# SNAG DENSITIES AND BREEDING BIRD POPULATIONS IN ELDORADO MOUNTAIN AREA PONDEROSA PINE FOREST

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-Anne Oyer

Written in 1993

## SUMMARY

I sampled snag densitites and breeding bird population densities on nine 2-ha ponderosa pine forest plots on the Lindsay and Lindsay-Jeffco properties (Eldorado Mountain area) and on one 2-ha ponderosa pine forest plot in a natural burn area on Shanahan Ridge. Mean snag density on the nine Eldorado Mountain area plots was 1.1 large snags/ha (snags > 25 cm DBH). Snag density on the Shanahan Ridge plot was approximately 30 large snags/ha. Prior studies have suggested that a density of 5-8 large snags/ha is necessary to support cavity-nesting bird populations at natural levels in Rocky Mountain ponderosa pine forests.

Mean breeding bird density on the nine Eldorado Mountain area plots was 4.4 individuals/ha, and cavity-nesters comprised 26% of all individuals seen. Mean breeding bird density on the Shanahan Ridge plot was 10.0 individuals/ha, and cavity-nesters comprised 42% of all individuals. Mean breeding bird density on the nine Eldorado Mountain area plots was significantly lower ($p < .01$) than mean breeding bird density on eight randomly located 2-ha ponderosa pine forest plots sampled on City of Boulder Open Space by Thompson and Strauch (1986). I found only five active cavity nests on the nine Eldorado Mountain area plots.

Individual Eldorado Mountain area plots with higher snag densitites supported significantly higher numbers of cavity-nesting birds ($p < .01$) and slightly higher numbers of breeding bird species ($p < .10$). Plots located in open canopy ponderosa pine "woodland" supported significantly higher numbers of species ($p < .03$) and individuals ($p < .01$) than did plots located in closed canopy ponderosa pine "forest."

I recommend that Open Space staff institute an aggressive snag recruitment program on the Lindsay and Lindsay-Jeffco properties. Staff may wish to experiment with a variety of techniques, including prescribed burns, girdling, and topping, to create snags. Prescribed burns, which create snags while also improving habitat for ground and shrub nesting birds, should definitely be continued in this area.

# INTRODUCTION

Standing dead trees (snags) are an important component of Rocky Mountain coniferous forest ecosystems. Snags provide roosting, nesting, and denning sites for a variety of birds and mammals. These and other wildlife feed on insect populations which abound in dead and dying trees. In areas of the forest where snag density is high, the forest canopy opens up and allows light to penetrate to the forest floor, encouraging the growth of shrubs and young trees.

Management of Rocky Mountain coniferous forests has often resulted in degradation of habitat for snag dependent birds and mammals (Scott and Oldemeyer 1983, Mannan and Meslow 1984, Ohmann et. al. 1994). Cutting of large trees, removal of snags, and suppression of fires have created even-aged forests with low snag densities. Until recently, the Colorado State Forest Service's prescription for thinning foothills ponderosa pine forests recommended leaving only one large snag per acre (2.4 snags/ha, Colorado State Forest Service 1982). Studies of snag density relationship to cavity-nesting bird populations in Rocky Mountain coniferous forests have recommended maintaining a density of at least 5 large snags/ha (Balda 1975, Scott 1978, Bull 1983).

Two recent studies of breeding bird populations within the Boulder Mountain Park suggest that low snag densities in some regions of the Park may limit cavity-nesting bird populations (Jones 1990, 1991). A total of twenty-two 5-ha plots within the Park supported a mean snag density of only 2.4 large snags/ha (snags larger than 20 cm DBH). Cavity-nesting birds comprised only 21% of all individuals seen during breeding bird surveys conducted on these plots. Six 2-ha plots on Flagstaff Mountain supported a mean snag density of 1.6 large snags/ha. Cavity-nesting birds comprised only 21% of all breeding birds observed on these six plots, and only three plots contained active cavity nests (Jones 1991).

Surveys of breeding bird populations on the Lindsay and Lindsay-Jeffco Open Space Properties on the eastern slopes of Eldorado Mountain indicate that some cavity-nesting species, including flammulated owl, hairy woodpecker and western bluebird, are nesting at unusually low densities and that snag distribution within the area is spotty (Jones 1993, 1994). In April 1995, I initiated a sampling of snag densities and breeding bird population densities on these properties. The goals of 1995 field work were:

I. To sample snag densities in three types of ponderosa pine forest (riparian, mesa top open canopy, and mesa top closed canopy).

II. To sample breeding populations of cavity-nesting birds within the three ponderosa pine forest types.

III. To investigate the relationship of snag density to cavity-nesting bird density within the three forest types.

IV. To use data from this study and previous local studies to formulate forest management alternatives for the area.

Open Space staff has expressed a desire to manage the Lindsay and Lindsay-Jeffco properties as natural areas where human disturbance is limited. Staff hopes to use prescribed burns and other management tools to restore the forest in this area to a more natural condition. A sampling of snag densities and cavity-nesting bird population densities can help Open Space staff to better understand the condition of the ponderosa pine forest and to determine which management steps should be taken (including thinning, prescribed burns, and snag creation) to improve wildlife habitat. Permanent plots established for the study will facilitate long term monitoring of forest condition.

## STUDY AREA

The Lindsay and Lindsay-Jeffco Open Space properties lie in southern Boulder County and northern Jefferson County within T1S, R70W, section 31; and T2S, R70W, section 6. These parcels lie at the interface between the High Plains and Rocky Mountain foothills. Their topography is dominated by gently sloping mesas which were formed when upturned sedimentary rocks were eroded and later covered by a thin layer of younger gravel (Chronic 1980). Elevation of the mesas ranges from approximately 1830-1980 m. Mean annual precipitation is around 50 cm, with maximum precipitation occurring during April and May. The mean annual temperature is 10.5°C, with a July mean of 23°C and a January, mean of 0°C (Barry 1973).

The mesas' gravely soils and sunny, relatively mild climate provide favorable growing conditions for ponderosa pine (<u>Pinus ponderosa</u>) forest. Nearly continuous stands occur on the mesas between 1860-1980 m. At higher elevations, particularly on north and east-facing slopes, the ponderosa pine forest mixes with Douglas fir (<u>Psutotsuga menziesii</u>) forest. At lower elevations the ponderosa pines become scattered and slowly give way to the mixed grasslands of lower Doudy Draw. Small streams cutting across the mesas support isolated stands of cottonwoods (Populus spp.) and willows (Salix spp.), along with shrub communities dominated by chokecherry (Padus virginiana), hawthorne (Craetagus spp.), sumac (Rhus spp.), and box elder (Negundo aceroides).

Peet (1988) characterized Rocky Mountain ponderosa pine forest as consisting of two types: a "forest" type where canopy cover exceeds 50%, and a "woodland" type characterized by an open canopy and a grammanoid dominated understory. Historically, when periodic fires swept through the forest and killed the younger trees, the woodland type probably predominated, with closed canopy ponderosa pine forest occurring only in areas untouched by fire (Peet 1988).

During the early period of European settlement, much of the foothills ponderosa pine forest in Boulder County was destroyed by logging or catastrophic fire (Veblen and Lorenz 1990). The replacement stands, which began growing in the late 19th and early 20th centuries, were subsequently protected from natural fire. As a result, much of the forest on the mesas to the west and southwest of Boulder consists of even-aged stands of stunted, densely crowded trees (Colorado State Forest Service 1982). Open canopy ponderosa pine woodland still occurs on the steeper and rockier slopes, in recently logged or recently thinned areas of the forest, and in the forest-grassland transition zone.

Within the study area, closed canopy ponderosa pine forest occurs on the mesa in section 31. Open canopy ponderosa pine woodland occurs along the periphery of the mesa in section 31, throughout the mesa top in section 6, and in an area west of the Diversion Canal in section 31. This area appears to have been recently logged or thinned (Figure 1). The ponderosa pine forest growing along Spring Brook appears to be structurally different from both the crowded and stunted "forest" type and the open, grassy understory "woodland" type. In several locations along Spring Brook, this ponderosa pine forest exhibits old-growth characteristics (USDA Forest Service, 1994), including relatively large diameter trees, large diameter snags, a multi-layered canopy, and an understory dominated by mixed shrubs and small deciduous trees.

The disturbance history of the ponderosa pine forest within the study area is not well known. Prior to acquisition by the city in 1990, the area was under private ownership and used primarily for cattle grazing and mining. A swath of forest was cleared during construction of the Denver and Rio Grande Railroad in 1904 and construction of the Diversion Canal and adjacent road in 1935.

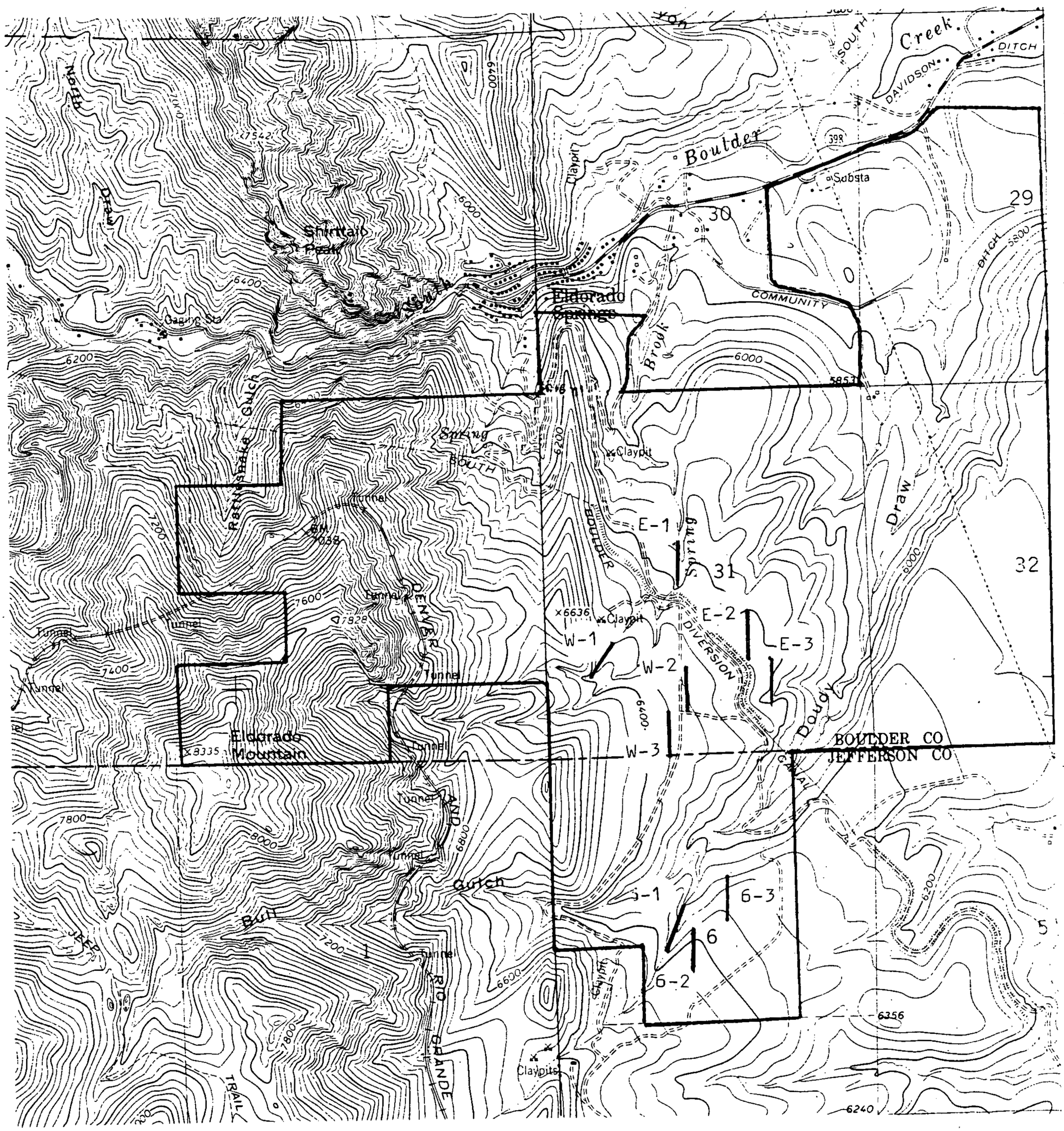



Figure 1. Open Space Boundary and Plot Locations, Eldorado Mt. Area.

Much of the forest in section 31 west of the Diversion Canal appears to have been thinned during the 1970s and 1980s. A townsite was platted in section 31 west of the Diversion Canal in 1907, and stone walls delineating homesites are still visible in that area.

During May-June of 1993 and 1994, I conducted breeding bird surveys in Doudy Draw and on the mesas to the west of the Draw. I observed a total of 91 potential breeding species, including 56 species which typically nest in ponderosa pine forest. These 56 species include 4 primary cavity-nesters (Williamson's sapsucker, hairy woodpecker, downy woodpecker, and northern flicker) and 12 secondary cavity-nesters (flammulated owl, northern pygmy owl, northern saw-whet owl, tree swallow, violet-green swallow, mountain chickadee, red-breasted nuthatch, white-breasted nuthatch, pygmy nuthatch, brown creeper, northern house wren, and western bluebird). Although cavity-nesters occurred throughout the study area, populations seemed most concentrated along the edge of the mesa east of the Diversion Canal and in the Spring Brook drainage west of the Diversion Canal. Five cavity-nesting species--flammulated owl, northern pygmy owl, northern saw-whet owl, Williamson's sapsucker, and western bluebird--were seen only in the upper Spring Brook drainage (Jones 1993, 1994).

## METHODS

Three permanent 2-ha plots were randomly located and marked with metal flashing in each of three study sites (Figure 1). Study site 31W encompassed the mesa in section 31 west of the Diversion Canal; site 31E encompassed the mesa in section 31 east of the Diversion Canal; site 6 encompassed the northern portion of the mesa in section 6 and south of Doudy Draw. Three ponderosa pine forest types were identified for sampling: riparian, mesa top closed canopy, and mesa top open canopy. These forest types were mapped on 1": 24000" maps using 1": 6000" aerial photographs. Each forest type within each study site was then divided into 200 x 100 m cells, and cells were numbered consecutively within each site. A random numbers table was then used to select one plot of each forest type within each site. Site 6 did not contain enough closed canopy forest to encompass a 200 x 100 m plot, so a second open canopy plot was substituted. Open and closed canopy plots were oriented north-south. Riparian plots were oriented along the directional gradient of stream courses.

Open Space biologists expressed an interest in comparing breeding bird densities in the Eldorado Mountain plots with breeding bird density in a recently burned ponderosa pine forest stand on Shanahan Ridge, in section 18 of T1S, R70W (Figure 2). This approximately 5-ha site had been burned by a hot, lightning caused fire in 1989. A single 2-ha plot was laid out along the long axis of the burned area and marked with metal flashing.

Between 15 April-15 May I mapped and marked all snags within the nine Eldorado Mountain plots. I located snags by walking slowly along 200 m strip transects, 20 m apart, within each plot. I defined snags as standing dead or dying trees at least 3 m high and 20 cm in diameter and with less than 50% of normal live canopy growth; and live trees with dead branches containing potential nest cavities. I defined nest cavities as woodpecker holes or other excavations or natural cavities at least 3 cm in diameter and at least 5 cm in depth. There is no generally agreed upon definition of a nest cavity or a snag, but studies suggest that cavities smaller than 3 cm in diameter and snags smaller than 20 cm DBH and 3 m high are infrequently used by cavity-nesting birds (Miller and Miller 1980, Morrison et. al. 1983, Brush et. al. 1983). Due to time constraints, I did not mark or measure the more than 60 snags on the Shanahan Ridge plot.

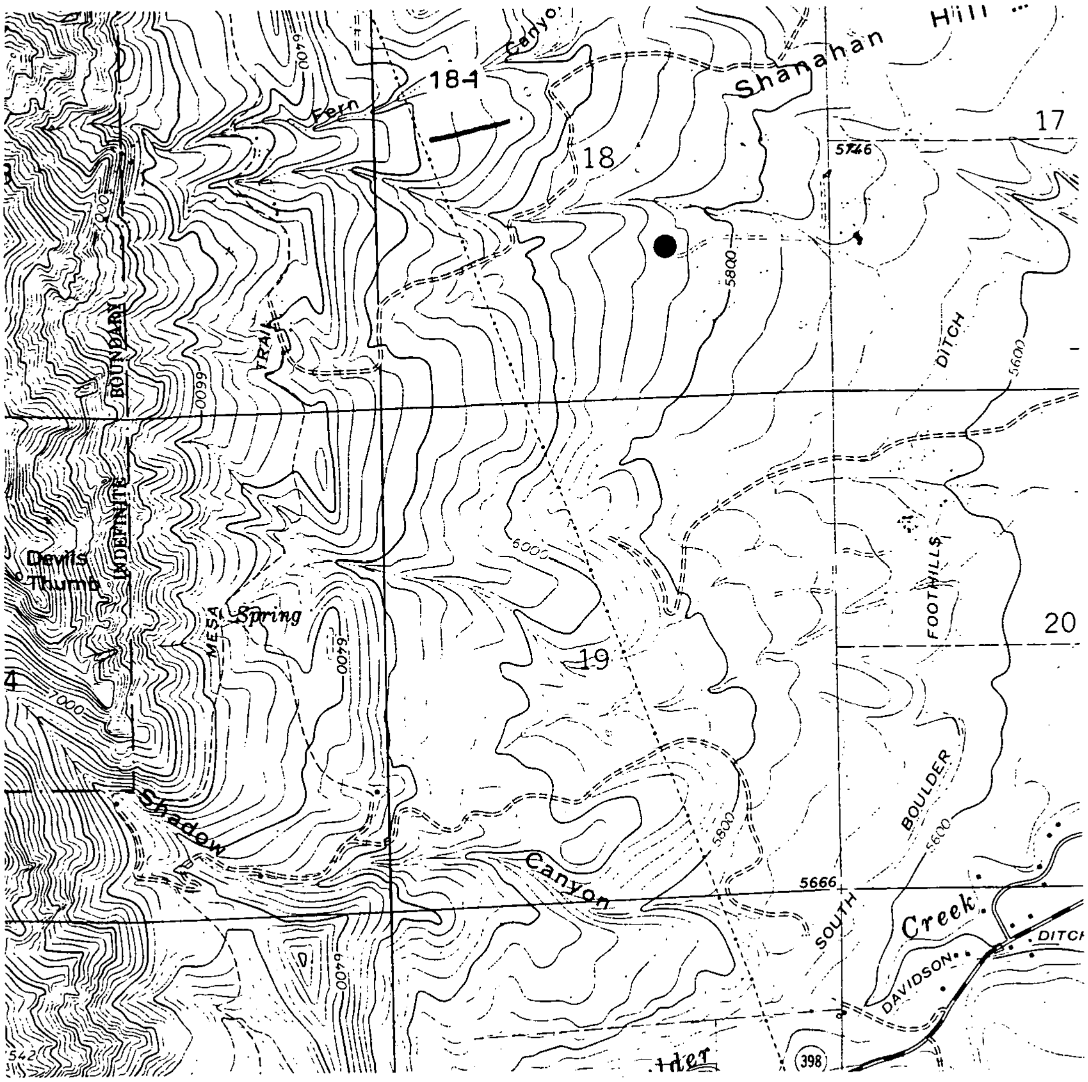



Figure 2. Shanahan Ridge Plot Location.

Between 20 May-10 July I conducted four breeding bird surveys on each plot. Surveys were carried out between sunrise and 9:00 a.m. M.S.T. I walked slowly along the medial axis of each plot, stopping every 25 m for one minute to look and listen for birds. All birds seen or heard within 50 m of the transect line were counted. I used a 15-70 m rangefinder to determine whether observed birds fell within 50 m of the transect line. After completing each breeding bird survey, I checked all snags within each plot for signs of nesting activity. If a snag contained potential nest cavities, I observed the snag from a distance of 30-50 m for 5 minutes on each visit. I used a DBH tape and clinometer to determine the diameter and height of each snag. I also characterized the species and type (straight top or broken top) of each snag, determined whether it contained nest cavities, and estimated the percentage of retained bark.

Data from this study were compared with data from a previous study on Flagstaff Mountain and Enchanted Mesa (Jones 1991). During the 1991 study, seven 2-ha plots were sampled using the same methodology. Four of these plots were located in recently thinned ponderosa pine forest on Enchanted Mesa and Flagstaff Mountain at elevations ranging from 1800-2000 m.

## RESULTS AND DISCUSSION

### Snag Densities and Snag Characteristics

Mean snag density in the nine Eldorado Mountain area study plots was 1.1 snags/ha, and the range was 0-5 snags/plot. Biologists who have studied snag use by cavity-nesting birds in western ponderosa pine forests have generally recommended maintaining snag densities of at least 5-8 large snags/ha (Thomas et. al. 1979, Cunningham et. al. 1980, Scott and Oldemeyer 1983). The snag density on the nine Eldorado Mountain plots is about one-fifth that recommended for maintaining "natural" populations of cavity-nesting birds in western ponderosa pine forests.

The "quality" of the snags in the Eldorado Mountain plots is relatively high (Table 1). Of the 20 identified snags, 11 (55%) had diameters greater than 50 cm, 12 (60%) had broken tops, which facilitate rotting and cavity excavation, and 12 (60%) contained potential nest cavities. Percent of bark cover also influences snag use by cavity-nesting birds. Scott et. al. (1980), Cunningham et. al. (1980), and Scott and Oldemeyer (1983) all found that cavity-nesters favored trees retained 25% or more of their bark

Table 1. Snag Characteristics, Eldorado Mountain.

| Snag Type | Number | With Cavities | With Nests |
| --- | --- | --- | --- |
| Ponderosa pine straight top | 8 | 6 | 1 |
| Ponderosa pine broken top | 12 | 6 | 4 |
| Total | 20 | 12 | 5 |

Table 2. Snag Characteristics, Eldorado Mountain, Enchanted Mesa, and Flagstaff Mountain[1].

| Snag Type | Number | With Cavities | With Nests |
| --- | --- | --- | --- |
| Ponderosa pine straight top | 13 | 7 | 2 |
| Ponderosa pine broken top | 39 | 19 | 7 |
| Total | 52 | 26 | 9 |

[1]Includes ponderosa pine snags in mixed forest (ponderosa pine/Douglas fir) plots on Flagstaff Mountain.

cover. Of the 20 Eldorado Mountain area snags, 14 (70%) retained 40% or more of their bark cover. The bark retains moisture in the whitewood and keeps the wood from hardening, making it easier for primary cavity-nesters to drill their own holes.

Mean snag density in the three ponderosa pine forest types was: riparian .85 snags/ha, closed canopy 1.25 snags/ha, open canopy 1.25 snags/ha. Snag distribution was patchy throughout the study area. For instance, on plot 31E-3 four of the five snags were clustered in a .25 ha area at the southwest corner of the plot, and in plot 31E-2 all three snags were clustered within a 20 $m^2$ area near the southeast corner. This patchy snag distribution partially explains why mean snag density for the three riparian plots (.85 snags/ha) was so low. The Spring Brook drainage contains several clusters of large snags. One cluster of five snags lies approximately 50 m northeast of the northern boundary of plot 31W-1. A second cluster of three large snags lies approximately 100 m west of the southwestern boundary of plot 31W-1.

In forests with high snag densities, patchy snag distribution may benefit birds with differing habitat requirements; snag patches provide nesting habitat for primary and secondary cavity-nesters as well as ground and shrub nesters, while snag-free, closed canopy areas provide nesting habitat for forest interior species. In forests with low snag densities, patchy snag distribution restricts the number of potential nest sites for territorial species. For example, northern house wrens, which nest at densities of about 1 pair/ha in areas of the Boulder Mountain Park where snag densities are relatively high (Jones 1990), nested at a density of .06 pairs/ha (1 pair in nine 2-ha plots) within the Eldorado Mountain study area.

## Breeding Bird Populations

I observed a total of 37 species on the nine Eldorado Mountain plots from 20 May-10 July (Table 3). I observed a single additional species (mountain bluebird) on the Shanahan Ridge plot (Table 4). Pygmy nuthatches were most abundant, followed by chipping sparrows and pine siskins. I observed a total of seven cavity-nesting species on the Eldorado Mountain plots: hairy woodpecker, northern flicker, violet-green swallow, mountain chickadee, pygmy nuthatch, northern house wren, and western bluebird. I observed seven cavity-nesting species on the Shanahan Ridge plot: hairy woodpecker, northern flicker, violet-green swallow, pygmy nuthatch, northern house wren, western bluebird, and mountain bluebird. Among all cavity-nesters on all plots, pygmy

Table 3. Plot Densities of Breeding Birds, Eldorado Mountain.
Mean No. per Count.*

| Species | W-1 | W-2 | W-3 | E-1 | E-2 | E-3 | 6-1 | 6-2 | 6-3 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Mallard | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Mourning Dove | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.5 | 0.5 | 0.5 | 2.5 |
| Great Horned Owl | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Broad-tailed Hummingbird | 0.5 | 0.0 | 0.3 | 0.3 | 0.3 | 0.5 | 1.0 | 0.0 | 0.3 | 3.0 |
| Hairy Woodpecker | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.5 |
| Northern Flicker | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Western Wood-Pewee | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.8 | 0.5 | 0.8 | 0.5 | 2.9 |
| Hammond's Flycatcher | 0.8 | 0.0 | 0.0 | 0.5 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 2.3 |
| Dusky Flycatcher | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Violet-green Swallow | 1.0 | 0.0 | 0.0 | 0.0 | 1.8 | 2.3 | 0.0 | 0.0 | 0.8 | 5.9 |
| Steller's Jay | 0.3 | 0.0 | 1.8 | 0.0 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 | 3.6 |
| Common Raven | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.3 | 0.5 |
| Mountain Chickadee | 0.8 | 0.0 | 0.0 | 0.3 | 0.0 | 1.0 | 0.0 | 0.3 | 0.0 | 2.3 |
| Pygmy Nuthatch | 2.0 | 2.3 | 1.0 | 0.5 | 1.5 | 1.8 | 0.0 | 0.8 | 1.5 | 11.4 |
| Northern House Wren | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.8 | 2.3 |
| Western Bluebird | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.3 |
| Townsend's Solitaire | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 |

Table 3. cont'd.

| Species | W-1 | W-2 | W-3 | E-1 | E-2 | E-3 | 6-1 | 6-2 | 6-3 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Swainson's Thrush | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.5 |
| Hermit Thrush | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| American Robin | 0.0 | 0.0 | 0.0 | 0.8 | 0.0 | 0.5 | 0.8 | 1.8 | 1.8 | 5.7 |
| Solitary Vireo | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 | 0.0 | 0.0 | 0.3 | 0.8 |
| Warbling Vireo | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Virginia's Warbler | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.5 | 0.0 | 0.0 | 0.8 |
| Yellow-rumped Warbler | 0.0 | 0.3 | 0.8 | 0.0 | 0.8 | 0.3 | 0.3 | 0.8 | 1.0 | 4.2 |
| Northern Parula | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.3 |
| MacGillavray's Warbler | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.3 |
| Yellow-breasted Chat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.3 |
| Western Tanager | 0.0 | 0.0 | 0.5 | 0.3 | 0.0 | 0.0 | 0.5 | 0.3 | 0.0 | 1.5 |
| Lazuli Bunting | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.8 | 0.0 | 0.0 | 1.1 |
| Rufous-sided Towhee | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 |
| Chipping Sparrow | 0.0 | 1.5 | 2.0 | 0.8 | 0.0 | 1.0 | 0.3 | 2.8 | 1.8 | 10.2 |
| Gray-headed Junco | 0.3 | 0.5 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 1.5 |
| Brown-headed Cowbird | 0.3 | 0.3 | 0.3 | 0.3 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 1.3 |
| Cassin's Finch | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| Pine Siskin | 0.0 | 0.0 | 1.3 | 0.0 | 1.0 | 1.3 | 0.3 | 1.3 | 1.8 | 6.8 |

Table 3. cont'd.

| Species | W-1 | W-2 | W-3 | E-1 | E-2 | E-3 | 6-1 | 6-2 | 6-3 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Lesser Goldfinch | 0.0 | 0.0 | 0.3 | 0.3 | 0.0 | 0.3 | 0.3 | 0.3 | 0.8 | 2.1 |
| American Goldfinch | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.5 |
| Total | 7.1 | 5.2 | 9.6 | 5.6 | 6.3 | 15.6 | 7.2 | 10.8 | 13.3 | 80.7 |

*Due to rounding, total numbers do not always equal the sum of individual plot numbers.

nuthatches were most abundant, followed by violet-green swallows and northern house wrens.

The near absence of primary cavity-nesters (birds that excavate their own holes) in the Eldorado Mountain area is particularly striking. I observed more hairy woodpeckers and northern flickers on the Shanahan Ridge plot, alone, than on the nine Eldorado Mountain plots combined (Table 4). Primary cavity-nesters tend to occupy snags that are harder and younger than those used by secondary cavity-nesters (Marzloff and Lyon 1983). All of the snags on Shanahan Ridge plot were relatively young,having been created by the 1989 fire; most of the snags in the Eldorado Mountain area appeared to be relatively old and soft.

Tables 5 and 6 show snag densities and breeding bird population densities on the nine Eldorado Mountain plots, the Shanahan Ridge plot, and four ponderosa pine forest plots sampled on Flagstaff Mountain in 1990 (Jones 1991). For the nine Eldorado Mountain plots, there was a weak positive relationship between number of snags and mean number of species ($r = .432$, $p < .10$); a weak positive relationship between number of snags and mean number of individuals ($r = .5$, $p < .10$); and a strong positive relationship between number of snags and mean number of cavity-nesting individuals ($r = .92$, $p < .01$). When the data from all 14

Table 4. Plot Densities of Breeding Birds, Eldorado Mt. and Shanahan Rdg.
Mean No. per Plot per Count.

| Species | Eld. Mt. 9 plots | Shan. Rdg. 1 plot |
|---|---|---|
| Mallard | 0.0 | 0.0 |
| Mourning Dove | 0.3 | 0.5 |
| Great Horned Owl | 0.0 | 0.0 |
| Broad-tailed Hummingbird | 0.3 | 0.5 |
| Hairy Woodpecker | 0.1 | 0.5 |
| Northern Flicker | 0.0 | 1.0 |
| Western Wood-Pewee | 0.3 | 1.0 |
| Hammond's Flycatcher | 0.3 | 0.0 |
| Dusky Flycatcher | 0.0 | 0.0 |
| Violet-green Swallow | 0.6 | 1.5 |
| Steller's Jay | 0.4 | 0.0 |
| Common Raven | 0.1 | 0.0 |
| Mountain Chickadee | 0.3 | 0.0 |
| Pygmy Nuthatch | 1.3 | 1.0 |
| Northern House Wren | 0.3 | 2.3 |
| Western Bluebird | 0.0 | 2.3 |
| Mountain Bluebird | 0.0 | 0.3 |
| Townsend's Solitaire | 0.1 | 0.0 |
| Swainson's Thrush | 0.1 | 0.0 |
| Hermit Thrush | 0.0 | 0.0 |

Table 4. cont'd.

| Species | Eld. Mt. 9 plots | Shan. Rdg. 1 plot |
|---|---|---|
| American Robin | 0.6 | 2.5 |
| Solitary Vireo | 0.1 | 0.3 |
| Warbling Vireo | 0.0 | 0.0 |
| Virginia's Warbler | 0.1 | 0.0 |
| Yellow-rumped Warbler | 0.5 | 0.0 |
| Northern Parula | 0.0 | 0.0 |
| MacGillavray's Warbler | 0.0 | 0.0 |
| Yellow-breasted Chat | 0.0 | 0.0 |
| Western Tanager | 0.2 | 0.0 |
| Lazuli Bunting | 0.1 | 0.0 |
| Rufous-sided Towhee | 0.1 | 0.3 |
| Chipping Sparrow | 1.1 | 1.8 |
| Gray-headed Junco | 0.2 | 0.3 |
| Brown-headed Cowbird | 0.1 | 0.5 |
| Cassin's Finch | 0.1 | 0.0 |
| Pine Siskin | 0.8 | 3.5 |
| Lesser Goldfinch | 0.2 | 0.3 |
| American Goldfinch | 0.1 | 0.0 |
| Total | 8.8 | 20.4 |

Table 5. Snag Densities and Breeding Bird Densities, Eldorado Mountain.

| Plot No. | Plot Type | No. Snags | Mean Species | Mean Individuals | % Cavity Nesters |
|---|---|---|---|---|---|
| 31W-1 | Riparian | 3 | 5.2 | 7.3 | 58 |
| 31W-2 | Closed canopy | 2 | 3.0 | 5.0 | 45 |
| 31W-3 | Open canopy | 0 | 6.5 | 9.8 | 10 |
| 31E-1 | Riparian | 1 | 4.8 | 5.3 | 14 |
| 31E-2 | Closed canopy | 3 | 4.0 | 6.0 | 54 |
| 31E-3 | Open canopy | 5 | 9.8 | 15.0 | 43 |
| 6-1 | Riparian | 1 | 6.3 | 7.3 | 0 |
| 6-2 | Open canopy | 2 | 5.8 | 10.5 | 9 |
| 6-3 | Open canopy | 3 | 7.5 | 13.0 | 23 |
| Total | Ponderosa pine | 20 | 5.9 | 8.8 | 26 |

Table 6. Snag Densities and Breeding Bird Densities, Shanahan Ridge, Enchanted Mesa, and Flagstaff Mountain.

| Plot No. | Plot Type | No. Snags | Mean Species | Mean Individuals | % Cavity Nesters |
|---|---|---|---|---|---|
| 18-1 | Natural burn | 60+ | 8.8 | 20.0 | 42 |
| E1-1 | Open canopy | 9 | 3.5 | 4.5 | 11 |
| E1-2 | Open canopy | 12 | 9.0 | 17.8 | 37 |
| F2-1 | Open canopy | 3 | 5.3 | 8.3 | 12 |
| F2-2 | Open canopy | 2 | 2.3 | 4.8 | 0 |

18: Shanahan Ridge
E: Enchanted Mesa
F: Flagstaff Mountain

plots were aggregated, weak positive relationships existed for all three pairs of variables (see Figures 2, 3, and 4).

Other investigators have concluded that snag density is a good predictor of cavity-nester density, species diversity, and breeding bird abundance (Mannan et. al. 1980, Diem 1980, Mannan and Meslow 1984). The absence of stronger correlations in the present study may stem from small sample size or non-homogeneity of study plots. On Eldorado Mountain, closed canopy plots supported fewer species and fewer individuals than open canopy plots. Dense, stunted ponderosa pine forests may be less attractive to breeding birds for a number of reasons. These forests may lack sufficient ground cover for foraging, shrub nesting, and hiding from predators; their trees may lack branch foliage for foraging and placing of nests; and their trees may produce subaverage cone and seed crops. In addition, snags on the Enchanted Mesa plots were structurally different from snags on the Eldorado Mountain plots. Approximately half of the Enchanted Mesa snags were relatively small trees (< 30 cm DBH) that had been topped off in a recent windstorm and were still too hard to contain nest cavities; most of the Eldorado Mountain area snags were relatively large trees that appeared to have been dead for many years.

Figure 3. Relationship of Snag Density to Breeding Bird Species Abundance, All Plots.

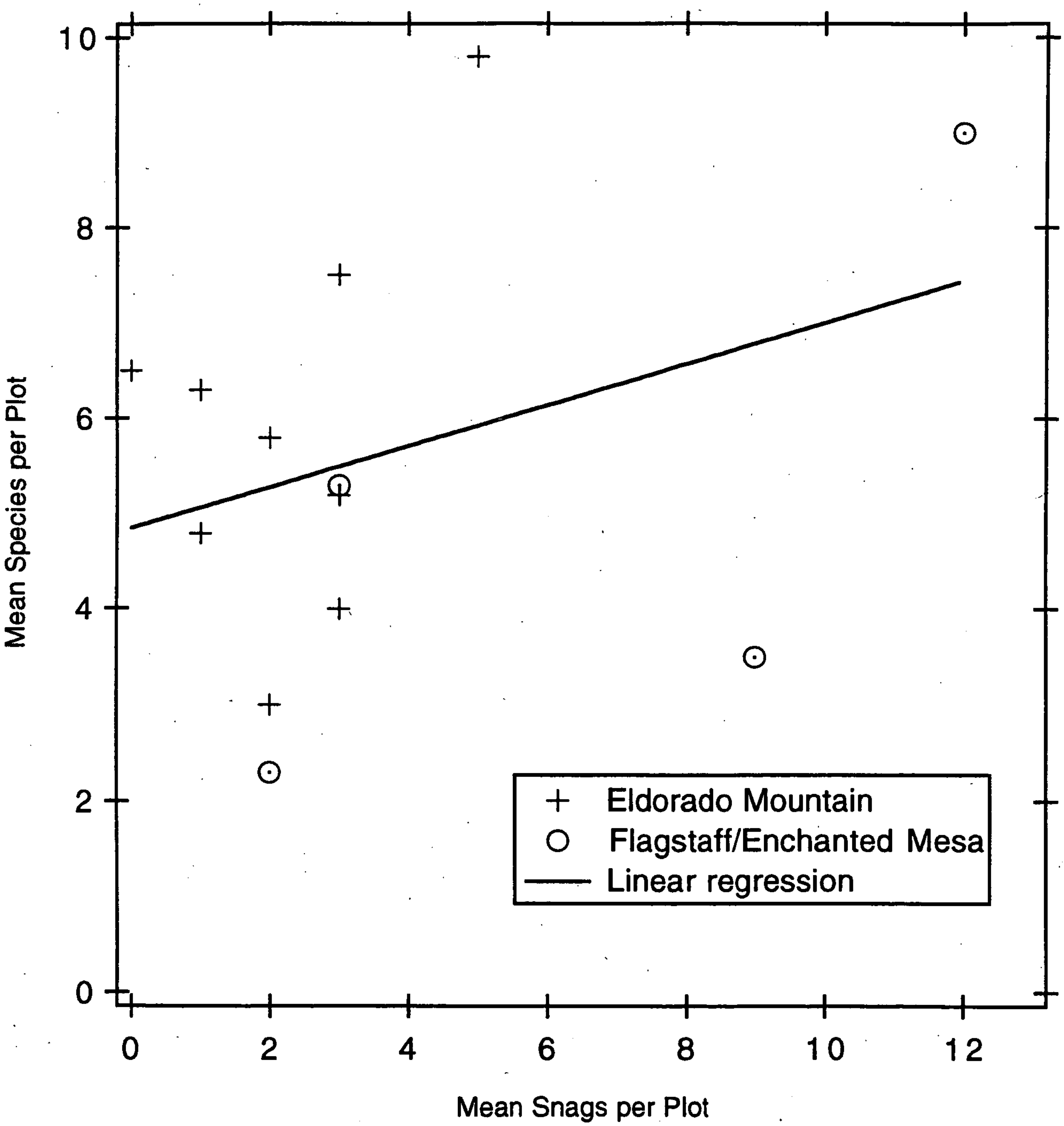


Figure 4. Relationship of Snag Density to Cavity-Nesting Bird Abundance, All Plots.

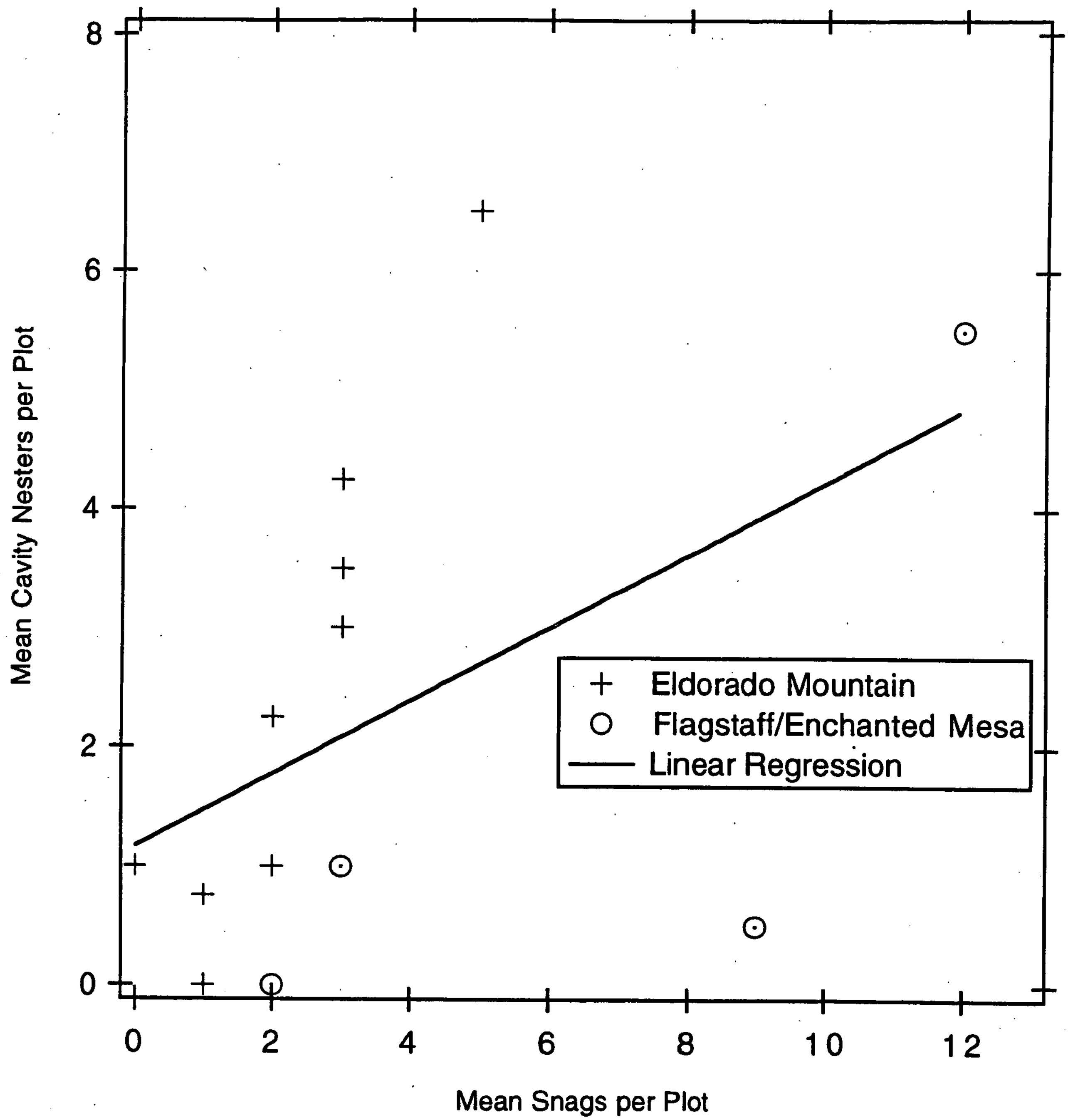
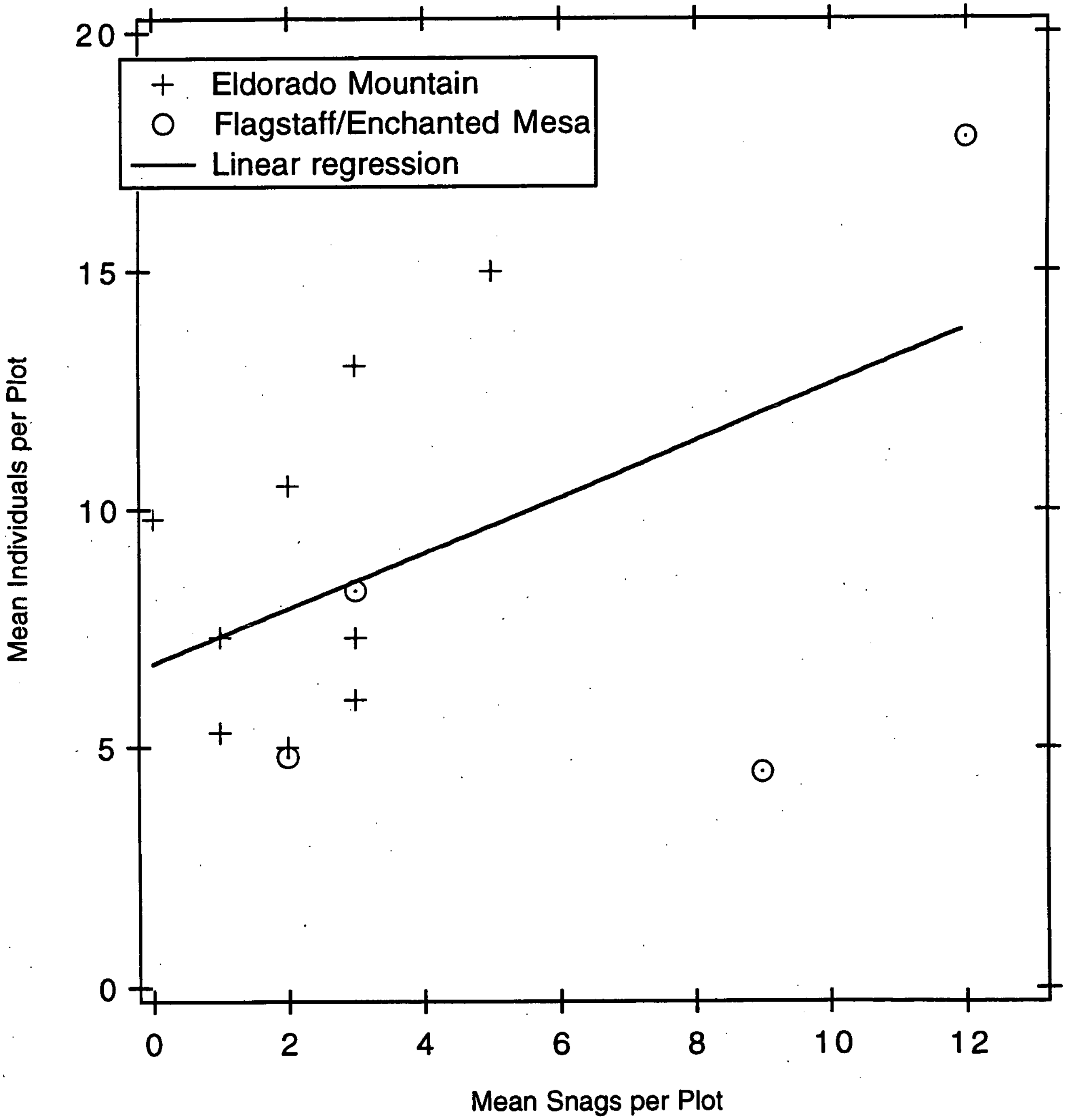


Figure 5. Relationship of Snag Density to Breeding Bird Abundance, All Plots.



Cavity-nesters comprised 26% of all individuals observed on the Eldorado Mountain plots and 19% of all individuals observed on the Enchanted Mesa and Flagstaff Mountain plots. These values are low compared to those reported from previous breeding bird studies conducted in Rocky Mountain coniferous forests. Cavity-nester densities in six Colorado and Arizona breeding bird studies summarized by Scott et. al. (1980) ranged from 32-46%, with a mean of 40%. Cavity-nester densities in 11 western old-growth coniferous forest breeding bird studies summarized by Mannan (1980) ranged from 21-46%, with a mean of 30%.

Table 7 compares breeding bird density on Eldorado Mountain with breeding bird densities in ponderosa pine forests throughout City of Boulder Mountain Parks and Open Space. Breeding bird density on the nine Eldorado Mountain plots was significantly lower than breeding bird density on eight Open Space ponderosa pine forest plots sampled by Thompson and Straugh in 1986 ($p < .01$) but not significantly different from breeding bird densities on seven Mountain Park ponderosa pine plots sampled by Jones in 1990 ($p > .05$).

In six Colorado and Arizona ponderosa pine forest breeding bird studies summarized by Scott et. al. (1980), breeding bird densities ranged from 1.4-6.5 pairs/ha, with a mean of 3.3

Table 7. Breeding Bird Densities in Boulder Area Ponderosa Pine Forests.

| Location | Investigator | No. Plots | Individuals/ha |
|---|---|---|---|
| Eldorado Mountain | Jones 1995 | 9 | 4.4 |
| Shanahan Ridge | Jones 1995 | 1 | 10.0 |
| Enchanted Mesa/Flag. Mt. | Jones 1991 | 4 | 4.9 |
| Mountain Park | Jones 1990 | 7* | 4.5 |
| NCAR Mesa | Jones 1993 | 2 | 5.8 |
| Open Space | Thompson & Strauch 1986 | 8 | 8.1 |

*5-ha plots. All others were 2-ha plots.

pairs/ha. The Eldorado Mountain numbers would appear to fall within the lower half of this range of values. However, since bird counting is a subjective activity, comparisons of data obtained by different observers, working in different areas, and employing different methodologies must be viewed with caution.

Only 5 of the 20 Eldorado Mountain snags contained active nests. Characteristics of nest trees are summarized in Table 8. In coniferous forests, a minority of snags are likely to be used for nesting at any one time (Bull 1983, Cunningham et. al. 1983). Snags may stand for ten years or more before the wood becomes soft enough for excavation by primary cavity-nesters (Bull 1983). Snags that are more than 30 years old or that have lost all of their bark cover may be too soft to support nests of either primary or secondary cavity-nesters (Bull 1983).

Snags with broken tops typically receive a higher rate of use by both primary and secondary cavity-nesters (Bull 1983). Rapid decay in broken top snags may facilitate cavity excavation. In some cases decay may weaken a tree and cause it to break; in others, the top of a healthy tree may snap off and heart rot fungus will work its way into the tree through the wound (Cunningham et. al. 1983). Four of the five active nest trees on the Eldorado Mountain plots were broken top snags. Four of the five active nest

Table 8. Cavity-Nest Locations, Eldorado Mountain.

| Species | Plot No. | Snag Type | DBH(cm) | Tree Ht.(m) | %Bark | Nest Ht.(m) |
|---|---|---|---|---|---|---|
| Pygmy Nuthatch | 31W-1 | Broken top | 67 | 15.0 | 70 | 14.0 |
| Pygmy Nuthatch | 31W-2 | Broken top | 21 | 4.6 | 100 | 4.0 |
| V.G. Swallow | 31E-3 | Broken top | 55 | 11.4 | 90 | 8.0 |
| Northern Flicker | 31E-3 | Broken top | 54 | 10.4 | 50 | 7.5 |
| House Wren | 6-3 | Straight top | 66 | 18.0 | 25 | 4.5 |

trees were at least 50 cm DBH, and all five trees retained at least 25% of their bark.

## Cavity-Nesting Species of Special Concern

The Boulder County Avian Species of Special Concern List (Boulder County Parks and Open Space 1994) includes the following cavity-nesting species:

Eastern screech owl (Audubon Blue List)

Flammulated owl (isolated or restricted population)

Boreal owl (Rocky Mountain Region vulnerable)

Lewis's woodpecker (declining)

Red-headed woodpecker (declining)

Hairy woodpecker (Audubon Blue List)

Three-toed woodpecker (Rocky Mountain Region vulnerable)

Two species from this list, flammulated owl and hairy woodpecker, were observed within the study area during the 1994-1995 breeding seasons. Accounts and descriptions follow:

### Flammulated Owl

Flammulated owls nest in aspen groves and in foothills canyons containing late successional ponderosa pine/Douglas fir forests

(Reynolds and Linkhart 1986, Jones 1991). In the Boulder Mountain Park they nest in Shadow Canyon, Bear Canyon, Skunk Canyon, Bluebell Canyon, Long Canyon, and several other unnamed canyons at elevations from 1800-2400 m (Jones 1995). They typically nest in woodpecker holes 5-20 m off the ground in standing dead aspens or standing dead ponderosa pines (Linkhart and Reynolds 1986).

I observed two calling flammulated owls in the upper Spring Brook drainage on 20 May, 1994 (Figure 6). The habitat in this area (mixed ponderosa pine/Douglas fir forest with a brushy understory and several large snags) conforms to flammulated owl nesting habitat in the Boulder Mountain Park and in the Woodland Park area west of Manitou Springs (Linkhart and Reynolds 1986, Jones 1991). Flammulated owl populations in this area should be monitored and all large snags should be retained.

Hairy Woodpecker

Hairy woodpeckers were included on the National Audubon Society's Blue List of birds with declining North American populations (Tate 1986). Boulder County populations from 1907-1994 appear to be stable (Boulder County Comprehensive Plan 1986, Boulder County Parks and Open Space 1994). Thomas et. al. (1979), who studied snag densities and woodpecker population densities in

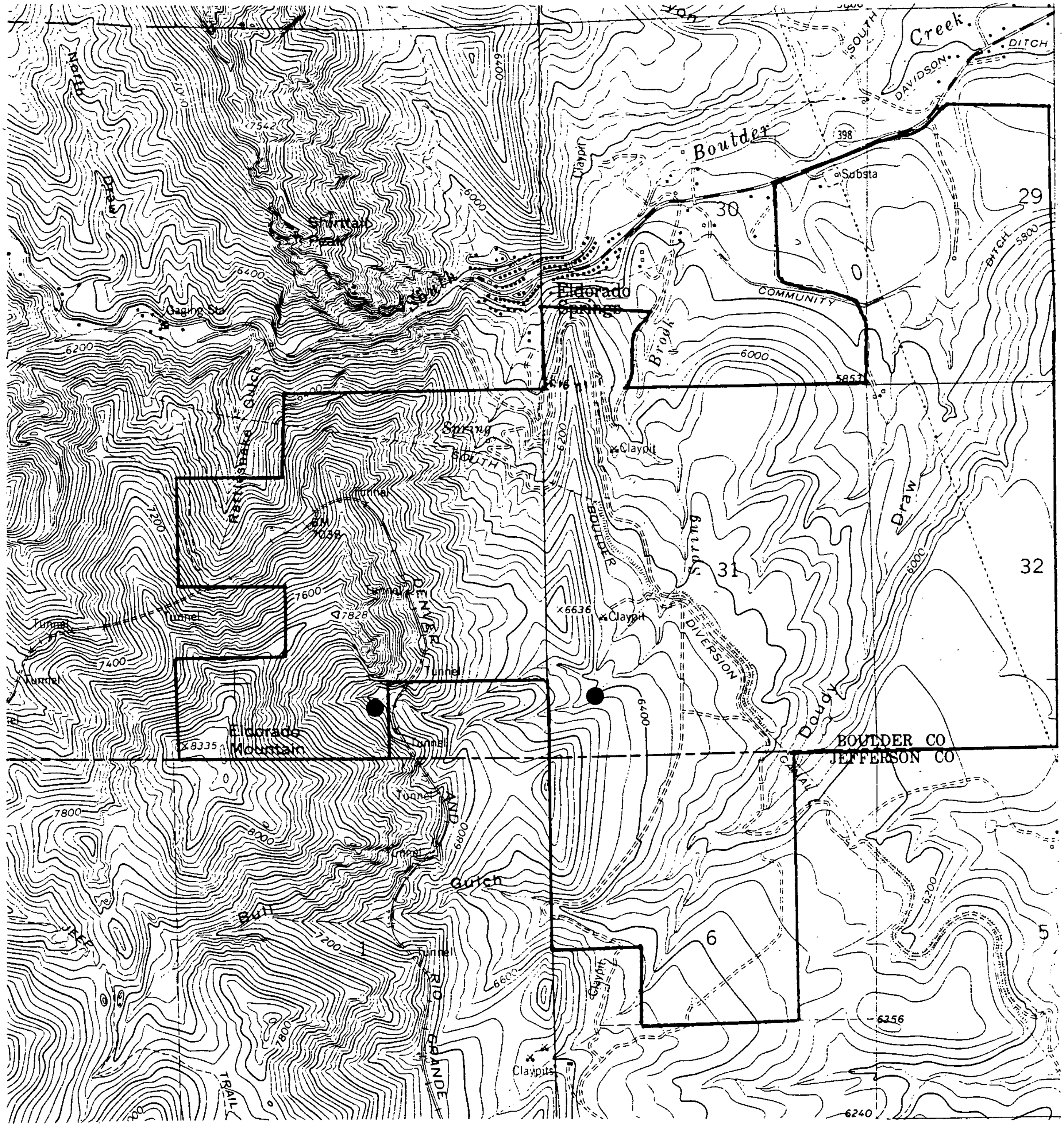



Figure 6. Flammulated Owl Sighting Locations, 20 May-10 July, 1994.

an eastern Oregon ponderosa pine forest, concluded that 4-5 large snags/ha (snags greater than 25.4 cm DBH) were needed to maintain hairy woodpecker populations at "natural" levels. Hairy woodpeckers prefer large, broken top snags showing evidence of heart rot and retaining more than 40% bark (Thomas et. al. 1979, Short 1982).

Low snag density in the Eldorado Mountain area probably limits hairy woodpecker nesting population density. I observed only one hairy woodpecker on the nine Eldorado Mountain plots. Creation of large, broken top snags should benefit this species.

## MANAGEMENT

Low snag densities on the Lindsay and Lindsay-Jeffco properties may limit nesting populations of many cavity-nesting species. Of particular concern are species such as flammulated owl, Williamson's sapsucker, brown creeper, western bluebird, and mountain bluebird, which already nest in low numbers on City of Boulder Parks and Open Space (Jones 1990, 1993, 1994). Institution of a program of snag creation in the Eldorado Mountain/Doudy Draw area would certainly increase these species' chances for survival on City Open Space.

There will never be complete agreement on the number of snags necessary to support viable cavity-nesting bird populations in various ecological settings. However, scientists and agencies have developed guidelines for maintaining adequate snag densities. Scott and Oldemeyer (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 > 47 cm DBH, whereas only 28% of snags < 47 cm DBH had nest holes. The majority of nest holes were found in snags that had been dead at least 6 years and that had retained 40% bark cover.

Marzluff and Lyon used a multi-variant model to estimate habitat requirements of open nesting birds on nineteen 5-ha 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 were 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 > 30 cm DBH was an excellent predictor of bird abundance on study plots. This conclusion was supported by the Boulder Mountain Park Forest Bird Study (Jones 1989) and by other studies of breeding birds in western coniferous forests (Mannan 1980, Ffolliott 1983).

Thomas et. al. (1979) 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 > 25.4 cm DBH; hairy woodpeckers required 4.46 snags/ha > 25.4 cm DBH; and Williamson's sapsuckers required 3.71 snags/ha > 30.5 cm 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 < 47 cm 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.

Ohmann et. al. (1994), who studied snag abundance on nonfederal forest lands in Oregon and Washington, concluded that snag densities were far below those needed to support maximum potential populations (MPP) of indigidous species of primary cavity-nesting birds. Mean MPP's for 2,715 plots in 4 plant communities were 40% for temperate coniferous forest, 28% for conifer-hardwood forest, 24% for mixed-conifer forest, and only 6% for ponderosa pine forest. They concluded that much greater attention needs to be directed toward retaining snags on nonfederal lands and providing adequate snag densities on federal lands to compensate for poor management of adjacent nonfederal lands.

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 > 33 cm.

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

(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 is considerable agreement among researchers about desirable characteristics of snags. Cavity-nesting birds consistently select large diameter, broken top snags with at least

Table 9. Recommended Snag Densities for Ponderosa Pine/Douglas-fir Forest.

| Study | Minimum Snags/ha | Minimum Snag DBH (cm) | Minimum Snag Ht. (m) | Other Consider. |
|---|---|---|---|---|
| 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 |
| 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 |
| Lundquist and Mariani (1991) Douglas-Fir, Southern Washington | --- | 76 | 5 | Tall, hard snags prefered |

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 Eldorado Mountain area are synthesized from results of the current study and the study summarized in Table 9. These guidelines should be modified as additional information is gathered concerning snag use by cavity-nesting birds on City of Boulder Open Space:

(1) Maintain snag densities of at least 10 snags/ha > 25 cm DBH.

(2) Retain all snags containing nest cavities.

(3) Retain all snags > 35 cm DBH.

(4) Retain broken top snags > 25 cm 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.

To achieve these goals, the Open Space Department will have to initiate a snag creation program in the Eldorado Mountain/Doudy Draw area. A variety of methods have been used to create snags for cavity-nesting birds. Some of the more successful techniques are described below, and recommendations are given for their use on City of Boulder Open Space 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).

## Burning Individual Trees

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 one year after treatment.

Injection of Heart Rot Fungus

Connor and Locke (1982, 1983) have experimented with injecting red heart fungus (<u>Phellinus pine</u>) into loblolly pines (<u>Pinus taeda</u>) in Texas. Hollow pine dowels infected with the fungus were inserted into drill holes in the trees at a height of 3 m. 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 three years after inoculation. They predicted that excavation of nest cavities by red-headed woodpeckers would occur 8-12 years after successful inoculation.

Prescribed Burns

Moderate intensity prescribed fires create snags quickly while mimicking natural forest processes. Initially, moderate intensity fires will destroy large numbers of snags. Horton and Mannan (1988), who studied the effects of moderate intensity prescribed burns in three southeastern Arizona ponderosa pine stands, reported that the fires destroyed more than half of snags with diameters > 15 cm DBH. However, no species of cavity-nesting birds disappeared completely from their plots, and only two species declined in abundance. Within 2-5 years, after a prescribed fire, as burned trees begin to decay, cavity-nesting bird populations should increase dramatically.

### Topping

Because broken top snags are generally favored by cavity-nesting birds, topping may be more productive than girdling as a means of creating usable snags. This method is obviously more dangerous and time consuming than girdling. Trees should be topped off at a point at least 10 m above the ground.

### Nest Boxes

By erecting nest boxes, land managers can immediately increase populations of cavity-nesting birds. Of 20 bluebird boxes erected by Kathy Gibson at Walker Ranch, 18 were occupied by nesting mountain bluebirds during the first year (Kathy Gibson, pers. commun.). Bock (1995) studied the effects of nest boxes on bird populations in Arizona and Boulder County ponderosa pine forests. In Arizona, erection of nest boxes led to increased numbers of cavity-nesting birds while appearing to suppress populations of other species. At Betasso Preserve in Boulder County, erection of nest boxes greatly increased populations of cavity-nesting birds while appearing to have no effect on other bird populations. Nest boxes may be particularly useful in managing for locally endangered or threatened species, but they should not be seen as a long term solution to the problem of insufficient snag density.

## RECOMMENDATIONS FOR ADDITIONAL RESEARCH

Staff may wish to experiment with a variety of techniques, including prescribed burns, heart rot inoculation, girdling, topping, and erection of nest boxes, to enhance habitat for cavity-nesting birds in the Eldorado Mountain area. In August, 1995, a moderate to high intensity burn was carried out by Open Space staff on 10 ha of section 31, west of the Diversion Canal. Plot 31W-2 lies within the burned area. This plot should be sampled annually to observed the effects of the burn on breeding bird populations. The remaining eight plots should be sampled periodically to observe the effects of forest succession and forest management on breeding bird populations.

Staff should pay particular attention to the Spring Brook drainage, west of the Diversion Canal, since this area supports at least two Boulder County cavity-nesting species of special concern. I recommend placement of an Open Space wildlife transect in the upper Spring Brook drainage so that volunteers can carry out annual breeding bird counts.

Staff may also wish to sample snag densities on other Open Space properties including Flatirons Vista, Marshall Mesa, Shadow Canyon, and Mount Sanitas. Over time, snag inventories can help to guide forest management efforts in these areas.

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## APPENDIX A: PLOT MAPS

ABBREVIATIONS USED IN TABLES

SNAG NO.: Snags are numbered consecutively from plot 31W-1 to plot 6-3.

DBH: Diameter at breast height in centimeters.

HT: Height in meters.

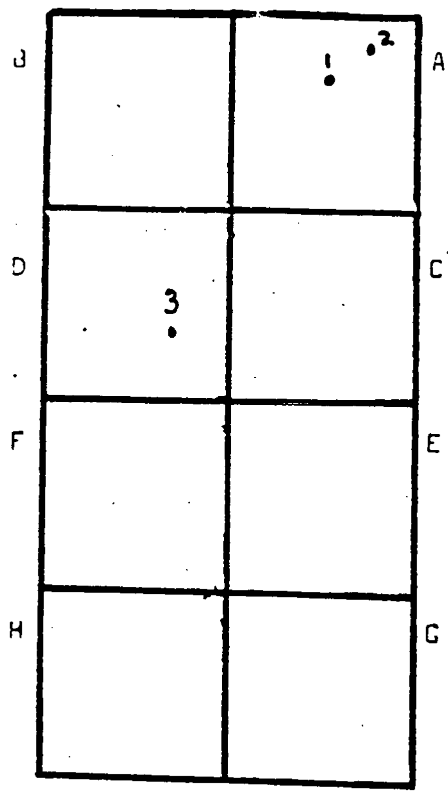
%BARK: Estimated percent of bark retained by snag.

PP: Ponderosa pine.

B: Broken top.

PLOT NAME: 31W-1 LOCATION: Lindsay

YEAR: 1995



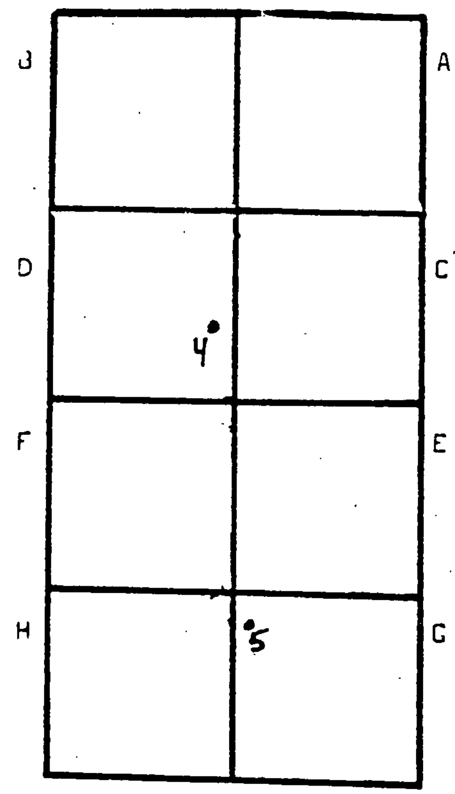

| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| A1 | 67 | 15.0 | 70 | PPB | Yes | PN |
| A2 | 42 | 3.0 | 80 | PPB | No | No |
| D3 | 90 | 13.6 | 90 | PPB | Yes | No |

Cav: nest cavities
Occ: occupied nest

PN: Pygmy Nuthatch

PLOT NAME: 31W-2 LOCATION: Lindsay

YEAR: 1995



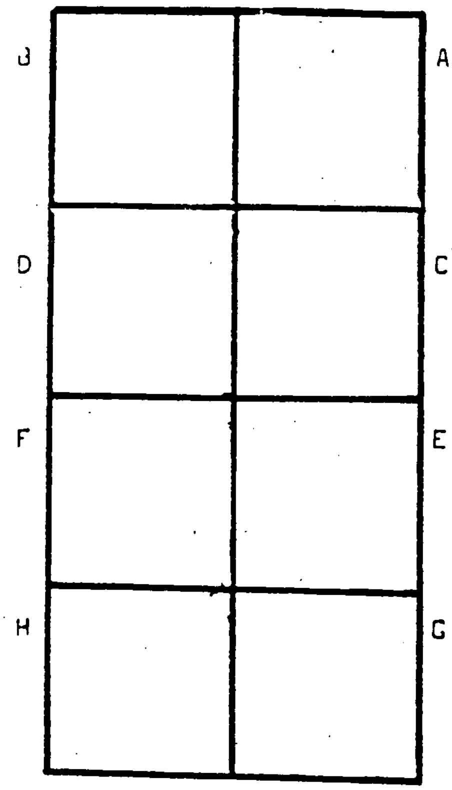

| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| G5 | 21 | 4.6 | 100 | PPB | Yes | PN |
| D4 | 48 | 14.8 | 0 | PP | Yes | No |

Cav: nest cavities
Occ: occupied nest

PN: Pygmy Nuthatch

PLOT NAME: 31W-3 LOCATION: Lindsay

YEAR: 1995

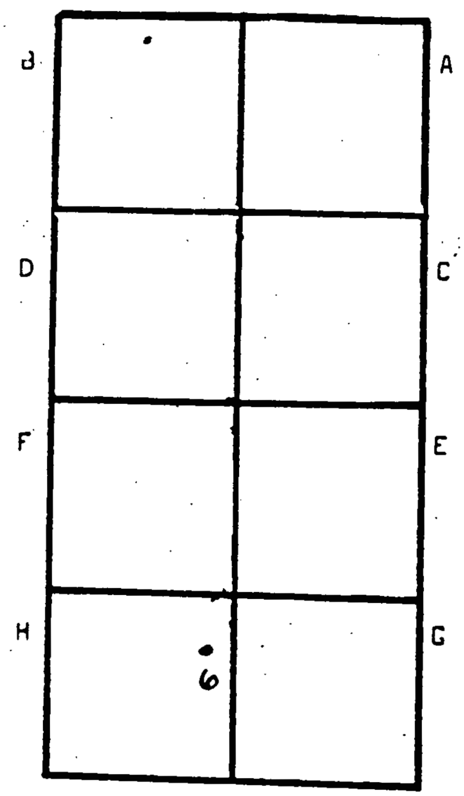



| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|

Cav: nest cavities
Occ: occupied nest

PLOT NAME: 31E-1 LOCATION: Lindsay

YEAR: 1995

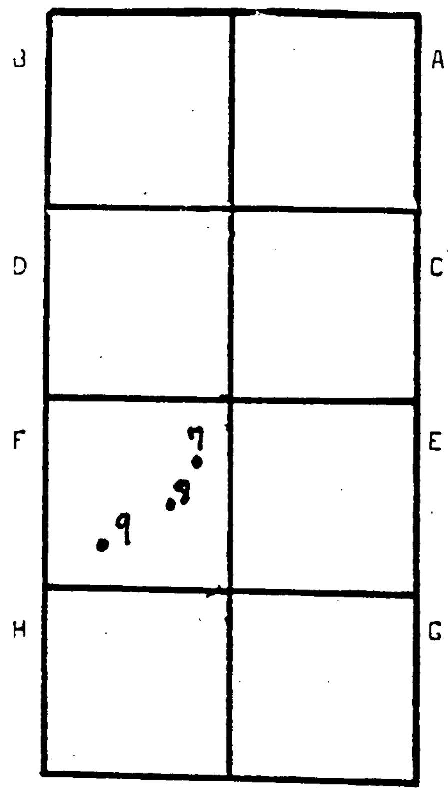



| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| H6 | 48 | 10.4 | 100 | PPB | No | No |

Cav: nest cavities
Occ: occupied nest

PLOT NAME: 31E-2 LOCATION: Lindsay

YEAR: 1995

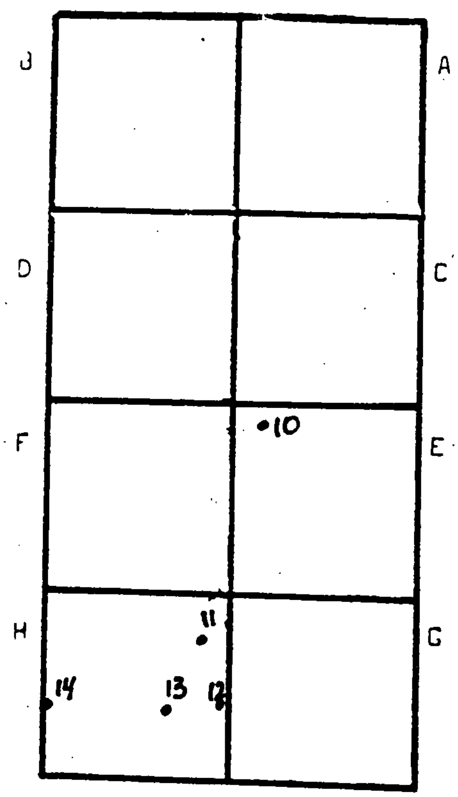



| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| F7 | 53 | 16.0 | 50 | PP | Yes | No |
| F8 | 44 | 10.6 | 0 | PPB | Yes | No |
| F9 | 58 | 17.0 | 80 | PP | Yes | No |

Cav: nest cavities
Occ: occupied nest

PLOT NAME: 31E-3 LOCATION: Lindsay

YEAR: 1995




| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| E10 | 30 | 6.8 | 100 | PPB | No | No |
| H11 | 58 | 16.0 | 20 | PP | Yes | No |
| H12 | 59 | 20.2 | 20 | PP | Yes | No |
| H13 | 55 | 11.4 | 90 | PPB | Yes | VG |
| H14 | 54 | 10.4 | 50 | PPB | Yes | NF |

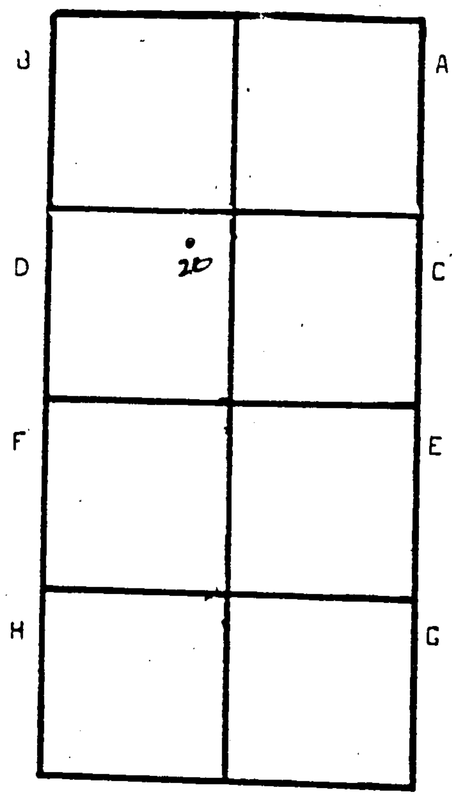
Cav: nest cavities
Occ: occupied nest

NF: Northern Flicker
VG: Violet Green Swallow

PLOT NAME: 6-1

LOCATION: Lindsay-Jeffco

YEAR: 1995




| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| D20 | 32 | 5.6 | 90 | PSB | No | No |

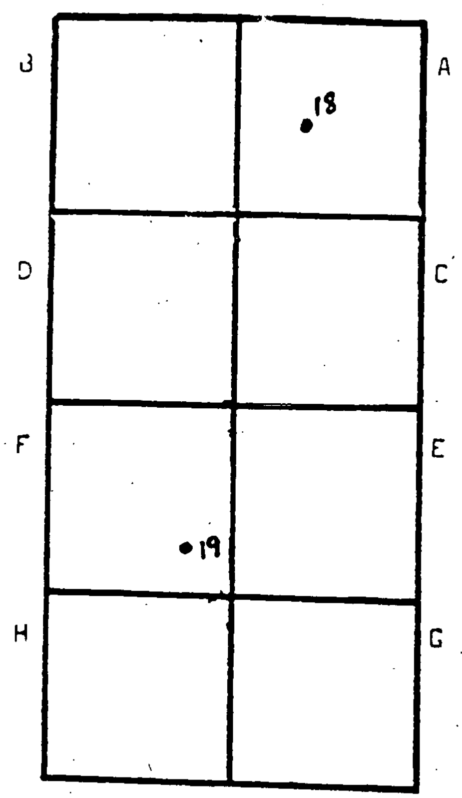
Cav: nest cavities
Occ: occupied nest

PS: Populus species

PLOT NAME: 6-2

LOCATION: Lindsay-Jeffco

YEAR: 1995

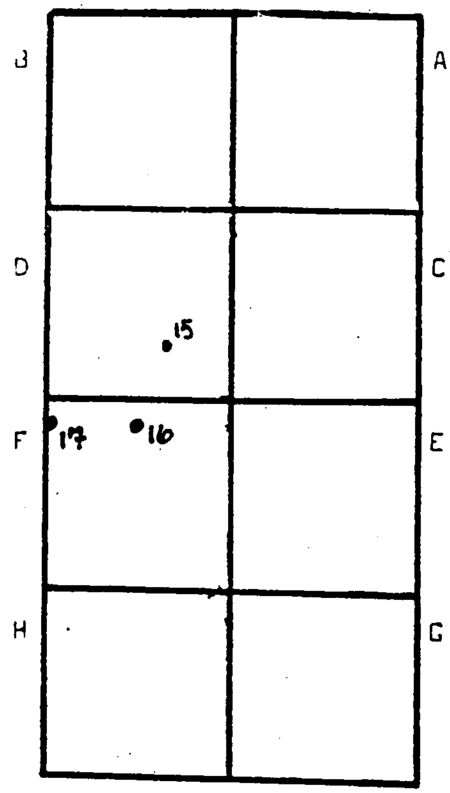



| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| A18 | 55 | 10.6 | 95 | PP | No | No |
| F19 | 29 | 4.0 | 90 | PPB | No | No |

Cav: nest cavities
Occ: occupied nest

PLOT NAME: 6-3 LOCATION: Lindsay-Jeffco

YEAR: 1995




| SNAG NO. | DBH | HT | %BARK | TYPE | CAV? | OCC? |
|---|---|---|---|---|---|---|
| D15 | 74 | 3.5 | 95 | PPB | No | No |
| F16 | 28 | 13.2 | 10 | PP | No | No |
| F17 | 66 | 18.0 | 25 | PP | Yes | HW |

Cav: nest cavities
Occ: occupied nest

HW: House Wren