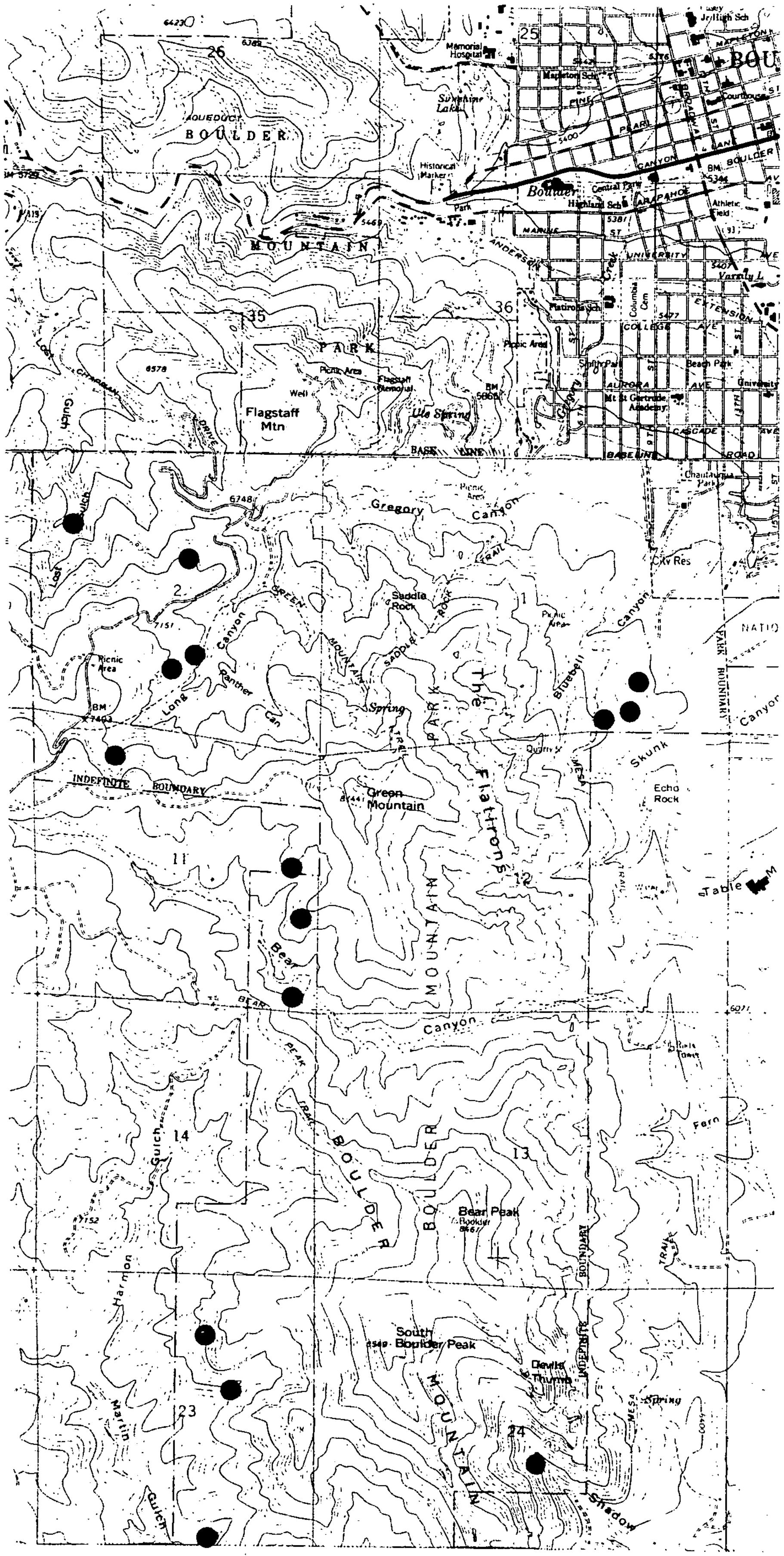


Figure 6. Hairy Woodpecker Sightings, 1989-91. Each dot represents one territorial male or one pair.

5. Brown Creeper

Status: Restricted habitat; rare breeder in Boulder Mountain Park; Mountain Park populations may be as low as 1-2 pairs/100 ha (Jones 1990, 1989).

Narrative: Brown creeper was listed as a rare or uncommon breeder by Henderson (1908), Betts (1913), and Alexander (1937). Populations may be declining in the Mountain Park (Jones 1989). Hallock (1987) listed this species as fairly common in spruce-fir forests at higher elevations of Boulder County. Brown creepers often nest in cavities or sloughed-off bark of dead or dying trees (Davis 1978, Bent 1964).

Management Recommendations: Retain dense thickets, large snags, and large trees in thinned stands; avoid disturbance of late successional and old-growth stands throughout the Park.

6. Western Bluebird

Status: Rare and declining in Boulder County; American Birds "Blue List;" estimated Mountain Park population of 3-5 pairs.

Narrative: Western bluebird was listed as an infrequent mountain resident by Henderson, Betts, and Alexander. It is now classified as rare in Boulder County (Boulder County Comprehensive Plan). Western bluebird populations throughout the western United States have been negatively impacted by the cutting of dead trees and competition from introduced species, including house sparrow and European starling (Ehrlich et. al. 1988).

During the last three years, western bluebirds have nested in three known locations in the Boulder Mountain Park (Figure 8).

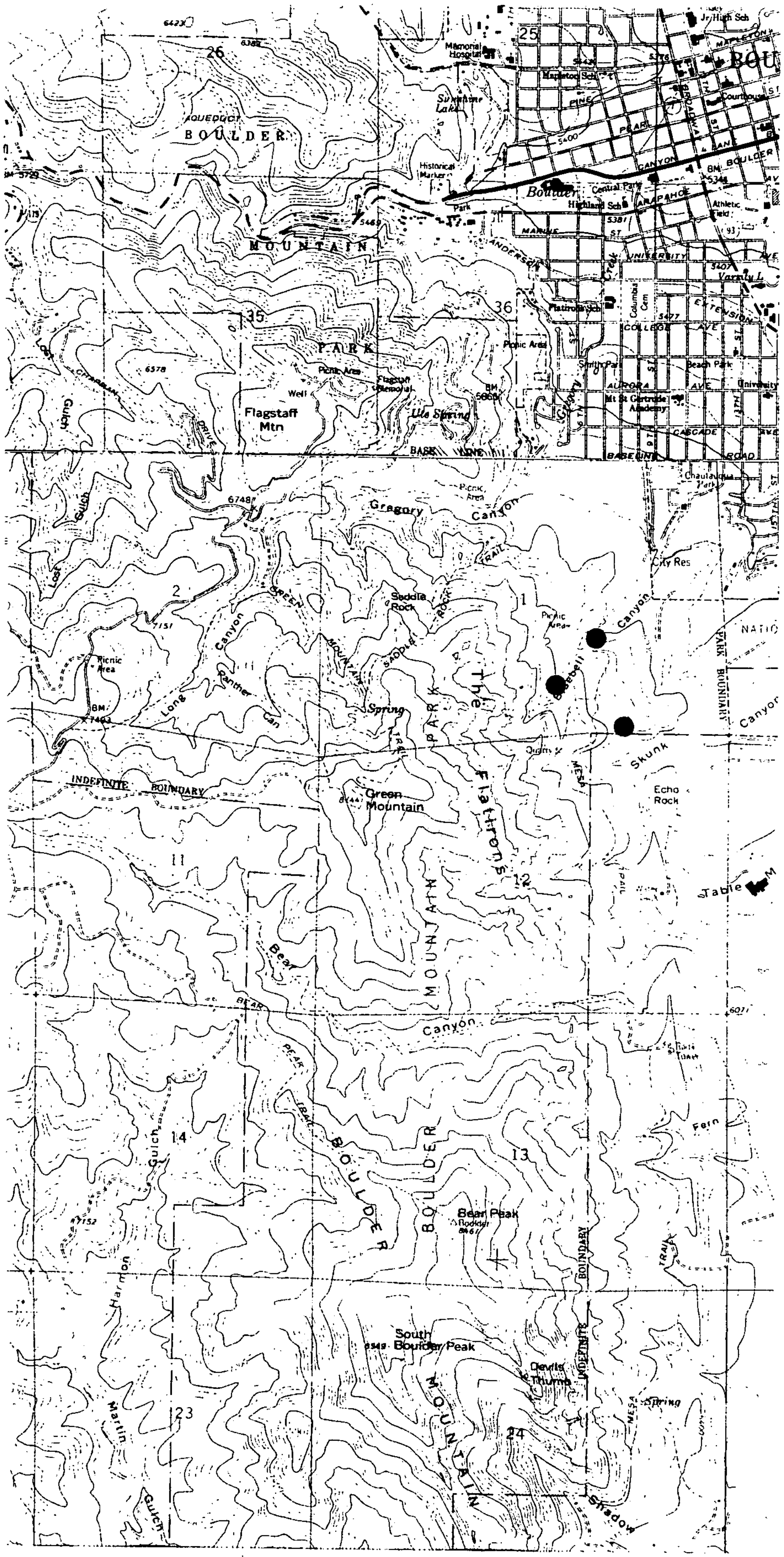


Figure 7. Brown Creeper Distribution, 1989-91. Each dot represents one territorial male or one pair.

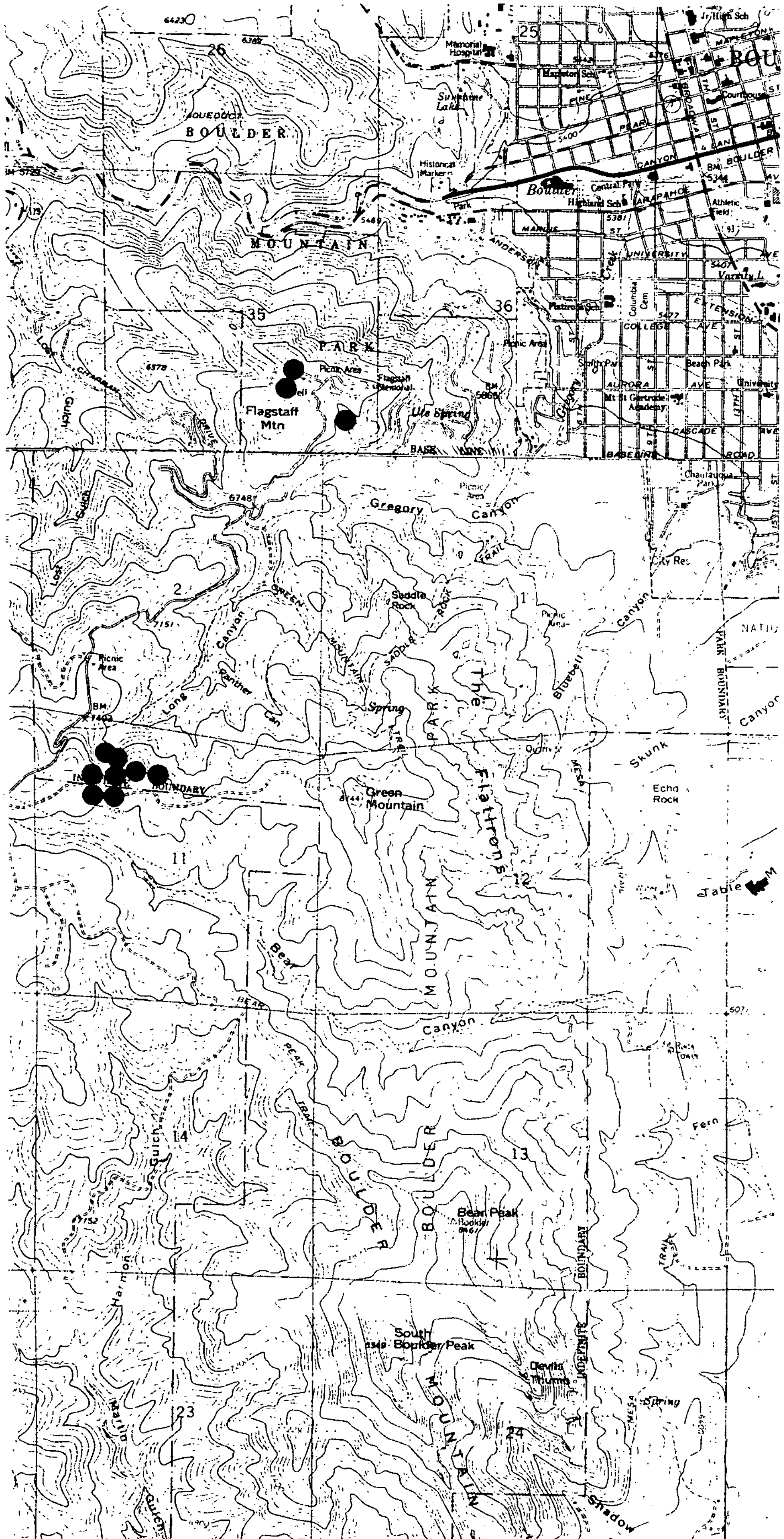


Figure 8. Western Bluebird Sightings, 1989-91. Each dot represents one territorial male or one pair.

Green Mountain West Ridge has been the most productive site, with at least 4 pairs in 1989, at least 2 pairs in 1990 (Jones 1990, 1989), and at least 2 pairs in 1991. A pair of western bluebirds was observed near Artist's Point in 1990, and an active nest was found about 50m south of Artist's Point in a ponderosa pine snag in 1991 (Jeanne Scholl, pers. comm.). During the 1989 breeding season, another pair of western bluebirds was observed on Flagstaff Mountain in the meadow south of the Flagstaff Summit Center (Ann Wichmann, pers. comm.). These are the only currently documented nest sites for western bluebird in all of Boulder County (Dave Hallock pers. comm.). No other western bluebirds were sighted within the Mountain Park during breeding bird surveys conducted during 1989, 1990, and 1991.

Western bluebirds nest in woodpecker holes or naturally occurring openings in dead or dying trees (Bent 1964). They will also use nest boxes, although competition with swallows and house wrens can be a problem (Bent 1964). Western bluebird nests are only occasionally parasitized by cowbirds (Ehrlich et. al. 1988). Preferred nesting habitat is open woodland and open country with scattered trees (Ehrlich et. al. 1988). Boulder County lies at the extreme eastern edge of the western bluebird's summer range in North America.

Management Recommendations: Avoid cutting of snags containing cavities or cutting any other snags > 25cm DBH on Green Mountain West Ridge; monitor western bluebird populations annually on Green Mountain West Ridge. Create additional snags on Flagstaff Mountain near Artist's Point to supplement existing snags (snag density is

low in that area). Consider erecting nest boxes near Artist's Point and on Green Mountain West Ridge.

7. Mountain Bluebird

Status: Declining in Boulder County; American Birds "Blue List;" one nest site and one territory were found within the Boulder Mountain Park during the 1989-91 breeding seasons.

Narrative: Listed as very common throughout Boulder County by Betts and abundant in the County by Alexander, mountain bluebird is now a rare to uncommon breeder in the Boulder Mountain Park (Jones 1989). I observed a single mountain bluebird nest in the Mountain Park during the 1989-91 breeding seasons. It was located in an open stand of ponderosa pine on Green Mountain West Ridge (see Figure 9). I also observed a singing male mountain bluebird in ponderosa pine woodland in a canyon west of Bear Peak during June, 1991.

Mountain bluebirds are considered common summer residents of the high mountains of Boulder County (Hallock 1987). The Boulder Mountain Park probably lies at the lower end of their elevational range. Ehrlich et. al. (1988) reported that mountain bluebirds usually nest in open coniferous and deciduous forests, sub-alpine meadows, and other open country above 7,000'. Mountain bluebirds adapt readily to nest boxes (Herlugson 1981). A "bluebird trail" erected by Kathy Gibson just west of the Mountain Park at Walker Ranch has been quite successful. In 1990, 18 of 20 nest boxes were occupied by mountain bluebirds (Kathy Gibson, pers. comm.). Erection of nest boxes throughout North America has helped arrest

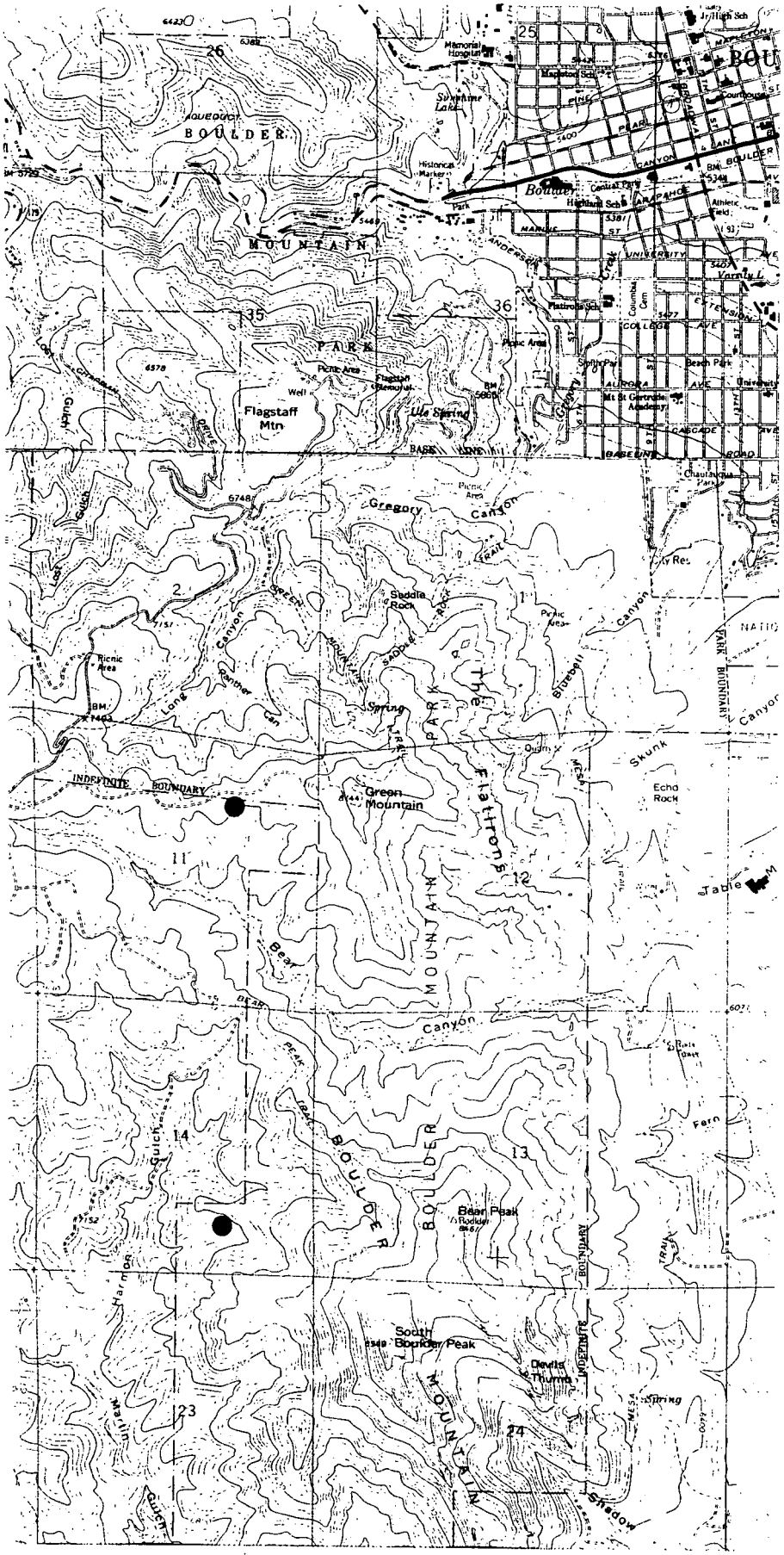


Figure 9. Mountain Bluebird Sightings, 1989-91. Each dot represents one territorial male or one pair.

a decline in mountain bluebird populations resulting from snag removal, competition from starlings and house sparrows, and rarely, nest parasitism by cowbirds (Ehrlich et. al. 1988).

Management Recommendations: Monitor populations annually; avoid snag removal in areas where mountain bluebirds are nesting.

8. European Starling

Status: Increasing population posing a threat to species in categories 1-5. Observed on only 1 of 30 breeding bird plots in the Mountain Park, 1989-90.

Narrative: The starling is an introduced species to North America which was first observed in Boulder County during the 1940's (Boulder County Comprehensive Plan 1988). Starlings are considered important competitors of bluebirds, Lewis' woodpeckers, and other cavity-nesting species (Ehrlich et. al. 1988). Although starling populations are increasing throughout North America (Ehrlich et. al. 1988), starlings still appear to be rare to uncommon in the Boulder Mountain Park. Ehrlich et. al. (1988) reported that starlings are usually absent from dense coniferous forest, the predominant habitat type in the Mountain Park. Starlings have been observed in the Mountain Park on the lower slopes of Flagstaff Mountain, in Chautauqua Meadow, and in lower Skunk Canyon (Jones 1990, 1989). A pair of starlings disrupted the nesting activity of a pair of Lewis's woodpeckers on Flagstaff Mountain during summer, 1986 (Jones 1989).

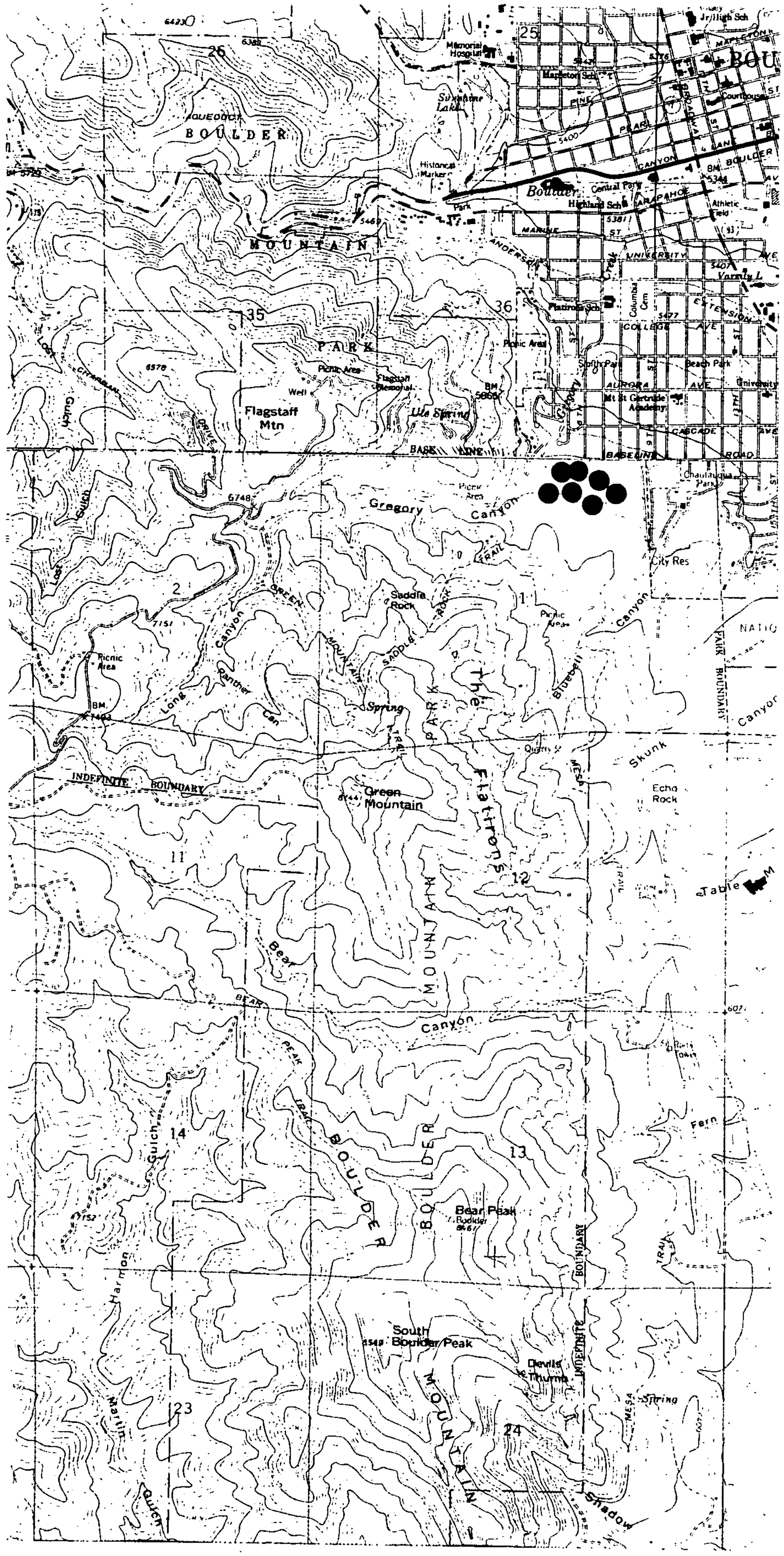


Figure 10. European Starling Distribution, 1989-91. Each dot represents one sighting.

Management Recommendations: Monitor starling populations in the Mountain Park to assess their impact on other cavity-nesting birds.

Additional Research: Snag Recruitment

A variety of methods have been used to create snags for cavity-nesting birds. Some of the more successful techniques are described below, with recommendations given for their use in the Boulder Mountain Park as part of an ongoing snag management program.

Girdling

Girdling may be the most cost effective method for creating snags. Two parallel rings 4-6 inches apart are cut with a chainsaw, and then the bark between the rings is chipped off with a polaski. Production rates using this method average about 15 minutes/tree (Conklin et. al. 1991). Girdled trees die slowly, are susceptible to being toppled by windstorms, and rot slowly (Conklin et. al. 1991). Girdling is recommended for Flagstaff Plot No. 2.

Burning

Researchers in New Mexico have experimented with using fire to create snags (Conklin et. al. 1991). Slash is piled 3-5 feet high around the base of a tree and ignited with a drip torch. Trees are scorched at the base, but crowns are left intact. Production time averages about 1 hour/tree. Preliminary results suggest that most snags created in this way show signs of woodpecker drill holes and bark scaling within 1 year after treatment. This method is recommended for Cathedral Park Plot No. 2.

Injection of Heart Rot Fungus

Connor and Locke (1983, 1982) have experimented with injecting red heart fungus (Phellinus pine) into loblolly pines (Pinus taeda) in Texas. Hollow pine dowels infected with the fungus were inserted into drill holes in the trees at a height of 3m. Although this technique successfully mimics natural heart rot invasion of pines, it is time consuming, and the success rate is low. Connor and Locke (1983) reported that only 50% of inoculated trees showed signs of infection 3 years after inoculation. They predicted that excavation of nest cavities by red-cockaded woodpeckers would occur 8-12 years after successful inoculation. This procedure is recommended for Enchanted Mesa Plot No. 1.

Literature Cited

Alexander, G. 1937. The birds of Boulder County, Colorado. The University of Colorado Studies, 24:79-105.

Balda, R.P. 1975. The relationship of secondary cavity nesters to snag densities in western coniferous forests. U.S.D.A. Forest Service Wildlife Habitat Technical Bulletin 1, 37 pp.

Bent, A. C. 1964. Life Histories of North American Thrushes, Kinglets, and Their Allies. Dover Publications, Inc., New York.

Betts, N. 1913. Birds of Boulder County, Colorado. The University of Colorado Studies, 10:177-232.

Boulder Audubon Society. 1975-91. Monthly wildlife inventories.

Boulder County Parks and Open Space Dept. 1988. Boulder County Comprehensive Plan, Environmental Resources Element.

Brush, T., B.W. Anderson, and R.D. Ohmart. 1983. Habitat selection related to resource availability among cavity-nesting birds. U.S.D.A. Forest Service Technical Report RM-99.

Bull, E. L. 1983. Longevity of snags and their use by woodpeckers. Proc. of Symposium on Snag Management. U.S.D.A. Forest Service Technical Report RM-99.

Colorado State Forest Service. 1982. Forest Management Plan: Mountain Parks and Open Space Lands.

Conklin, D., B. Ferguson, and L. Pope. 1991. Forest Pest Management Report. U.S.D.A. Forest Service, General Technical Report R-3 91-4.

Conner, R. N., J. G. Dickson, and J. H. Williamson. 1983. Potential woodpecker nest trees through artificial inoculation of heart rots. Snag habitat management: Proceedings of the Symposium. J.W. Davis, G.A. Goodwin, and R.A. Ockenfels, Tech. Coord. U.S.D.A. Forest Service, General Technical Report RM-99: 68-72

Conner, R.N. and B.A. Locke. 1982. Fungi and red-cockaded woodpecker cavity trees. Wilson Bull, 94(1): 64-70

Conner, R.N., and B.A. Locke. 1983. Artificial inoculation of red heart fungus into loblolly pines. Pages 81-82, in Red-cockaded Woodpecker Symposium II, D.A. Wood, Ed. Fl Game and Forest Water Fish Comm., U.S. FWS, and U.S.D.A. Forest Service.

Crockett, A. B., Jr., and P. L. Hansley. 1977. Coition, nesting, and post-fledging behavior in Williamson's Sapsucker in Colorado. Living Bird 16:7-19.

Cunningham, J., R. Balda, and W. Gaud. 1980. Selection and use of range by secondary cavity-nesting birds of the ponderosa pine forest. U.S.D.A. Forest Service Research Paper RM-222, Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado, 15p.

Davis, C. M. 1978. A nesting study of the brown creeper. Living Bird 17:237-263.

Ehrlich, P., D. Dobkin, and D. Wheye. 1988. The Birder's Handbook. Simon and Schuster, New York.

Ffolliott, P. F. 1983. Implications of snag policies on management of southwestern ponderosa pine forests. Proc. of Symposium on Snag Habitat Management. U.S.D.A. Forest Service General Technical Report RM-99, 28-29.

Hallock, D. 1987. Indian Peaks Four Season Bird Counts: A Five Year Retrospective, 1982-1986. Boulder County Association, Publication No. 7.

Henderson, J. 1908. An annotated list of the birds of Boulder County, CO. University of Colorado Studies, 6:220-242.

Herlugson, C. J. 1981. Nest site selection of Mountain Bluebirds. Condor 83:252-255.

Jones, S.R. 1989. Boulder Mountain Park Forest Bird Study. Report for Boulder Parks and Recreation Dept.

Jones, S.R. 1990. Managing Boulder Mountain Park Ecosystems for Bird and Mammal Populations. Report for Boulder Parks and Recreation Dept. Unpublished.

Jones, S.R. 1991. Distribution of small forest owls in Boulder County, Colorado. C.F.O. Journal 25: 55-70.

Mannan, R.W. 1980. Assemblages of bird species in western coniferous old-growth forest. Management of Western Forests and Grasslands for Nongame Birds. U.S.D.A. Forest Service General Technical Report INT-86. Ogden, Utah, 357-368.

Mannan, R.W., E.C. Meslow, and H.M. Wright. 1980. Use of snags by birds in Douglas fir forests, western Oregon. Journal of Wildlife Management, 44:787-797.

Mannan, R.W., and E.C. Meslow. 1984. Bird populations and vegetative characteristics in managed and old-growth forests, northeastern Oregon. Journal of Wildlife Management, 48:1219-1238.

Marzluff, J., and J. Lyon. 1983. Snags as indicators of habitat suitability for open nesting birds. U.S.D.A. Forest Service General Technical Report RM-99. Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado, 140-146.

McClelland, B.R., and S.S. Frissell. 1975. Identifying forest snags useful for hole-nesting birds. J. For., 73:414-417.

Miller, E., and D.R. Miller. 1980. Snag use by birds. Management of Western Forests and Grasslands for Nongame Birds. U.S.D.A. Forest Service Technical Report INT-86. Ogden, Utah, 337-356.

Morrison, M. L., M. G. Raphael, and R. C. Heald. 1983. The use of high-cut stumps by cavity-nesting birds. Proc. of the Symposium Snag Habitat Management. U.S.D.A. Forest Service General Technical Report RM-99.

Reynolds, R.T., and B.D. Linkhart. 1987. The nesting biology of flammulated owls in Colorado. Symposium on Biology and Conservation of Northern Forest Owls. U.S.D.A. Forest Service General Technical Report RM-142.

Scott, V.E. 1978. Characteristics of ponderosa pine snags used by cavity-nesting birds in Arizona. Journal of Forestry, 76(1):26-28.

Scott, V.E. J.A. Whelan, and P.L. Svoboda. 1980. Cavity-nesting birds and forest management. Management of Western Forests and Grasslands for Nongame Birds. U.S.D.A. Forest Service General Technical Report INT-86. Ogden, Utah, 311-324.

Scott, V.E., and J.L. Oldmeyer. 1983. Cavity-nesting bird requirements and responses to snag cutting in ponderosa pine. Snag Habitat Management: Proceedings of the Symposium. U.S.D.A. Forest Service General Technical Report RM-99. Fort Collins, CO 19-23.

Short, L. L. 1982. Woodpeckers of the World. Delaware Museum Natural History, Greenville.

Tate, J. Jr. 1986. The blue list for 1986. American Birds, 40(2):227-237.

Thomas, J.W., R.G. Anderson, C.Maser, and E.L. Bull. 1979. Snags. Wildlife Habitats in Managed Forests: The Blue Mountains of Oregon and Washington. U.S.D.A. Forest Service Agricultural Handbook 553. Washington, D.C., 60-77.

Appendix A

Scientific Names of Birds Mentioned in Text

Common Name	Scientific Name
American Kestrel	Falco sparverius
Lewis's Woodpecker	Melanerpes lewis
Williamson's Sapsucker	Sphyrapicus thyroideus
Hairy Woodpecker	Picoides villosus
Northern Flicker	Colaptes auratus
Violet-green Swallow	Tachycineta thalassina
Mountain Chickadee	Parus gambeli
Red-breasted Nuthatch	Sitta canadensis
White-breasted Nuthatch	Sitta carolinensis
Pygmy Nuthatch	Sitta pygmaea
Brown Creeper	Certhia americana
House Wren	Troglodytes aedon
Western Bluebird	Sialia mexicana
Mountain Bluebird	Sialia currucoides
European Starling	Sturnus vulgaris

APPENDIX B: PLOT MAPS

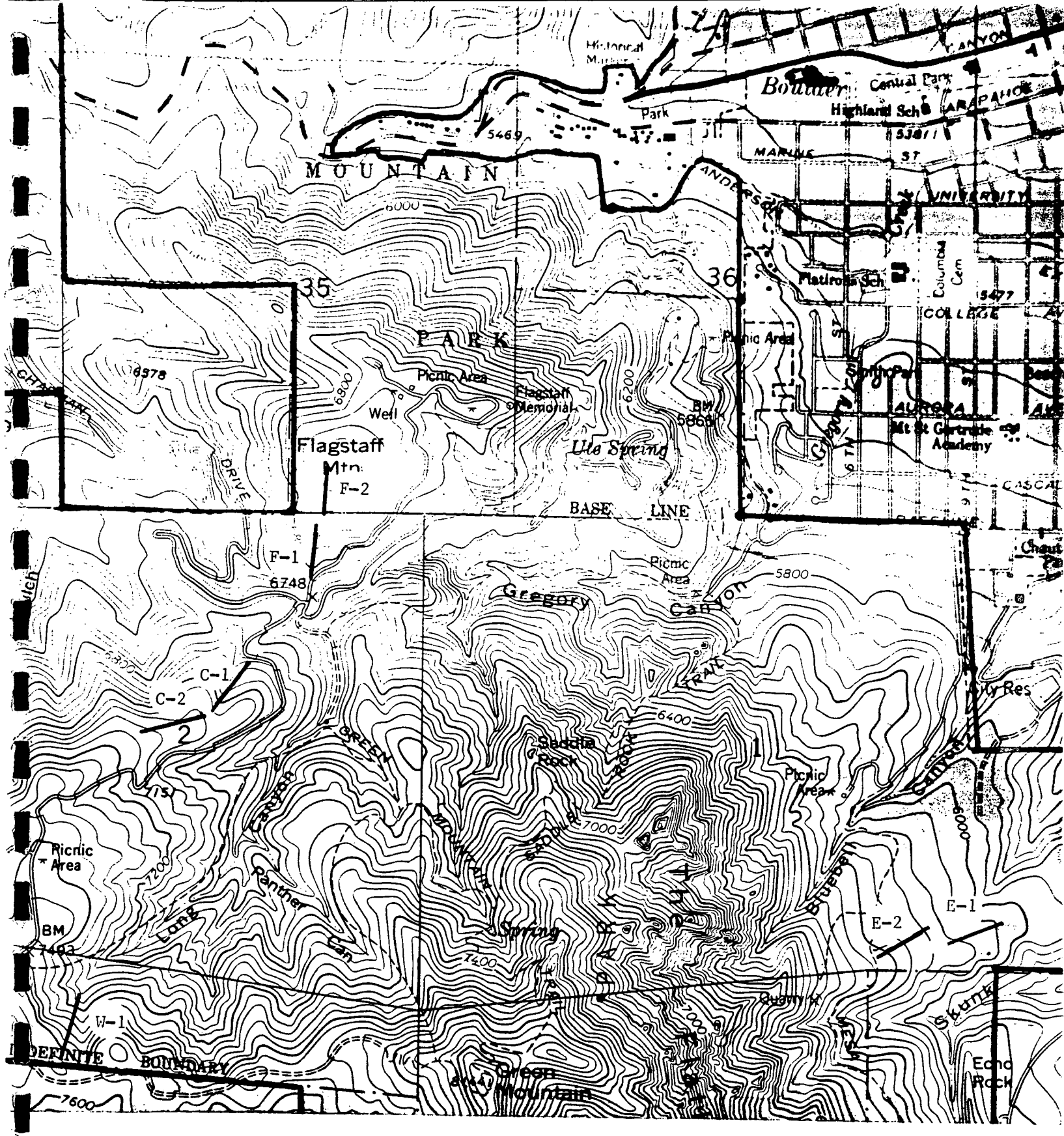
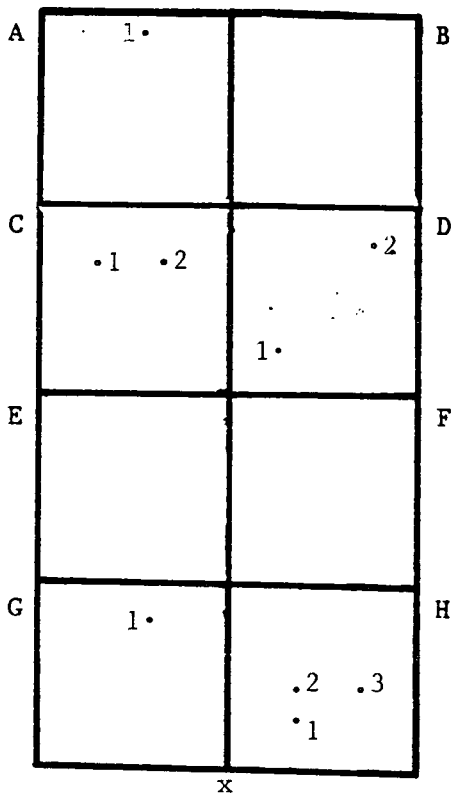


Figure 11. Plot Location (Detail). Lines show approximate location of median transect in each plot.

PLOT NAME Enchanted Mesa East LOCATION G/H begins at fence at intersection of Kohler Mesa and Skunk Cyn Trail; direction of center transect is 250° WSW.

YEAR 1991



Snag No.	DBH (in.)	Height(m)	%Crown[1]	%Bark[2]	Type[3]	#Cavities[4]	Occupied?
G1	15	4.0	0	80	PP B	1 W	
H1	11	7.5	0	35	PP B	0 W	
H2	12	6.2	0	100	PP B	0 W	
H3	9	3.9	0	100	PP B	10 W	
D1	14	6.7	0	100	PP B	0 W	
D2	8	8.0	0	10	PP B	0 W	
C1	11	4.2	0	0	PP B	5 W	
C2	19	12.2	0	100	PP	0 W	
A1	10	7.0p	0	100	PP B	0	

[1]Percent of live growth

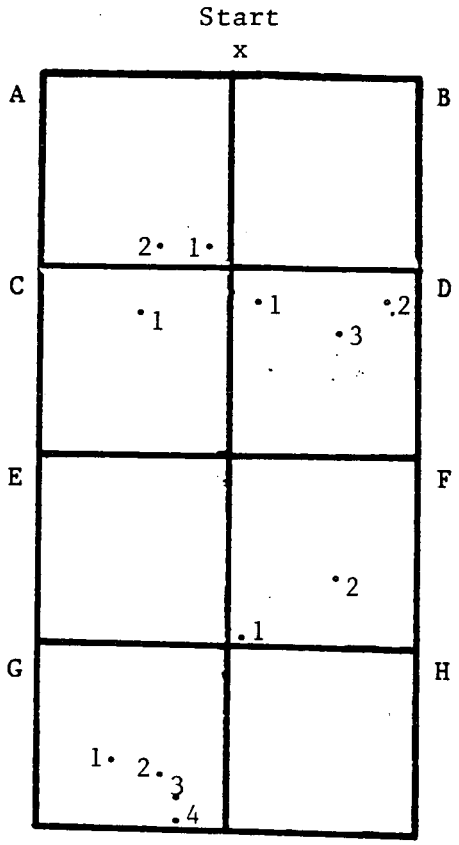
[2]Percent of bark remaining on tree

[3]"B" means "broken top."

[4]"W" means "woodpecker damage."

PLOT NAME Enchanted Mesa West LOCATION A/B begins at Mesa Trail, 30m ESE of small stone shelter; direction is 70° ESE.

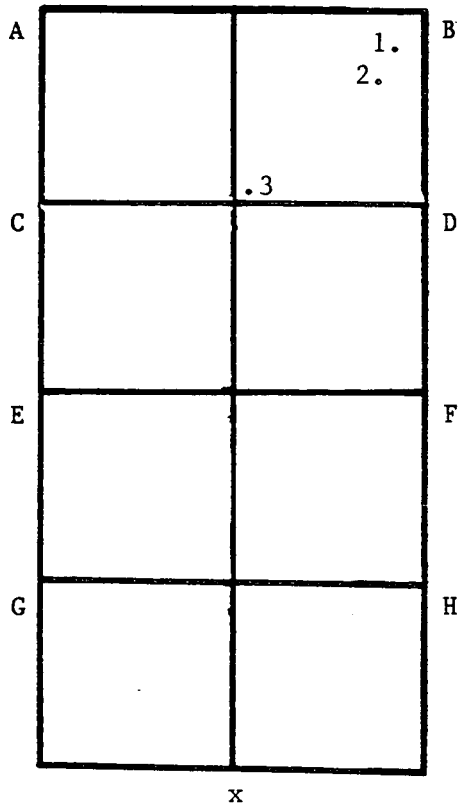
YEAR 1991



Snag No.	DBH	Height	%Crown	%Bark	Type	#Cavities	Occupied?
A1	8	4.5	0	80	PP B	0 W	
D1	20	6.5	0	100	PP B	4	1 H. Wood
D2	24	21.0	0	20	PP	1 W	1 V. Green
D3	15	5.5	0	100	PP B	0 W	
C1	8	7.5	50	100	PP B	0	
F1	18	8.2	0	5	PP B	7	
F2	14	6.8	0	5	PP B	15	Rotting/leani
G1	8	7.1	25	100	PP B	0	
G2	8	7.5	0	90	PP B	0 W	
G3	24	9.6	0	100	PP B	8	
G4	22	6.2	0	75	PP B	6	
A2	8	3.5	0	65	PP B	0W	

PLOT NAME FLAGSTAFF SOUTH LOCATION G/H begins on ponderosa, 40m NNE of intersection Flagstaff Rd. and Flagstaff Summit Rd; direction is NNE, 15°.

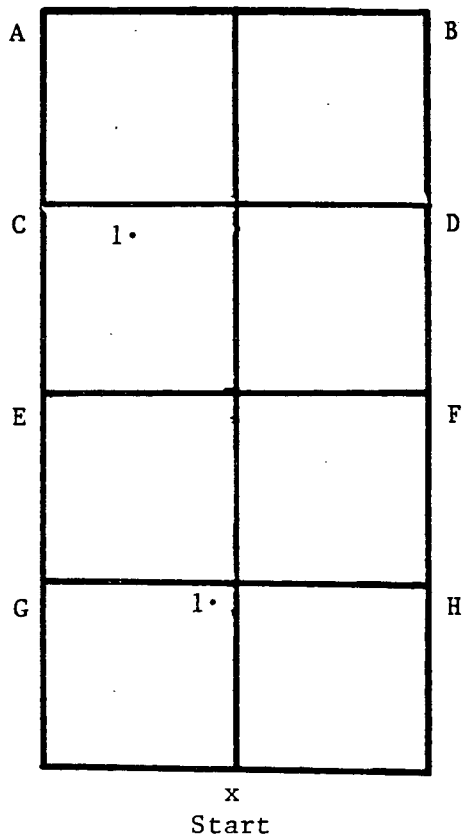
YEAR 1991



Snag No.	DBH	Height	%Crown	%Bark	Type	#Cavities	Occupied?
B1	13	17.0	0	100	PP	0 W	
B2	10	11.5	0	100	PP	0 W	
B3	11	5.1	0	0	PP B	7	

PLOT NAME FLAGSTAFF NORTH LOCATION G/H begins 50m NNE of end of Flag. South center transect; direction is 15°, NNE.

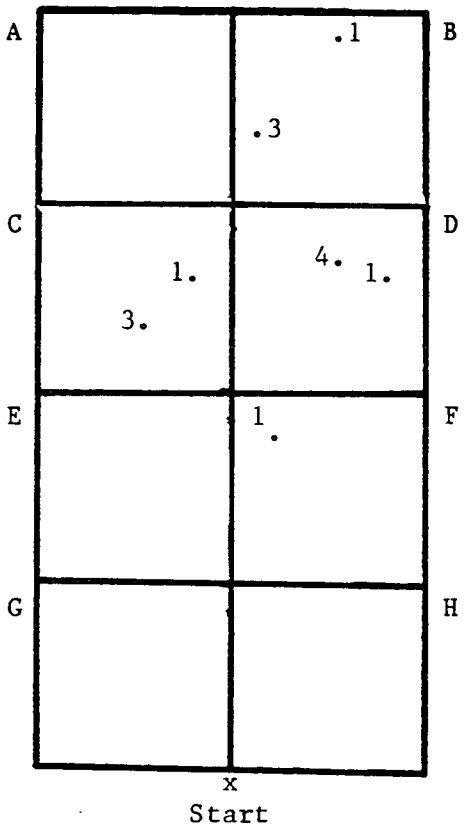
YEAR 1991



Snag No.	DBH	Height	%Crown	%Bark	Type	#Cavities	Occupied?
C1	11	4.5	0	85	PP B	OW	
G1	17	3.7	0	90	PP B	OW	

PLOT NAME Cathedral East LOCATION Begins first power pole, 30m south of curve on Flagstaff Rd; direction 210°, SSW.

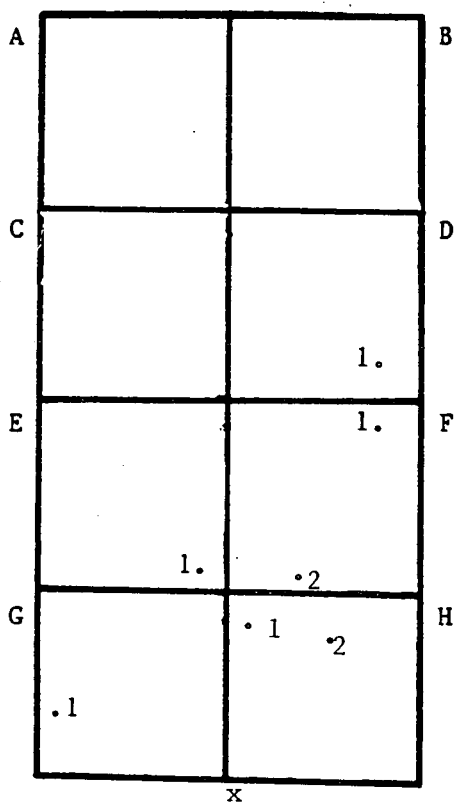
YEAR 1991



Snag No.	DBH	Height	%Crown	%Bark	Type	#Cavities	Occupied?
B1	10	10.0	0	0	Df	0W	
SKIP							
B3	10	11.6	0	85	Df	0W	
C1	13	8.0	0	100	PP B	0	
C2	SKIP						
C3	13	21.0	0	35	Df	0	
D1	10	8.5	0	65	Df	0W	
D2	SKIP						
D3	SKIP						
D4	8	3.5	0	100	PP B	0	
F1	13	17.5	0	80	Df	CW	

PLOT NAME Cathedral West LOCATION Begins at last power pole, 50m SSW of end of Cathedral East plot; direction 240°, WSW.

YEAR 1991



Snag No.	DBH	Height	%Crown	%Bark	Type	#Cavities	Occupied?
D1	9.0	9.6	0	100	Df	0W	
E1	15.0	3.6	0	95	Df B	8	1 H. Wren
F1	8.0	6.0	0	70	Df	0W	
H2	15	17	0	80	Df	0W	
G1	13	8.5	0	70	PP	1	
F2	11	12.5	0	90	Df	0 W	
E1	14	3.1	0	90	Df B	1 W	