

**NESTING AND HABITAT SELECTION IN CAVITY NESTING BIRDS**

**FINAL PROJECT REPORT**

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## INTRODUCTION

Many non-game bird species have experienced long-term continental population declines, including a wide variety of cavity-nesting birds (see Robbins et al. 1989, Peterjohn et al. 1995). Current population status information is based primarily on large scale census type surveys such as the Breeding Bird Survey (i.e., Robbins et al. 1989, Peterjohn et al. 1995). Such surveys can detect population trends on regional and national levels, but they do not address the causes of declines (Martin 1992, Martin and Geupel 1993). Declines are generally considered the result of changing habitat conditions impinging on reproductive output. Yet, the detailed information on habitat requirements for successful reproduction that has long been considered essential for effective management of game species is largely unavailable for non-game birds. Identification of habitat features that allow successful reproduction and maintenance of healthy populations of sensitive nongame bird species and habitats is needed before reaching the crisis management stage to allow implementation of cost-effective management practices (Martin 1992, Martin and Geupel 1993). Cavity-nesting birds, in particular, are often known to be limited by nest site availability and suitable nesting habitat (e.g., von Haartman 1957, Brush 1983, Raphael and White 1984, Belles-Isles and Picman 1986, Brawn et al. 1987, Brawn and Balda 1988, Conway and Martin 1993, but see Waters et al. 1990), but suitability of cavities and nesting patches have rarely been examined using nesting success (but see Martin and Li 1991, Conway and Martin 1993). Here, we report summaries of nesting success and habitat preferences by cavity-nesting birds on the Mogollon Rim.

## STUDY SITE

The study was conducted on the Coconino and Sitgreaves National Forests in Coconino County, Arizona. The habitat consisted of shallow, snow-melt drainages dominated by White Fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), and Trembling Aspen (*Populus tremuloides*) in the overstory, and Canyon Maple (*Acer grandidentatum*), New Mexican Locust (*Robinia neomexicana*), and Gambel's Oak (*Quercus gambelii*) in the understory. Ridge-tops and the upper slopes of the drainages were dominated by Ponderosa Pine (*Pinus ponderosa*), and are selectively logged on a 10 year rotation (see Martin 1988 for detailed description of the site). The drainages are considered critical wildlife habitat because of their importance to black bear and elk and the lower two-thirds of the drainage slopes are currently protected from logging. The area supports one of the most diverse assemblages of cavity-nesting species recorded (Table 1).

## METHODS

Study plots were centered on snow-melt drainages and included adjacent selectively logged ridge tops. Twenty-five 4-25 hectare plots were searched for bird nests every 2 days from May through mid-July, 1992-1994 (Figures 1 and 2). Nests were checked every 3-4 days to monitor nest status, and to determine causes of nest failure. Nest

success rates and standard errors were calculated using the Mayfield method (Mayfield 1961, 1975) as detailed by Hensler and Nichols (1981).

Nest-tree species, diameter at breast height (DBH), height, and nest-tree condition were recorded for each nest. Nest-tree health was categorized as live, dead, or dying, and snags were classified as young (bark still on, dead within the last few years), middle-aged (some bark still in place, sturdy tree), or old (little bark remaining, rotting, ready to fall down). Topographic location within the drainage (drainage bottom, lower 1/3 of side slope, middle 1/3 of side slope, upper 1/3 of side slope, and ridge-top) was also recorded for each nest tree.

Availability of suitable cavity trees on nest plots was estimated in 1993 by counting potential nest trees along transects established parallel to the main drainage of each plot. Tree species, DBH, number of cavities, height, tree health, and snag age were recorded for all snags and live aspen within 10 meters on either side of transects. Transects were divided into 20 m sections (20 x 20 m blocks) for counting purposes. Transects were spaced 50 m apart, and a sufficient number of transects were established to cover the entire nest-search plot (Figure 3). Within each plot, 25-38 % of plot area was sampled for nest trees.

## RESULTS AND DISCUSSION

### Nest location and success

Over 1400 nests of 14 species were located between 1992 and 1994 (Table 2). Nest fate was determined for 1173 of these nests. Sample sizes were sufficient (20 or more nests) to calculate overall Mayfield nest success estimates for 12 species when years were combined (Table 3), and yearly nest success was calculated for 8 of those species (Table 4.). Species-specific nest success was high both within and across years in 11 of the 12 species for which estimates were possible. Minimum nest success estimates (within or across years) for 11 of the 12 species ranged from a low of 47.7% in Mountain Chickadees in 1993 to 94.5% in Red-naped Sapsuckers in 1993 (Table 4). Nest success rates in this range should be sufficient to compensate for adult mortality. However, nest success in Cordilleran Flycatchers was much lower. Estimates of flycatcher nest success ranged from 23.8 % in 1994 to 28.7% with years combined. Nest success in this range is lower than reported for other flycatchers (see review of data in Martin 1995) and may be insufficient to compensate for adult mortality. Data on nest success over a wider range of years, more detailed information on re-nesting attempts, and adult and juvenile survival data are needed to confirm nest success estimates, and to evaluate the importance of observed nest success levels to population health of flycatchers on these sites.

Nest success did not differ ( $P = 0.073$ ) among nests located in the lower portion of drainages (bottom and lower 1/3 of slopes), on mid-slopes (middle 1/3), or on logged upper slopes (upper 1/3 and ridge-tops) in the 7 species with sufficient sample sizes for meaningful comparisons (Table 5). Nest success in Mountain Chickadees tended to be lower on the upper slopes than on either the mid-slopes ( $P = 0.073$ ) or lower portion of

drainages ( $P = 0.073$ ), but annual variation in chickadee nest success could not be adequately controlled for in the comparison. Chickadee nest success did not differ ( $P = 0.505$ ) between upper slopes (success = 42.9%,  $n = 17$  nests) and lower slopes (success = 58.5%,  $n = 29$  nests) in 1992, the one year with at least marginal sample sizes for testing within year.

### **Nest-tree species**

The majority of nests (76.0%,  $n = 1087/1444$ ) located during the study were found in live aspen or aspen snags (Table 6, 7). Within bird species, 63.1 - 100% of nests of the 13 exclusively tree-nesting species were found in aspen (Table 6). Cordilleran Flycatcher nested in niches formed by scars in aspen trunks 35.3 % of the time, but nests were frequently found in a wide variety of other sites, including rock crevices and downed tree roots (Table 7). Non-aspen sites were important nest substrates for individual bird species, but no tree species approached the importance of aspen to the cavity-nesting bird community as a whole.

Live, dead, and dying trees provided important nest sites for cavity-nesting birds. Live aspen supported 25.1 % (across species average) of nests of the 13 exclusively tree-nesting species (Table 8), while dead and dying aspen supported 60.6% of nests. Live maple contained 12.5% of House Wren nests, and 10.3% of White-breasted Nuthatch nests were located in live Gambel's Oak. Excluding aspen, few nests of any other bird species were located in live trees (Table 8). Douglas-fir and White Fir snags were important nesting sites for Brown Creepers (15.6 %), Red-breasted Nuthatches (28.6%), and White-breasted Nuthatches (10.3%). Ponderosa pine snags were moderately common nest sites in Acorn Woodpeckers (16.7%), Pygmy Nuthatches (8.3%), and Northern Flickers (5.7%) (Table 8). The dead and dying tree health classes were combined in further analyses.

### **Nest-tree size and condition**

DBH - Birds nested in trees from 10-100 cm DBH and from 2-36 meters high (Table 9). Live trees and snags of almost any size class were potential nest sites for at least a few bird species (Table 10). Within tree species and health classes (i.e. aspen snags), patterns of use of DBH size classes differed from availability of size in all 6 tree/health classes for which availability data were obtained (Chi-square contingency analysis,  $P < 0.05$ ; Table 10, 11). However, it should be noted that these differences were obtained by lumping nests across bird species and that sample sizes are quite large in many cases, allowing detection of relatively small difference between use and availability. Generally, either DBH size class use was similar to availability (e.g. aspen snags, DBH 30-40 cm, Table 10) or substantial use of a size class occurred despite apparent selection against it (e.g., aspen snags, DBH 20-30 cm, Table 10). In other words, raw numbers (Table 10) provide a more useful measure of the importance of tree species and DBH size classes than Chi-square tests of selection. However, some specific cases should be highlighted. Fir snags

of less than 20 cm DBH were used infrequently, as were Ponderosa Pine snags of less than 30 cm DBH. There was strong selection for Canyon maple snags in the 10-20 cm DBH range which supported 77% of nests while making up only 22 % of available maple snags.

Tree height - Little use was made of trees shorter than 5 m in height, except for fir snags, which were used extensively by Red-breasted Nuthatches (Table 12). Approximately 16% of nests in firs were located in trees 1.7 - 5 m tall and over 50% were located in firs under 10 m tall. Extensive use of shorter fir snags reflects both availability (Table 13, conifer snags frequently lose their tops) and selection of fir snags with broken tops in excess ( $\chi^2 = 61.3$ ,  $df = 1$ ,  $P < 0.001$ ) of availability (Table 14). Birds also selected Ponderosa pine snags with broken tops in excess of availability ( $\chi^2 = 16.3$ ,  $df = 1$ ,  $P < 0.001$ ; Table 13), but no selection for short snags was evident.

Live aspens less than 10 m tall supported few nests ( $n = 2$ ), while aspen snags in the same height range contained a substantial number of nests ( $n = 40$ ), although these made up only 6% of nests in aspen snags (Table 12). However, trees in the 5-10 m range were important within all non-aspen tree species/health classes, supporting 12-60 percent of nests within each non-aspen tree/health classes (Table 12).

Trees above 10 m in height were generally used in proportion to or in excess of their availability (Table 12, 13). However, discrepancies between height distributions above 15 m obtained from nest data (height measured with a clinometer, Table 12) and aspen/snag availability data (height estimated, Table 13) suggest systematic measurement biases which make more specific conclusions questionable.

Snag age - Birds made substantial use of aspen, pine, and fir snags in any condition as nest sites (Table 15). There was no evidence of selection for a particular age class in the coniferous species ( $P = 0.333$ ) but a greater proportion of nests were located in young aspen snags ( $\chi^2 = 36.9$ ,  $df = 2$ ,  $P < 0.001$ ) and a smaller proportion in old snags than expected from availability data (Table 15). Insufficient data were available to evaluate use of different age classes of oak and maple snags.

### **Nest-tree selection in primary cavity nesters**

We evaluated nest-tree selection using potential nest-tree availability data from aspen/snag availability transects located within each nest search plot. Nest-tree selection in primary cavity nesters (species capable of excavating their own nest holes, Table 16) was tested with 2 different sets of availability data: all trees counted along transects (all snags plus live aspen) and all trees showing some evidence of heart rot (all snags, and any live aspen containing at least one cavity). Live aspen free of heart rot may not provide suitable excavation sites for primary excavators, therefore inclusion of all live aspen probably overestimates availability of suitable live aspen. In contrast, many live aspen without cavities probably provide suitable excavation sites. Therefore, excluding live

Williamson's Sapsucker - Williamson's Sapsuckers exhibited strong selection (SI = 2.6-4.7) for aspen snags and against non-aspen snags (SI = 0.0), whether or not live aspen without cavities were excluded (Table 17, 18). Live aspen as a whole were weakly selected against (SI = 0.6) when trees without cavities were excluded, and strongly selected against (SI = 0.2) when all live aspen were included in the analysis (Table 17, 18).

Red-breasted Nuthatch - Red-breasted Nuthatches selected strongly for aspen snags (SI = 1.7 -3.2), and against deciduous snags (SI = 0.0) and live aspen (SI = 0.1-0.4), whether or not live aspen without cavities were excluded (Table 19, 20). Selection for fir snags was positive (SI = 1.3) when all aspen were included and negative when live aspen without cavities were excluded (SI = 0.7), suggesting that fir snags were used approximately in proportion to their availability (Table 19, 20). However, fir snags provided important nesting habitat, whether or not selection for them occurred, supporting 29% of all nests.

Pygmy Nuthatch - Pygmy Nuthatches nest-tree selection was unaffected by inclusion or exclusion of live aspen without cavities (Table 19, 20). Pygmy nuthatches exhibited very strong selection (SI = 2.2-3.9) for aspen snags and ponderosa pine snags (2.0-3.6), and selected against live aspen (SI = 0.2-0.7), fir snags (SI = 0.2-0.3), and deciduous snags (SI = 0.0).

Northern Flicker - Northern Flickers selected for aspen snags (SI = 1.9-3.4) and Ponderosa Pine snags (SI = 1.3-2.4), and against fir snags (SI = 0.0-0.1) and deciduous snags (SI = 0.0), whether or not live aspen without cavities were excluded (Table 19, 20). Flickers selected positively for live aspen containing at least one cavity (SI = 1.9), but against live aspen as a whole (SI = 0.5). Unlike sapsuckers and most other woodpeckers on these sites (Table 16), flickers frequently use old cavities or enlarged existing cavities, so presence of cavities in live aspen may be a better indicator of nest-tree suitability in flickers than in other primary excavators that rely less on old holes.

### **Nest-tree and cavity selection in secondary cavity nesters**

Nest-tree selection in secondary cavity nesters (species that do not excavate their own holes) was tested at the level of the nest-tree (availability = all trees containing at least one cavity) and at the level of the cavity (availability = total cavities within each tree species/health class).

House Wren - Availability data were incomplete with respect to nest-tree selection of House Wrens, because House Wrens frequently nested in live canyon maple that were not included in availability surveys. Nest-site selection analyses were limited to the 87% of House Wren nests in tree types that were surveyed. House wrens selected aspen snags

containing at least one cavity in excess of availability (SI = 1.4), strongly selected for deciduous snags (SI = 4.0), used live aspen in proportion to availability (SI = 1.0), and selected against fir (SI = 0.1) and pine (SI = 0.2) snags (Table 21). Patterns were similar when all cavities were used as an index to nest-site availability, rather than the number of trees containing at least one cavity. Wrens showed weak selection for cavities in live and dead aspen (SI = 1.2), strong selection for cavities in deciduous snags (3.4), and strong selection against cavities in conifers (Table 22). Limiting analyses to aspen, wrens selected for aspen snags containing at least one cavity (SI = 1.16) and against (SI = 0.84) live aspen ( $\chi^2 = 4.1$ ,  $df = 1$ ,  $P < 0.05$ ), but this preference was not evident at the level of cavities, as wrens selected cavities in live and dead aspen in almost exact proportion to their availability ( $\chi^2 = 0.06$ ,  $df = 1$ ,  $P > 0.05$ ), suggesting that nest-site selection was acting at the level of the cavity, but not at the level of the nest tree.

Mountain Chickadee - Chickadees selected aspen snags containing at least one cavity in excess of availability (SI = 1.6), strongly selected for deciduous snags (SI = 3.0), selected weakly against live aspen (SI = 0.8), and selected against fir (SI = 0.2) and pine (SI = 0.6) snags (Table 21). Within aspen alone, chickadees showed strong selection ( $\chi^2 = 18.6$ ,  $df = 1$ ,  $P < 0.01$ ), for aspen snags (SI = 1.4), and against live aspen (SI = 0.6).

At the level of the cavity rather than the tree, chickadees showed similar patterns. There was still selection for cavities in dead aspen (SI = 1.4), no selection for cavities in live aspen (SI = 0.9), strong selection for cavities in deciduous snags (SI = 2.6), and strong selection against cavities in conifers (Table 22). Within aspen, there was continued but weaker selection ( $\chi^2 = 5.2$ ,  $df = 1$ ,  $P < 0.05$ ) for cavities in snags (SI = 1.2) and against cavities in live aspen (SI = 0.8).

White-breasted Nuthatch - As with House Wrens, a substantial proportion (15.5%) of White-breasted Nuthatch nests were found in tree types excluded from nest-tree availability surveys. Most of these nests were found in live Gambel's oak. Nests in tree types that were not included in availability surveys were excluded from further analyses. No deviations from expected numbers of nests in live aspen, aspen snags, or non-aspen snags could be detected when using trees containing at least one cavity as an index to availability (Table 23). At the level of the cavity (Table 24), White-breasted Nuthatches selected cavities in aspen snags and non-aspen snags approximately in proportion to availability, but selected strongly for cavities in live aspen (SI = 1.7).

Western Bluebird - Western Bluebirds showed positive selection (SI = 2.0) for aspen snags at the level of the tree (Table 23), but cavity use could not be distinguished from availability (Table 24), although selectivity index patterns were very similar.

### **Nest and nest-tree density**

Nest density of cavity nesters was higher in the bottom and on the lower slopes of snow-melt drainages than on the upper slopes and ridge-tops in all 7 of the most common cavity nesting species (Table 25). Nest density in drainage bottoms ranged from 2.6 - 11.2 times that on ridge tops. The greatest changes in nest density across topographic location usually occurred between bottoms and mid-slopes, with significant declines occurring in 5 species. Density of potential nest trees was also related to topographic location within drainages. Both live aspen and aspen snag density decreased 10-fold from drainage bottoms up side slopes to the ridge-tops (Table 26). Fir snag densities were lowest in drainage bottoms, but similar from lower slopes to ridge-tops. Ponderosa Pine snags were most common on ridges and upper slopes. Patterns were similar for trees containing at least one cavity (Table 27) and for total cavities (Table 28).

Nest density was positively related to aspen density in all seven of the common cavity nesting birds. Live aspen and aspen snag densities were highly inter-correlated ( $R = 0.734$ ,  $n = 65$ ) resulting in multi-collinearity problems in multiple regression models including both variables. Aspen snag density was a better predictor of nest density than live aspen density in all common bird species, so live aspen were omitted from subsequent models.

Topographic location was highly (negatively) correlated with aspen snag density ( $r = -0.694$ ,  $n = 65$ ), and was also associated with other habitat differences relating to the shift from fir/aspen dominated drainage bottoms to ponderosa pine dominated ridge tops. Despite this, aspen snag density explained more of the variance in nest density than topographic location in all but 1 of the 7 most common species, although topographic location was negatively related to nest density in all 7 species ( $P = 0.007$ ,  $df = 63, 1$ ). Multiple regression models that included both topographic location and aspen snag density performed only slightly better than simple regression models that included only aspen snag density. On average, inclusion of topographic location explained an additional 3.3% of the variance in nest density over simple regression models of aspen snag density. Aspen availability was the single most important predictor of nest density identified in this study, explaining an average of 26% of the variance in nest density in simple regression models (Table 29). Aspen snag density was also positively related to nest density within topographic location in several species. Within the lower slopes of drainages, aspen snag density was positively related to nest density in 4 of the 7 species common bird species (Table 30). Nest density was unrelated ( $P = 0.122$ ) to aspen snag density on middle slopes in all 7 species, but on upper slopes nest density was positively related to aspen density in 4 species (Table 31).

## MANAGEMENT IMPLICATIONS

### Drainage Diversity

Snow melt drainages on Coconino and Sitgreaves National Forests have previously been recognized as critical wildlife habitat because of their importance to

black bear and elk. We found that drainages supported denser and more diverse populations of cavity-nesting birds than many other habitats studied throughout North America (e.g., Raphael and White 1984, Brawn and Balda 1988) and much more than adjacent ridge tops and Ponderosa Pine Hhabitat (see Brawn and Balda 1988), indicating that these drainages are also very important to cavity nesting birds as well as big game.

The diversity of cavity-nesting birds using drainages is undoubtedly related to a broad range of vegetative conditions that exist in drainage/ridge complexes, including the presence of Douglas-fir, White Fir, Canyon Maple, and Trembling Aspen. Diversity of habitat is important to maintaining a diversity of birds because they typically differ in nest habitat preferences and these differences are critical for successful coexistence (Martin 1993, 1996). Aspen served as the primary nest site for all 14 common species of cavity nesting birds and nest density was related to aspen snag density in all 7 of the most common species (also see Li and Martin 1991, Conway and Martin 1993). Other tree species found primarily in drainages were also important nest sites, including fir (snags) and Canyon Maple (both live and dead). Habitat characteristics at the patch, or territory, scale are also undoubtedly important. The exact history of logging, active management, and fire on our sites is uncertain, but the result has been a unique habitat that supports a very high diversity of bird species.

### **Aspen Management**

The most pressing management concern currently affecting nest-site availability for cavity nesters in these sites is a lack of natural aspen regeneration. Aspen snags are falling at a fairly high rate among years (Martin, unpubl. Data). These losses are offset to some extent as live trees recruit to dead classes. However, numbers of live trees are declining (Martin, unpubl. Data) because casual observations suggest that there has been little or no aspen regeneration on our study sites for the past 10 or more years. Aspen suckers began appearing on our sites in June, and were plentiful on all plots in late July when our field work terminated. In early May, when we first arrive on site, virtually no aspen suckers are present. Aspen are heavily browsed by deer and elk and have little opportunity to successfully grow, although site conditions (disturbance, shade, etc) may also contribute to success of recruitment. Unless aspen regeneration can be stimulated over large areas within these high elevation drainages, it is virtually certain that the density and diversity of cavity-nesting birds will decline on these sites, and on the forest as a whole.

### **Nest-tree Selection Summary**

Species specific nest-site selection data are summarized in Table 32 and 33. All 14 cavity nesting species were highly reliant on aspen for nest sites on our study sites, and aspen snags were the primary nest sites for 11 of the 14 bird species. Moreover, nest density was related to aspen snag density within drainage bottoms (high aspen density) and on upper slopes and ridge-tops (lower aspen density) for 4 of the 7 common bird

species. Forest Service practices in the area should consider the importance of aspen snags to cavity-nesting birds. Preservation of aspen snags and regeneration of live aspen should be a high priority if habitat condition for many cavity nesters are to be maintained. Several other tree species were important to specific bird species. In particular, Douglas-fir and White Fir snags (especially those with broken tops) were used extensively by Red-breasted Nuthatches, live and dead Canyon Maple were used by House Wrens, and live and dead Gambel's Oak were frequently used by White-breasted Nuthatches. Ponderosa pine snags were important to Northern Flickers, Pygmy Nuthatches, and Acorn Woodpeckers.

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Table 1. Cavity, niche, and bark-nesting birds breeding in fir/aspen drainages, and on intervening ponderosa pine dominated ridges at 7600 ft in Coconino and Sitgreaves National Forests, Coconino County, Arizona.

| Common name   | Scientific name                |
|---|--------------------------------|
| <u>Very common species (&gt; 20 nests per year)</u> |                                |
| Cordilleran Flycatcher                              | <u>Empidonax difficilis</u>    |
| House Wren  | <u>Troglodytes aedon</u>       |
| Mountain Chickadee                                  | <u>Parus gambeli</u>           |
| Northern Flicker                                    | <u>Colaptes auratus</u>        |
| Pygmy Nuthatch                                      | <u>Sitta pygmaea</u>           |
| Red-breasted Nuthatch                               | <u>Sitta canadensis</u>        |
| Red-naped Sapsucker                                 | <u>Sphyrapicus varius</u>      |
| Williamson's Sapsucker                              | <u>Sphyrapicus thyroideus</u>  |
| <u>Fairly common species (5-20 nests per year)</u>  |                                |
| Acorn Woodpecker                                    | <u>Melanerpes formicivorus</u> |
| Brown Creeper                                       | <u>Certhia americana</u>       |
| Downy Woodpecker                                    | <u>Picooides pubescens</u>     |
| Hairy Woodpecker                                    | <u>Picooides villosus</u>      |
| Western Bluebird                                    | <u>Sialia mexicana</u>         |
| White-breasted Nuthatch                             | <u>Sitta carolinensis</u>      |

Table 2. Number of cavity, niche, and under bark nesting bird nests located between 1992 and 1994 on the Coconino and Sitgreaves National Forests, Coconino County, AZ.

| Species                   | Year |     |     | All  |
|---------------------------|------|-----|-----|------|
|                           | 92   | 93  | 94  |      |
| <u>Cavity-nesters</u>     |      |     |     |      |
| Acorn Woodpecker          | 3    | 5   | 4   | 12   |
| Northern Flicker          | 38   | 53  | 82  | 173  |
| Downy Woodpecker          | 4    | 9   | 10  | 23   |
| Hairy Woodpecker          | 10   | 8   | 14  | 32   |
| House Wren                | 89   | 76  | 85  | 250  |
| Mountain Chickadee        | 62   | 60  | 53  | 175  |
| Pygmy Nuthatch            | 34   | 56  | 61  | 151  |
| Red-breasted Nuthatch     | 36   | 63  | 89  | 188  |
| Red-naped Sapsucker       | 25   | 23  | 32  | 80   |
| Western Bluebird          | 5    | 3   | 8   | 16   |
| White-breasted Nuthatch   | 11   | 18  | 16  | 45   |
| Williamson's Sapsucker    | 29   | 27  | 36  | 92   |
| <u>Under-bark nesters</u> |      |     |     |      |
| Brown Creeper             | 10   | 12  | 20  | 42   |
| <u>Niche-nesters</u>      |      |     |     |      |
| Cordilleran Flycatcher    | 23   | 23  | 126 | 172  |
| Total                     | 379  | 436 | 636 | 1451 |

Table 3. Nest success in less common cavity nesting birds between 1992 and 1994 (years combined) on the Coconino and Sitgreaves National Forests, Coconino County, AZ

| Bird species            | Number of nests | Number of Successful nests | Number of Failed nests | Total days <sup>1</sup> observed | Daily nest <sup>2</sup> success | SE <sup>3</sup> | Mayfield nest success |
|-------------------------|-----------------|----------------------------|------------------------|----------------------------------|---------------------------------|-----------------|-----------------------|
| Brown Creeper           | 29              | 18                         | 11                     | 564                              | 0.9805                          | 0.0058          | 52.7                  |
| Cordilleran Flycatcher  | 131             | 44                         | 87                     | 2378.5                           | 0.9634                          | 0.0038          | 28.7                  |
| Downy Woodpecker        | 21              | 18                         | 3                      | 616                              | 0.9951                          | 0.0028          | 83.1                  |
| Hairy Woodpecker        | 30              | 25                         | 5                      | 712.5                            | 0.9930                          | 0.0031          | 72.3                  |
| House Wren              | 200             | 169                        | 31                     | 4231.5                           | 0.9927                          | 0.0013          | 77.3                  |
| Mountain Chickadee      | 146             | 108                        | 38                     | 3066                             | 0.9876                          | 0.0020          | 59.6                  |
| Pygmy Nuthatch          | 120             | 97                         | 23                     | 3302                             | 0.9930                          | 0.0014          | 73.8                  |
| Red-breasted Nuthatch   | 153             | 124                        | 29                     | 4304.5                           | 0.9933                          | 0.0012          | 78.4                  |
| Red-naped Sapsucker     | 73              | 71                         | 2                      | 2378.5                           | 0.9992                          | 0.0006          | 96.3                  |
| Northern Flicker        | 150             | 130                        | 20                     | 4952.5                           | 0.9960                          | 0.0009          | 83.5                  |
| White-breasted Nuthatch | 36              | 28                         | 8                      | 830                              | 0.9904                          | 0.0034          | 72.6                  |
| Williamson's Sapsucker  | 84              | 75                         | 9                      | 3007.5                           | 0.9970                          | 0.0010          | 86.3                  |

<sup>1</sup> Total number of days nests were observed active (exposure).

<sup>2</sup> Daily survival rate of nests.

<sup>3</sup> Standard error of the daily survival estimate.

Table 4. Annual nest success in common cavity and niche-nesting birds between 1992 to 1994 on the Coconino and Sitgreaves National Forests, Coconino County, AZ.

| Bird species           | Year | Total number of nests | Number of successful nests | Number of failed nests | Total days <sup>1</sup> observed | Daily nest success | SE <sup>2</sup> | Mayfield <sup>3</sup> nest success |    |
|------------------------|------|-----------------------|----------------------------|------------------------|----------------------------------|--------------------|-----------------|------------------------------------|----|
| Cordilleran Flycatcher | 94   | 102                   | 26                         | 76                     | 1813                             | 0.9581             | 0.0044          | 23.8                               |    |
| House Wren             | 92   | 66                    | 56                         | 10                     | 1057                             | 0.9905             | 0.0021          | 71.7                               | a  |
|                        | 93   | 72                    | 53                         | 19                     | 1509.5                           | 0.9874             | 0.0011          | 64.2                               | a  |
|                        | 94   | 62                    | 60                         | 2                      | 1665                             | 0.9988             | 0.0006          | 95.9                               | b  |
| Mountain Chickadee     | 92   | 48                    | 37                         | 11                     | 762                              | 0.9856             | 0.0032          | 54.7                               | a  |
|                        | 93   | 57                    | 33                         | 24                     | 1358                             | 0.9823             | 0.0019          | 47.7                               | a  |
|                        | 94   | 41                    | 38                         | 3                      | 946                              | 0.9968             | 0.0018          | 87.7                               | b  |
| Pygmy Nuthatch         | 92   | 26                    | 26                         | 0                      | 523                              | 1.0000             |                 | 100.0                              | a  |
|                        | 93   | 51                    | 37                         | 14                     | 1420                             | 0.9901             | 0.0016          | 65.0                               | b  |
|                        | 94   | 43                    | 34                         | 9                      | 1359                             | 0.9934             | 0.0016          | 74.9                               | b  |
| Red-breasted Nuthatch  | 92   | 27                    | 22                         | 5                      | 579                              | 0.9914             | 0.0034          | 73.2                               | ab |
|                        | 93   | 58                    | 43                         | 15                     | 1701                             | 0.9912             | 0.0012          | 72.7                               | a  |
|                        | 94   | 68                    | 59                         | 9                      | 2024.5                           | 0.9956             | 0.0014          | 85.2                               | b  |
| Red-naped Sapsucker    | 92   | 22                    | 22                         | 0                      | 611                              | 1.0000             |                 | 100.0                              | a  |
|                        | 93   | 23                    | 22                         | 1                      | 788                              | 0.9987             | 0.0013          | 94.5                               | a  |
|                        | 94   | 28                    | 27                         | 1                      | 979.5                            | 0.9990             | 0.0010          | 95.6                               | a  |
| Northern Flicker       | 92   | 33                    | 29                         | 4                      | 776                              | 0.9948             | 0.0026          | 79.5                               | ab |
|                        | 93   | 52                    | 40                         | 12                     | 1787.5                           | 0.9933             | 0.0011          | 74.1                               | a  |
|                        | 94   | 65                    | 61                         | 4                      | 2389                             | 0.9983             | 0.0004          | 92.8                               | b  |
| Williamson's Sapsucker | 92   | 26                    | 25                         | 1                      | 665                              | 0.9985             | 0.0015          | 92.9                               | a  |
|                        | 93   | 26                    | 23                         | 3                      | 1107.5                           | 0.9973             | 0.0009          | 87.6                               | a  |
|                        | 94   | 32                    | 27                         | 5                      | 1235                             | 0.9960             | 0.0018          | 82.0                               | a  |

1. Total number of days nests were observed active (exposure).

2. Standard error of the daily survival estimate.

3. Different letters indicate differences ( $P < 0.05$ ) in daily survival rates between years within species.

Table 5. Nest success among bottoms, middle slopes, and ridge-tops of drainages for common cavity nesting birds on the Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Bird species           | Topographic Location | Total Number of nests | Number of Successful nests | Number of Failed nests | Total days <sup>1</sup> observed | Daily nest success | SE <sup>2</sup> | Mayfield <sup>3</sup> nest success |   |
|------------------------|----------------------|-----------------------|----------------------------|------------------------|----------------------------------|--------------------|-----------------|------------------------------------|---|
| House Wren             | Bottom               | 156                   | 130                        | 26                     | 3285.5                           | 0.9921             | 0.0015          | 75.7                               | a |
|                        | Mid-slope            | 29                    | 26                         | 3                      | 594.5                            | 0.9950             | 0.0029          | 83.8                               | a |
|                        | Upper slope          | 15                    | 13                         | 2                      | 351.5                            | 0.9943             | 0.0040          | 81.9                               | a |
| Mountain Chickadee     | Bottom               | 95                    | 71                         | 24                     | 2257.0                           | 0.9894             | 0.0022          | 64.2                               | a |
|                        | Mid-slope            | 16                    | 13                         | 3                      | 353.5                            | 0.9915             | 0.0049          | 70.2                               | a |
|                        | Upper slope          | 35                    | 24                         | 11                     | 455.5                            | 0.9759             | 0.0072          | 36.3                               | a |
| Pygmy Nuthatch         | Bottom               | 76                    | 64                         | 12                     | 2283.0                           | 0.9947             | 0.0015          | 79.5                               | a |
|                        | Mid-slope            | 19                    | 12                         | 7                      | 523.0                            | 0.9866             | 0.0050          | 55.6                               | a |
|                        | Upper slope          | 25                    | 21                         | 4                      | 496.0                            | 0.9919             | 0.0040          | 70.3                               | a |
| Red-breasted Nuthatch  | Bottom               | 91                    | 72                         | 19                     | 2641.0                           | 0.9928             | 0.0016          | 77.1                               | a |
|                        | Mid-slope            | 31                    | 26                         | 5                      | 854.0                            | 0.9941             | 0.0026          | 80.9                               | a |
|                        | Upper slope          | 31                    | 26                         | 5                      | 809.5                            | 0.9938             | 0.0028          | 80.0                               | a |
| Red-naped Sapsucker    | Bottom               | 48                    | 47                         | 1                      | 1601.5                           | 0.9994             | 0.0006          | 97.3                               | a |
|                        | Mid-slope            | 16                    | 15                         | 1                      | 527.5                            | 0.9981             | 0.0019          | 91.9                               | a |
|                        | Upper slope          | 9                     | 9                          | 0                      | 249.5                            | 1.0000             | 0.0000          | 100.0                              | a |
| Northern Flicker       | Bottom               | 107                   | 91                         | 16                     | 3466.0                           | 0.9954             | 0.0012          | 81.4                               | a |
|                        | Mid-slope            | 29                    | 27                         | 2                      | 1116.0                           | 0.9982             | 0.0013          | 92.3                               | a |
|                        | Upper slope          | 14                    | 12                         | 2                      | 370.5                            | 0.9946             | 0.0038          | 78.6                               | a |
| Williamson's Sapsucker | Bottom               | 63                    | 57                         | 6                      | 2376.5                           | 0.9975             | 0.0010          | 88.3                               | a |
|                        | Mid-slope            | 8                     | 7                          | 1                      | 246.0                            | 0.9959             | 0.0041          | 81.9                               | a |
|                        | Upper slope          | 13                    | 11                         | 2                      | 385.0                            | 0.9948             | 0.0037          | 77.5                               | a |

1. Total number of days nests were observed active (exposure).

2. Standard error of the daily survival estimate.

3. Different letters indicate differences ( $P < 0.05$ ) in daily survival rates between topographic locations within species.

Table 6. Nest-tree species used by cavity nesting birds on Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Bird Species                  | Aspen        | Douglas-fir | White Fir | Fir, species unknown | Ponderosa Pine | Canyon Maple | Gambel's Oak | Other    | ALL           |
|-------------------------------|--------------|-------------|-----------|----------------------|----------------|--------------|--------------|----------|---------------|
| Acorn Woodpecker <sup>1</sup> | 10<br>83.3   | 0<br>0.0    | 0<br>0    | 0<br>0               | 2<br>16.7      | 0<br>0.0     | 0<br>0.0     | 0<br>0.0 | 12<br>100.0   |
| Brown Creeper                 | 27<br>64.3   | 1<br>2.4    | 1<br>2.4  | 6<br>14.3            | 3<br>7.1       | 0<br>0.0     | 3<br>7.1     | 0<br>0.0 | 42<br>100.0   |
| Northern Flicker              | 160<br>92.5  | 0<br>0.0    | 11<br>0.6 | 2<br>1.2             | 9<br>5.2       | 0<br>0.0     | 0<br>0.0     | 0<br>0.0 | 173<br>100.0  |
| Downy Woodpecker              | 23<br>100.0  | 0<br>0.0    | 0<br>0.0  | 0<br>0.0             | 0<br>0.0       | 0<br>0.0     | 0<br>0.0     | 0<br>0.0 | 23<br>100.0   |
| Hairy Woodpecker              | 32<br>100.0  | 0<br>0.0    | 0<br>0.0  | 0<br>0.0             | 0<br>0.0       | 0<br>0.0     | 0<br>0.0     | 0<br>0.0 | 32<br>100.0   |
| House Wren                    | 181<br>73.3  | 0<br>0.0    | 2<br>0.8  | 6<br>2.4             | 2<br>0.8       | 45<br>18.2   | 5<br>2.0     | 2<br>0.8 | 247<br>100.0  |
| Mountain Chickadee            | 141<br>80.6  | 2<br>1.1    | 1<br>0.6  | 5<br>2.9             | 4<br>2.3       | 12<br>6.9    | 4<br>2.3     | 3<br>1.7 | 175<br>100.0  |
| Pygmy Nuthatch                | 121<br>80.1  | 0<br>0.0    | 1<br>0.7  | 10<br>6.6            | 13<br>8.6      | 0<br>0.0     | 0<br>0.0     | 2<br>1.3 | 151<br>100.0  |
| Red-breasted Nuthatch         | 118<br>63.1  | 10<br>5.3   | 5<br>2.7  | 39<br>20.9           | 8<br>4.3       | 1<br>0.5     | 0<br>0.0     | 0<br>0.0 | 187<br>100.0  |
| Red-naped Sapsucker           | 80<br>100.0  | 0<br>0.0    | 0<br>0.0  | 0<br>0.0             | 0<br>0.0       | 0<br>0.0     | 0<br>0.0     | 0<br>0.0 | 80<br>100.0   |
| Western Bluebird              | 13<br>81.3   | 0<br>0.0    | 0<br>0.0  | 0<br>0.0             | 0<br>0.0       | 0<br>0.0     | 1<br>6.3     | 0<br>0.0 | 16<br>100.0   |
| White-breasted Nuthatch       | 32<br>71.1   | 1<br>2.2    | 0<br>0.0  | 5<br>11.1            | 1<br>2.2       | 1<br>2.2     | 5<br>11.1    | 0<br>0.0 | 45<br>100.0   |
| Williamson's Sapsucker        | 89<br>97.8   | 0<br>0.0    | 0<br>0.0  | 1<br>1.1             | 0<br>0.0       | 0<br>0.0     | 0<br>0.0     | 0<br>0.0 | 91<br>100.0   |
| ALL <sup>2</sup>              | 1027<br>80.6 | 14<br>1.1   | 11<br>0.9 | 74<br>5.8            | 42<br>3.3      | 59<br>4.6    | 18<br>1.4    | 7<br>0.5 | 1274<br>100.0 |

1. Number of nests (upper number) and percent use of tree species by each bird species (row percents, lower number).

2. Number of nests found in each tree species (upper number, column totals), and average percent tree use across bird species (lower number, column average of row percents).

Table 7. Nest-site selection in Cordilleran Flycatchers breeding in the Coconino and Sitgreaves National Forests, Coconino County, AZ 1992-1994.

| Nest-site                         | Nest-tree health <sup>1</sup> |            | Total      |
|-----------------------------------|-------------------------------|------------|------------|
|                                   | Live                          | Dead       |            |
| Aspen                             | 39<br>22.9                    | 21<br>12.4 | 60<br>35.3 |
| Douglas-fir or White Fir          | 4<br>2.4                      | 14<br>8.2  | 18<br>10.6 |
| New Mexican Locust                | 1<br>0.6                      | 1<br>0.6   | 2<br>1.2   |
| Canyon Maple                      | 0<br>0.0                      | 5<br>2.9   | 5<br>2.9   |
| Gambel's Oak                      | 9<br>5.3                      | 6<br>3.5   | 15<br>8.8  |
| Ponderosa & Western<br>White Pine | 0<br>0.0                      | 6<br>3.5   | 6<br>3.5   |
| Downed log                        | ---                           | ---        | 3<br>1.8   |
| Rock crevice                      | ---                           | ---        | 46<br>27.1 |
| Tree roots                        | ---                           | ---        | 9<br>5.3   |
| Unknown tree species              | ---                           | ---        | 6<br>3.5   |
| Total nests                       | ---                           | ---        | 170        |

1. The dead tree category includes both dead and dying trees. Number of nests in each tree/health class (above) and percent of total nests (below).

Table 8. Species and health of trees used as nest sites by 13 species of cavity-nesting birds, Coconino and Sitgreaves National Forests, AZ, 1992-1994.

| Bird Species            | Aspen      |            |            | Fir      |            | Ponderosa |           | Canyon Maple |           |          | Gambel's Oak |          |          | Other    | ALL          |
|-------------------------|------------|------------|------------|----------|------------|-----------|-----------|--------------|-----------|----------|--------------|----------|----------|----------|--------------|
|                         | Live       | Dying      | Dead       | Dying    | Dead       | Dying     | Dead      | Live         | Dying     | Dead     | Live         | Dying    | Dead     | Dead     |              |
| Acorn Woodpecker        | 3<br>25.0  | 1<br>8.3   | 6<br>50.0  | 0<br>0.0 | 0<br>0.0   | 0<br>0.0  | 2<br>16.7 | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 12<br>100.0  |
| Brown Creeper           | 0<br>0.0   | 0<br>0.0   | 22<br>68.8 | 0<br>0.0 | 5<br>15.6  | 0<br>0.0  | 2<br>6.3  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 1<br>3.1     | 0<br>0.0 | 2<br>6.3 | 0<br>0.0 | 32<br>100.0  |
| Downy Woodpecker        | 1<br>4.5   | 0<br>0.0   | 21<br>95.5 | 0<br>0.0 | 0<br>0.0   | 0<br>0.0  | 0<br>0.0  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 22<br>100.0  |
| Hairy Woodpecker        | 14<br>46.7 | 3<br>10.0  | 13<br>43.3 | 0<br>0.0 | 0<br>0.0   | 0<br>0.0  | 0<br>0.0  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 30<br>100.0  |
| House Wren              | 70<br>32.4 | 14<br>6.5  | 77<br>35.6 | 0<br>0.0 | 5<br>2.3   | 0<br>0.0  | 2<br>0.9  | 27<br>12.5   | 10<br>4.6 | 5<br>2.3 | 1<br>0.5     | 4<br>1.9 | 0<br>0.0 | 1<br>0.5 | 216<br>100.0 |
| Mountain Chickadee      | 44<br>26.8 | 12<br>7.3  | 79<br>48.2 | 0<br>0.0 | 7<br>4.3   | 0<br>0.0  | 4<br>2.4  | 1<br>0.6     | 7<br>4.3  | 3<br>1.8 | 2<br>1.2     | 1<br>0.6 | 1<br>0.6 | 3<br>1.8 | 164<br>100.0 |
| Pygmy Nuthatch          | 13<br>9.8  | 13<br>9.8  | 85<br>63.9 | 0<br>0.0 | 10<br>7.5  | 0<br>0.0  | 11<br>8.3 | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 133<br>100.0 |
| Red-breasted Nuthatch   | 10<br>6.2  | 6<br>3.7   | 90<br>55.9 | 1<br>0.6 | 46<br>28.6 | 0<br>0.0  | 8<br>5.0  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 161<br>100.0 |
| Red-naped Sapsucker     | 52<br>69.3 | 13<br>17.3 | 10<br>13.3 | 0<br>0.0 | 0<br>0.0   | 0<br>0.0  | 0<br>0.0  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 75<br>100.0  |
| Northern Flicker        | 45<br>28.5 | 21<br>13.3 | 80<br>50.6 | 0<br>0.0 | 3<br>1.9   | 0<br>0.0  | 9<br>5.7  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 158<br>100.0 |
| White-breasted Nuthatch | 18<br>46.2 | 3<br>7.7   | 7<br>17.9  | 0<br>0.0 | 4<br>10.3  | 0<br>0.0  | 1<br>2.6  | 1<br>2.6     | 0<br>0.0  | 0<br>0.0 | 4<br>10.3    | 1<br>2.6 | 0<br>0.0 | 0<br>0.0 | 39<br>100.0  |
| Western Bluebird        | 3<br>21.4  | 4<br>28.6  | 6<br>42.9  | 0<br>0.0 | 0<br>0.0   | 0<br>0.0  | 0<br>0.0  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 1<br>7.1 | 0<br>0.0 | 0<br>0.0 | 14<br>100.0  |
| Williamson's Sapsucker  | 8<br>9.2   | 5<br>5.7   | 73<br>83.9 | 0<br>0.0 | 1<br>1.1   | 0<br>0.0  | 0<br>0.0  | 0<br>0.0     | 0<br>0.0  | 0<br>0.0 | 0<br>0.0     | 0<br>0.0 | 0<br>0.0 | 0<br>0.0 | 87<br>100.0  |
| Total                   | 281        | 95         | 569        | 1        | 81         | 0         | 39        | 29           | 17        | 8        | 8            | 7        | 3        | 4        | 1143         |
| Row percent             | 24.6       | 8.3        | 49.8       | 0.1      | 7.1        | 0.0       | 3.4       | 2.5          | 1.5       | 0.7      | 0.7          | 0.6      | 0.3      | 0.3      | 100.0        |
| Column percent average  | 25.1       | 9.1        | 51.5       | 0.0      | 5.5        | 0.0       | 3.7       | 1.2          | 0.7       | 0.3      | 1.2          | 0.9      | 0.5      | 0.2      | 100.0        |

1. Number of nests (above) and percent of nest in tree/health class within bird species (row percent, below).

Table 9. Average DBH and height of nest-trees used by 14 species of cavity, niche, and under-bark nesting birds on Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Tree and health                    | Nest-tree DBH (cm) |      |     |      |      | Nest-tree height (m) |     |     |      |     |
|------------------------------------|--------------------|------|-----|------|------|----------------------|-----|-----|------|-----|
|                                    | n                  | min  | max | avg  | SD   | n                    | min | max | avg  | SD  |
| Aspen snags                        | 664                | 12   | 86  | 38.2 | 10.5 | 646                  | 1.7 | 35  | 21.3 | 6.6 |
| Aspen live                         | 296                | 16   | 70  | 38.9 | 8.5  | 293                  | 8.4 | 36  | 23.1 | 5.6 |
| White Fir and<br>Douglas-fir snags | 92                 | 18   | 95  | 44.0 | 17.5 | 89                   | 1.7 | 32  | 11.3 | 6.9 |
| Canyon Maple snags                 | 26                 | 10   | 71  | 19.2 | 11.4 | 24                   | 2.2 | 15  | 8.1  | 3.0 |
| Canyon Maple live                  | 30                 | 12   | 29  | 19.4 | 4.4  | 30                   | 5.7 | 19  | 11.3 | 3.6 |
| Gambel's Oak snags                 | 15                 | 12   | 64  | 33.7 | 15.2 | 15                   | 5.6 | 17  | 9.7  | 3.8 |
| Gambel's Oak live                  | 13                 | 14   | 45  | 29.8 | 10.8 | 13                   | 5.5 | 17  | 12.1 | 3.5 |
| Ponderosa Pine snags               | 44                 | 17.5 | 100 | 56.0 | 20.8 | 42                   | 2.5 | 36  | 17.1 | 7.5 |

Table 10. DBH, species, and health of nest-trees used by 14 species of cavity, niche, and under-bark nesting birds on Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Nest-tree species<br>and health        | Diameter at breast height (cm) of nest tree |       |       |       |       |      | ALL   |
|--|---|-------|-------|-------|-------|------|-------|
|  | 10-20                                       | 20-30 | 30-40 | 40-50 | 50-60 | >60  |       |
| <b>Aspen snags</b>                     |   |       |       |       |       |      |       |
| # of bird species <sup>1</sup>         | 5   | 12    | 14    | 14    | 12    | 7    | 14    |
| # of nests <sup>2</sup>                | 12  | 135   | 235   | 189   | 78    | 15   | 664   |
| row % of nests <sup>3</sup>            | 1.8   | 20.3  | 35.4  | 28.5  | 11.7  | 2.3  | 100.0 |
| % tree availability <sup>4</sup>       | 1.3   | 27.2  | 38.2  | 24.1  | 6.6   | 2.6  | 100.0 |
| <b>Aspen live</b>                      |   |       |       |       |       |      |       |
| # of bird species                      | 1   | 9     | 11    | 13    | 9     | 5    | 13    |
| # of nests                             | 1   | 37    | 135   | 90    | 28    | 5    | 296   |
| row % of nests                         | 0.3   | 12.5  | 45.6  | 30.4  | 9.5   | 1.7  | 100.0 |
| % tree availability                    | 1.6   | 18.8  | 46.7  | 23.6  | 7.4   | 1.9  | 100.0 |
| <b>White Fir and Douglas-fir snags</b> |   |       |       |       |       |      |       |
| # of bird species                      | 1   | 7     | 5     | 8     | 4     | 5    | 9     |
| # of nests                             | 2   | 17    | 21    | 26    | 10    | 16   | 92    |
| row % of nests                         | 2.2   | 18.5  | 22.8  | 28.3  | 10.9  | 17.4 | 100.0 |
| % tree availability                    | 5.9   | 29.9  | 24.9  | 14.5  | 10.1  | 14.7 | 100.0 |
| <b>Canyon Maple snags</b>              |   |       |       |       |       |      |       |
| # of bird species                      | 3   | 2     | 0     | 0     | 0     | 0    | 3     |
| # of nests                             | 20  | 5     | 0     | 0     | 0     | 0    | 25    |
| row % of nests                         | 76.9  | 19.2  | 0.0   | 0.0   | 0.0   | 0.0  | 100.0 |
| % tree availability                    | 22.2  | 51.9  | 25.9  | 0.0   | 0.0   | 0.0  | 100.0 |
| <b>Canyon Maple live</b>               |   |       |       |       |       |      |       |
| # of bird species                      | 2   | 3     | 0     | 0     | 0     | 0    | 4     |
| # of nests                             | 17  | 13    | 0     | 0     | 0     | 0    | 30    |
| row % of nests                         | 56.7  | 43.3  | 0.0   | 0.0   | 0.0   | 0.0  | 100.0 |
| <b>Gambel's Oak snags</b>              |   |       |       |       |       |      |       |
| # of bird species                      | 2   | 4     | 3     | 2     | 0     | 1    | 6     |
| # of nests                             | 2   | 4     | 5     | 2     | 0     | 2    | 15    |
| row % of nests                         | 13.3  | 26.7  | 33.3  | 13.3  | 0.0   | 13.3 | 100.0 |
| % tree availability                    | 15.4  | 44.9  | 26.9  | 7.7   | 3.8   | 1.3  | 100.0 |
| <b>Gambel's Oak live</b>               |   |       |       |       |       |      |       |
| # of bird species                      | 2   | 3     | 2     | 4     | 0     | 0    | 5     |
| # of nests                             | 2   | 5     | 2     | 4     | 0     | 0    | 13    |
| row % of nests                         | 15.4  | 38.5  | 15.4  | 30.8  | 0.0   | 0.0  | 100.0 |
| <b>Ponderosa Pine snags</b>            |   |       |       |       |       |      |       |
| # of bird species                      | 1   | 0     | 6     | 5     | 4     | 7    | 9     |
| # of nests                             | 1   | 0     | 10    | 9     | 8     | 16   | 44    |
| row % of nests                         | 2.3   | 0.0   | 22.7  | 20.5  | 18.2  | 36.4 | 100.0 |
| % tree availability                    | 2.7   | 21.3  | 20.0  | 20.0  | 13.3  | 22.7 | 100.0 |
| <b>Total nests</b>                     |   |       |       |       |       |      | 1179  |

1. Number of bird species recorded nesting in each DBH class within tree species & health class.
2. Number of nests of all 14 bird species in each DBH class within tree species & health class.
3. Percent bird use (nesting) of each DBH class within tree species & health class.
4. Percent availability of each DBH class within tree species & health class along snag/aspen availability transects located within each nest search plot. Availability of live oak and live maple were not determined. See table 11 for sample sizes.

Table 11. DBH of potential nest-trees along aspen/snag availability transects located within each nest search study plot on Coconino and Sitgreaves National Forests, Coconino County, AZ.

| Nest tree species and health    | Diameter at breast height (cm) of nest tree |       |       |       |       |       | ALL   |
|---------------------------------|---|-------|-------|-------|-------|-------|-------|
|                                 | 10-20                                       | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 |       |
| Aspen snags <sup>1</sup>        | 8   | 165   | 232   | 146   | 40    | 16    | 607   |
|                                 | 1.3   | 27.2  | 38.2  | 24.1  | 6.6   | 2.6   | 100.0 |
| Aspen live                      | 28  | 319   | 793   | 401   | 125   | 32    | 1698  |
|                                 | 1.6   | 18.8  | 46.7  | 23.6  | 7.4   | 1.9   | 100.0 |
| White Fir and Douglas-fir snags | 42  | 214   | 178   | 104   | 72    | 105   | 715   |
|                                 | 5.9   | 29.9  | 24.9  | 14.5  | 10.1  | 14.7  | 100.0 |
| Canyon Maple snags              | 6   | 14    | 7     | 0     | 0     | 0     | 27    |
|                                 | 22.2  | 51.9  | 25.9  | 0.0   | 0.0   | 0.0   | 100.0 |
| Gambel's Oak snags              | 12  | 35    | 21    | 6     | 3     | 1     | 78    |
|                                 | 15.4  | 44.9  | 26.9  | 7.7   | 3.8   | 1.3   | 100.0 |
| Ponderosa Pine snags            | 2   | 16    | 15    | 15    | 10    | 17    | 75    |
|                                 | 2.7   | 21.3  | 20.0  | 20.0  | 13.3  | 22.6  | 100.0 |

1. Number of trees in each tree/health class (above) and percent of each size class within tree/health class (below, row percent).

Table 12. Nest-tree height, species, and health of nest-trees used by 14 species of cavity, niche, and under-bark nesting birds on Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Nest-tree<br>species and health        | Nest-tree height (m) |      |       |       |       |       |      | Total       |
|--|----------------------|------|-------|-------|-------|-------|------|-------------|
|  | 0-5                  | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 | >30  |             |
| <b>Aspen snags</b>                     |                      |      |       |       |       |       |      |             |
| # of bird species <sup>1</sup>         | 4                    | 8    | 13    | 13    | 14    | 14    | 13   | 14          |
| # of nests <sup>2</sup>                | 9                    | 30   | 66    | 137   | 204   | 137   | 63   | 646         |
| row % of nests <sup>3</sup>            | 1.4                  | 4.6  | 10.2  | 21.2  | 31.6  | 21.2  | 9.8  | 100.0       |
| <b>Aspen live</b>                      |                      |      |       |       |       |       |      |             |
| # of bird species                      | 0                    | 2    | 7     | 12    | 12    | 11    | 10   | 13          |
| # of nests                             | 0                    | 2    | 19    | 64    | 113   | 50    | 45   | 293         |
| row % of nests                         | 0.0                  | 0.7  | 6.5   | 21.8  | 38.6  | 17.1  | 15.4 | 100.0       |
| <b>White Fir and Douglas-fir snags</b> |                      |      |       |       |       |       |      |             |
| # of bird species                      | 3                    | 6    | 5     | 5     | 6     | 2     | 1    | 9           |
| # of nests                             | 14                   | 31   | 21    | 11    | 7     | 4     | 1    | 89          |
| row % of nests                         | 15.7                 | 34.8 | 23.6  | 12.4  | 7.9   | 4.5   | 1.1  | 100.0       |
| <b>Canyon Maple snags</b>              |                      |      |       |       |       |       |      |             |
| # of bird species                      | 2                    | 3    | 2     | 1     | 0     | 0     | 0    | 3           |
| # of nests                             | 3                    | 14   | 6     | 1     | 0     | 0     | 0    | 24          |
| row % of nests                         | 12.5                 | 58.3 | 25.0  | 4.2   | 0.0   | 0.0   | 0.0  | 100.0       |
| <b>Canyon Maple live</b>               |                      |      |       |       |       |       |      |             |
| # of bird species                      | 0                    | 2    | 2     | 2     | 0     | 0     | 0    | 4           |
| # of nests                             | 0                    | 14   | 11    | 5     | 0     | 0     | 0    | 30          |
| row % of nests                         | 0.0                  | 46.7 | 36.7  | 16.7  | 0.0   | 0.0   | 0.0  | 100.0       |
| <b>Gambel's Oak snags</b>              |                      |      |       |       |       |       |      |             |
| # of bird species                      | 0                    | 5    | 3     | 1     | 0     | 0     | 0    | 6           |
| # of nests                             | 0                    | 9    | 5     | 1     | 0     | 0     | 0    | 15          |
| row % of nests                         | 0.0                  | 60.0 | 33.3  | 6.7   | 0.0   | 0.0   | 0.0  | 100.0       |
| <b>Gambel's Oak live</b>               |                      |      |       |       |       |       |      |             |
| # of bird species                      | 0                    | 3    | 3     | 3     | 0     | 0     | 0    | 5           |
| # of nests                             | 0                    | 3    | 7     | 3     | 0     | 0     | 0    | 13          |
| row % of nests                         | 0.0                  | 23.1 | 53.8  | 23.1  | 0.0   | 0.0   | 0.0  | 100.0       |
| <b>Ponderosa Pine snags</b>            |                      |      |       |       |       |       |      |             |
| # of bird species                      | 2                    | 4    | 5     | 7     | 3     | 2     | 3    | 9           |
| # of nests                             | 2                    | 5    | 9     | 16    | 5     | 2     | 3    | 42          |
| row % of nests                         | 4.8                  | 11.9 | 21.4  | 38.1  | 11.9  | 4.8   | 7.1  | 100.0       |
| <b>Total nests</b>                     |                      |      |       |       |       |       |      | <b>1152</b> |

1. Number of bird species recorded nesting in each tree height class within tree species & health class.

2. Number of nests of all 14 bird species located in each tree height class within tree species & health class.

3. Percent bird use (nesting) of each tree height class within tree species & health class.

Table 13. Tree height of potential nest-trees along aspen/snag availability transects located within each nest search study plot on Coconino and Sitgreaves National Forests, Coconino County, AZ.

| Nest-tree<br>species and health     | Nest-tree height (m) |      |       |       |       |       |     | Total |
|-------------------------------------|----------------------|------|-------|-------|-------|-------|-----|-------|
|                                     | 3-5                  | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 | >30 |       |
| Aspen snags <sup>1</sup>            | 22                   | 85   | 120   | 246   | 131   | 0     | 0   | 604   |
|                                     | 3.6                  | 14.1 | 19.9  | 40.7  | 21.7  | 0.0   | 0.0 | 100.0 |
| Aspen live                          | 0                    | 16   | 141   | 946   | 585   | 5     | 0   | 1693  |
|                                     | 0.0                  | 0.9  | 8.3   | 55.9  | 34.6  | 0.3   | 0.0 | 100.0 |
| White Fir and Douglas-<br>fir snags | 119                  | 299  | 158   | 97    | 35    | 3     | 0   | 711   |
|                                     | 16.7                 | 42.1 | 22.2  | 13.6  | 4.9   | 0.4   | 0.0 | 100.0 |
| Canyon Maple snags                  | 1                    | 19   | 7     | 0     | 0     | 0     | 0   | 27    |
|                                     | 3.7                  | 70.4 | 25.9  | 0.0   | 0.0   | 0.0   | 0.0 | 100.0 |
| Gambel's Oak snags                  | 16                   | 42   | 15    | 5     | 0     | 0     | 0   | 78    |
|                                     | 20.5                 | 53.8 | 19.2  | 6.4   | 0.0   | 0.0   | 0.0 | 100.0 |
| Ponderosa Pine snags                | 6                    | 19   | 21    | 24    | 4     | 1     | 0   | 75    |
|                                     | 8.0                  | 25.3 | 28.0  | 32.0  | 5.3   | 1.3   | 0.0 | 100.0 |

1. Number of tree in each tree/health class (above) and percent of each size class with tree species (below, row percent).

Table 14. Use of nest-trees with and without broken-off tops by 14 species of cavity, niche, and under-bark nesting birds in contrast to availability of potential nest-trees with broken tops on Coconino and Sitgreaves National Forests, Coconino County, AZ, 1993-1994.

| Tree species & health           | Nest-trees <sup>1</sup> |            | Random trees <sup>2</sup> |             |
|---------------------------------|-------------------------|------------|---------------------------|-------------|
|                                 | tree top broken ?       |            | tree top broken ?         |             |
|                                 | NO                      | YES        | NO                        | YES         |
| Aspen snags                     | 409<br>83.0             | 84<br>17.0 | 492<br>81.1               | 115<br>18.9 |
| Aspen live                      | 193<br>97.0             | 6<br>3.0   | 1696<br>99.9              | 2<br>0.1    |
| White Fir and Douglas-fir snags | 10<br>12.8              | 68<br>87.2 | 424<br>59.3               | 291<br>40.7 |
| Canyon Maple snags              | 16<br>94.1              | 1<br>5.9   | 23<br>85.2                | 4<br>14.8   |
| Canyon Maple live               | 19<br>90.5              | 2<br>9.5   |                           |             |
| Gambel's Oak snags              | 5<br>50.0               | 5<br>50.0  | 53<br>67.9                | 25<br>32.1  |
| Gambel's Oak live               | 8<br>80.0               | 2<br>20.0  |                           |             |
| Ponderosa Pine snags            | 6<br>16.7               | 30<br>83.3 | 43<br>57.3                | 32<br>42.7  |

1. Number(above) and percentage (below) of nests (within tree species and health class) located in trees with and without broken tops.

2. Number (above) and percentage (below) of trees (within tree species and health class) with and without their tops broken out along aspen/snag availability transects located within each nest search plot.

Table 15. Numbers of bird species and nests in young, middle aged, and old snags in contrast to availability of snags on Coconino and Sitgreaves National Forests, Coconino County, AZ, 1993-1994.

| Tree species              | Nest-trees <sup>1</sup><br>Snag age |      |      | Random trees <sup>2</sup><br>Snag age |      |      |
|---------------------------|-------------------------------------|------|------|---------------------------------------|------|------|
|                           | Young                               | Mid  | Old  | Young                                 | Mid  | Old  |
| Aspen <sup>1</sup>        | 14                                  | 14   | 11   |                                       |      |      |
|                           | 138                                 | 186  | 145  | 77                                    | 238  | 228  |
|                           | 29.4                                | 39.7 | 30.9 | 14.2                                  | 43.8 | 42.0 |
| White fir and Douglas-fir | 7                                   | 8    | 5    |                                       |      |      |
|                           | 20                                  | 25   | 29   | 178                                   | 298  | 228  |
|                           | 27.0                                | 33.8 | 39.2 | 25.3                                  | 42.3 | 32.4 |
| Canyon Maple              | 1                                   | 2    | 2    |                                       |      |      |
|                           | 1                                   | 5    | 2    | 1                                     | 13   | 12   |
|                           | 12.5                                | 62.5 | 25.0 | 3.8                                   | 50.0 | 46.2 |
| Gambel's Oak              | 0                                   | 1    | 1    |                                       |      |      |
|                           | 0                                   | 2    | 1    | 7                                     | 17   | 47   |
|                           | 0.0                                 | 66.7 | 33.3 | 9.9                                   | 23.9 | 66.2 |
| Ponderosa Pine            | 5                                   | 6    | 6    |                                       |      |      |
|                           | 6                                   | 13   | 17   | 15                                    | 21   | 38   |
|                           | 16.7                                | 36.1 | 47.2 | 20.3                                  | 28.4 | 51.4 |

1. Number of birds species using a tree/age class (top), number of nests found in a tree/age class (middle), and percentage of nests in tree/age class within tree species (bottom).

Table 16. Use of newly excavated, newly expanded, and old cavities by breeding birds on the Coconino and Sitgreaves National Forests, Coconino County, AZ

| Typical nest site<br>Bird Species       | Cavity age <sup>1</sup> |              |            | Total       |
|---|-------------------------|--------------|------------|-------------|
|   | New                     | Expanded old | Old        |             |
| <u>Newly Excavated Cavities</u>         |                         |              |            |             |
| Downy Woodpecker                        | 19<br>83%               | 0<br>0%      | 4<br>17%   | 23<br>100%  |
| Hairy Woodpecker                        | 20<br>69%               | 1<br>3%      | 8<br>28%   | 29<br>100%  |
| Red-breasted Nuthatch                   | 119<br>69%              | 3<br>2%      | 50<br>29%  | 172<br>100% |
| Red-naped Sapsucker                     | 66<br>86%               | 1<br>1%      | 10<br>13%  | 77<br>100%  |
| Williamson's Sapsucker                  | 67<br>84%               | 0<br>0%      | 13<br>16%  | 80<br>100%  |
| <u>Newly Excavated and Old Cavities</u> |                         |              |            |             |
| Acorn Woodpecker                        | 6<br>55%                | 1<br>9%      | 4<br>36%   | 11<br>100%  |
| Pygmy Nuthatch                          | 76<br>55%               | 11<br>8%     | 51<br>37%  | 138<br>100% |
| Common Flicker                          | 68<br>43%               | 21<br>13%    | 68<br>43%  | 157<br>100% |
| <u>Old or Natural Cavities</u>          |                         |              |            |             |
| House Wren                              | 8<br>4%                 | 31<br>15%    | 170<br>81% | 209<br>100% |
| Mountain Chickadee                      | 7<br>4%                 | 20<br>13%    | 133<br>83% | 160<br>100% |
| White-breasted Nuthatch                 | 2<br>5%                 | 3<br>7%      | 37<br>88%  | 42<br>100%  |
| Western Bluebird                        | 2<br>14%                | 0<br>0%      | 12<br>86%  | 14<br>100%  |

1. Number of nests (above, row percent below) located in new cavities excavated during the current breeding season, in old cavities enlarged during the current breeding season (expanded), and in old cavities that were not excavated during the current season. Cavity age was usually determine by wood color, not direct observation of excavation, therefore, some cavities identified as new may not have been excavated by the occupant.

Table 17. Nest-tree selection in less common primary cavity and under-bark nesting birds using all snags and live aspen as an index to nest-tree availability.

| Species  | Aspen snags | Aspen live | Non-aspen snags | ALL      |
|--|-------------|------------|-----------------|----------|
| <b>Brown Creeper</b>                                     |             |            |                 |          |
| # of nests   | 22          | 0          | 9               | 31       |
| % of nests   | 71.0        | 0          | 29.03           | 100.0    |
| selection index <sup>1</sup>                             | 3.7         | 0          | 1.0             |          |
| expected # of nests <sup>2</sup>                         | 5.9         | 16.4       | 8.7             |          |
| Chi-square   | 44.2        | 16.4       | 0               | 60.6     |
|  |             |            |                 | P < 0.01 |
| <b>Downy Woodpecker</b>                                  |             |            |                 |          |
| # of nests   | 21          | 1          | 0               | 22       |
| % of nests   | 95.5        | 4.55       | 0               | 100.0    |
| selection index  | 5.0         | 0.1        | 0               |          |
| expected # of nests                                      | 4.2         | 11.7       | 6.2             |          |
| Chi-square   | 67.8        | 9.8        | 6.2             | 83.8     |
|  |             |            |                 | P < 0.01 |
| <b>Hairy Woodpecker</b>                                  |             |            |                 |          |
| # of nests   | 16          | 14         | 0               | 30       |
| % of nests   | 53.3        | 46.67      | 0               | 100.0    |
| selection index  | 2.8         | 0.9        | 0               |          |
| expected # of nests                                      | 5.7         | 15.9       | 8.4             |          |
| Chi-square   | 18.7        | 0.2        | 8.4             | 27.3     |
|  |             |            |                 | P < 0.01 |
| <b>Red-naped Sapsucker</b>                               |             |            |                 |          |
| # of nests   | 23          | 52         | 0               | 75       |
| % of nests   | 30.7        | 69.33      | 0               | 100.0    |
| selection index  | 1.6         | 1.3        | 0               |          |
| expected # of nests                                      | 14.2        | 39.8       | 21.0            |          |
| Chi-square   | 5.4         | 3.7        | 21.0            | 30.1     |
|  |             |            |                 | P < 0.01 |
| <b>Williamson's Sapsucker</b>                            |             |            |                 |          |
| # of nests   | 79          | 8          | 1               | 88       |
| % of nests   | 89.8        | 9.09       | 1.14            | 100.0    |
| selection index  | 4.7         | 0.2        | 0               |          |
| expected # of nests                                      | 16.7        | 46.7       | 24.6            |          |
| Chi-square   | 232.6       | 32.1       | 22.7            | 287.4    |
|  |             |            |                 | P < 0.01 |
| <b>Snag and live aspen <sup>3</sup><br/>availability</b> |             |            |                 |          |
| # of trees   | 607         | 1698       | 895             | 3200     |
| % of trees   | 19.0        | 53.06      | 27.97           | 100.0    |

1. Selectivity index compute by dividing % of nests in each tree/health class by % availability of each tree/health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).
2. Nest tree availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests in each plot).
3. Chi-square statistics computed with a goodness of fit test using % tree availability to generate expected nest values. Critical value for P=0.05,  $\chi^2=5.991$ , df=2.

Table 18. Nest-tree selection in less common primary cavity and under-bark nesting birds using all snags, and live aspen showing evidence of heart rot (1 or more cavities present) as an index to nest-tree availability.

| Species  | Aspen snags | Aspen live | Non-aspen snags | ALL      |
|--|-------------|------------|-----------------|----------|
| <b>Brown Creeper</b>                                     |             |            |                 |          |
| # of nests   | 22          | 0          | 9               | 31       |
| % of nests   | 71.0        | 0          | 29.03           | 100.0    |
| selection index <sup>1</sup>                             | 2.1         | 0          | 0.6             |          |
| expected # of nests <sup>3</sup>                         | 10.7        | 4.6        | 15.7            |          |
| Chi-square   | 12.0        | 4.6        | 2.9             | 19.5     |
|  |             |            |                 | P < 0.01 |
| <b>Downy Woodpecker</b>                                  |             |            |                 |          |
| # of nests   | 21          | 1          | 0               | 22       |
| % of nests   | 95.5        | 4.55       | 0               | 100.0    |
| selection index  | 2.8         | 0.3        | 0               |          |
| expected # of nests                                      | 7.6         | 3.2        | 11.2            |          |
| Chi-square   | 23.8        | 1.6        | 11.2            | 36.6     |
|  |             |            |                 | P < 0.01 |
| <b>Hairy Woodpecker</b>                                  |             |            |                 |          |
| # of nests   | 16          | 14         | 0               | 30       |
| % of nests   | 53.3        | 46.67      | 0               | 100.0    |
| selection index  | 1.5         | 3.2        | 0               |          |
| expected # of nests                                      | 10.3        | 4.4        | 15.2            |          |
| Chi-square   | 3.1         | 20.7       | 15.2            | 39.0     |
|  |             |            |                 | P < 0.01 |
| <b>Red-naped Sapsucker</b>                               |             |            |                 |          |
| # of nests   | 23          | 52         | 0               | 75       |
| % of nests   | 30.7        | 69.3       | 0               | 100.0    |
| selection index  | 0.9         | 4.7        | 0               |          |
| expected # of nests                                      | 25.8        | 11.1       | 38.1            |          |
| Chi-square   | 0.3         | 151.4      | 38.1            | 189.8    |
|  |             |            |                 | P < 0.01 |
| <b>Williamson's Sapsucker</b>                            |             |            |                 |          |
| # of nests   | 79          | 8          | 1               | 88       |
| % of nests   | 89.8        | 9.09       | 1.14            | 100.0    |
| selection index  | 2.6         | 0.6        | 0               |          |
| expected # of nests                                      | 30.3        | 13.0       | 44.7            |          |
| Chi-square   | 78.2        | 1.9        | 42.7            | 122.8    |
|  |             |            |                 | P < 0.01 |
| <b>Snag and live aspen <sup>3</sup><br/>availability</b> |             |            |                 |          |
| # of trees   | 607         | 260        | 895             | 1762     |
| % of trees   | 34.4        | 14.7       | 50.8            | 100.0    |

1. Selectivity index compute by dividing % of nests in each tree/health class by % availability of each tree health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).
2. Nest tree availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests in each plot).
3. Chi-square statistics computed with a goodness of fit test using % tree availability to generate expected nest values. Critical value for P=0.05,  $\chi^2=5.991$ , df=2.

Table 19. Nest-tree selection in common primary cavity nesting birds using all snags and live aspen as an index to nest-tree availability.

| Species   | Aspen snags | Aspen live | Douglas-fir & White Fir snags | Ponderosa Pine snags | Gambel's Oak & Canyon Maple snags | ALL               |
|---|-------------|------------|-------------------------------|----------------------|-----------------------------------|-------------------|
| <b>Pygmy Nuthatch</b>                               |             |            |                               |                      |                                   |                   |
| # of nests  | 98          | 13         | 10                            | 11                   | 0                                 | 132               |
| % of nests  | 74.2        | 9.8        | 7.6                           | 8.3                  | 0.0                               | 100.0             |
| selection index <sup>1</sup>                        | 3.9         | 0.2        | 0.3                           | 3.6                  | 0.0                               |                   |
| expected # of nests <sup>2</sup>                    | 25.0        | 70.0       | 29.5                          | 3.1                  | 4.3                               |                   |
| Chi-square  | 212.6       | 46.5       | 12.9                          | 20.2                 | 4.3                               | 296.5<br>P < 0.01 |
| <b>Red-breasted Nuthatch</b>                        |             |            |                               |                      |                                   |                   |
| # of nests  | 97          | 10         | 47                            | 8                    | 0                                 | 162               |
| % of nests  | 59.9        | 6.2        | 29.0                          | 4.9                  | 0.0                               | 100.0             |
| selection index                                     | 3.2         | 0.1        | 1.3                           | 2.1                  | 0.0                               |                   |
| expected # of nests                                 | 30.7        | 86.0       | 36.2                          | 3.8                  | 5.3                               |                   |
| Chi-square  | 142.9       | 67.1       | 3.2                           | 4.7                  | 5.3                               | 223.2<br>P < 0.01 |
| <b>Northern Flicker</b>                             |             |            |                               |                      |                                   |                   |
| # of nests  | 101         | 45         | 3                             | 9                    | 0                                 | 158               |
| % of nests  | 63.9        | 28.5       | 1.9                           | 5.7                  | 0.0                               | 100.0             |
| selection index                                     | 3.4         | 0.5        | 0.1                           | 2.4                  | 0.0                               |                   |
| expected # of nests                                 | 30.0        | 83.8       | 35.3                          | 3.7                  | 5.2                               |                   |
| Chi-square  | 168.3       | 18.0       | 29.6                          | 7.6                  | 5.2                               | 228.7<br>P < 0.01 |
| <b>Snag and live aspen<sup>3</sup> availability</b> |             |            |                               |                      |                                   |                   |
| # of trees  | 607         | 1698       | 715                           | 75                   | 105                               | 3200              |
| % of trees  | 19.0        | 53.1       | 22.3                          | 2.3                  | 3.3                               | 100.0             |

1. Selectivity index compute by dividing % of nests in each tree/health class by % availability of each tree/health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).
2. Nest tree availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests in each plot).
3. Chi-square statistics computed with a goodness of fit test using % tree availability to generate expected nest values. Critical value for P=0.05,  $\chi^2=9.488$ , df=4.

Table 20. Nest-tree selection in common primary cavity nesting birds, using all snags, and live aspen showing evidence of heart rot (1 or more cavities present), as an index to nest-tree availability.

| Species   | Aspen snags | Aspen live | Douglas-fir & White Fir snags | Ponderosa Pine snags | Gambel's Oak & Canyon Maple snags | ALL               |
|---|-------------|------------|-------------------------------|----------------------|-----------------------------------|-------------------|
| <b>Pygmy Nuthatch</b>                               |             |            |                               |                      |                                   |                   |
| # of nests  | 98          | 13         | 10                            | 11                   | 0                                 | 132               |
| % of nests  | 74.2        | 9.8        | 7.6                           | 8.3                  | 0.0                               | 100.0             |
| selection index <sup>1</sup>                        | 2.2         | 0.7        | 0.2                           | 2.0                  | 0.0                               |                   |
| expected # of nests <sup>2</sup>                    | 45.5        | 19.5       | 53.6                          | 5.6                  | 7.9                               |                   |
| Chi-square  | 60.7        | 2.2        | 35.4                          | 5.2                  | 7.9                               | 111.4<br>P < 0.01 |
| <b>Red-breasted Nuthatch</b>                        |             |            |                               |                      |                                   |                   |
| # of nests  | 97          | 10         | 47                            | 8                    | 0                                 | 162               |
| % of nests  | 59.9        | 6.2        | 29.0                          | 4.9                  | 0.0                               | 100.0             |
| selection index                                     | 1.7         | 0.4        | 0.7                           | 1.2                  | 0.0                               |                   |
| expected # of nests                                 | 55.8        | 23.9       | 65.7                          | 6.9                  | 9.7                               |                   |
| Chi-square  | 30.4        | 8.1        | 5.3                           | 0.2                  | 9.7                               | 53.7<br>P < 0.01  |
| <b>Northern Flicker</b>                             |             |            |                               |                      |                                   |                   |
| # of nests  | 101         | 45         | 3                             | 9                    | 0                                 | 158               |
| % of nests  | 63.9        | 28.5       | 1.9                           | 5.7                  | 0.0                               | 100.0             |
| selection index                                     | 1.9         | 1.9        | 0.0                           | 1.3                  | 0.0                               |                   |
| expected # of nests                                 | 54.4        | 23.3       | 64.1                          | 6.7                  | 9.4                               |                   |
| Chi-square  | 39.8        | 20.2       | 58.3                          | 0.8                  | 9.4                               | 128.5<br>P < 0.01 |
| <b>Snag and live aspen<sup>3</sup> availability</b> |             |            |                               |                      |                                   |                   |
| # of trees  | 607         | 260        | 715                           | 75                   | 105                               | 1762              |
| % of trees  | 34.4        | 14.8       | 40.6                          | 4.3                  | 6.0                               | 100.0             |

1. Selectivity index compute by dividing % of nests in each tree/health class by % availability of each tree/health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).
2. Nest tree availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests in each plot).
3. Chi-square statistics computed with a goodness of fit test using % tree availability to generate expected nest values. Critical value for P=0.05,  $\chi^2=9.488$ , df=4.

Table 21. Nest-tree selection in secondary common cavity nesting birds using snags and live aspen containing at least one cavity as an index to nest-tree availability.

| Species   | Aspen snags | Aspen live | Douglas-fir & White Fir snags | Ponderosa Pine snags | Gambel's Oak & Canyon Maple snags | ALL      |
|---|-------------|------------|-------------------------------|----------------------|-----------------------------------|----------|
| <b>House Wren</b>                                   |             |            |                               |                      |                                   |          |
| # of nests  | 92          | 70         | 5                             | 2                    | 19                                | 188      |
| % of nests  | 48.9        | 37.2       | 2.7                           | 1.1                  | 10.1                              | 100.0    |
| selection index <sup>1</sup>                        | 1.4         | 1.0        | 0.1                           | 0.2                  | 4.0                               |          |
| expected # of nests <sup>2</sup>                    | 65.7        | 68.8       | 40.5                          | 8.2                  | 4.8                               |          |
| Chi-square  | 10.6        | 0.0        | 31.1                          | 4.7                  | 42.5                              | 88.9     |
|   |             |            |                               |                      |                                   | P < 0.01 |
| <b>Mountain Chickadee</b>                           |             |            |                               |                      |                                   |          |
| # of nests  | 91          | 44         | 7                             | 4                    | 12                                | 158      |
| % of nests  | 57.6        | 27.8       | 4.4                           | 2.5                  | 7.6                               | 100.0    |
| selection index                                     | 1.6         | 0.8        | 0.2                           | 0.6                  | 3.0                               |          |
| expected # of nests                                 | 55.2        | 57.9       | 34.0                          | 6.9                  | 4.0                               |          |
| Chi-square  | 23.2        | 3.3        | 21.5                          | 1.2                  | 16.0                              | 65.2     |
|   |             |            |                               |                      |                                   | P < 0.01 |
| <b>Snag and live aspen<sup>3</sup> availability</b> |             |            |                               |                      |                                   |          |
| # of trees  | 248         | 260        | 153                           | 31                   | 18                                | 710      |
| % of trees  | 34.9        | 36.6       | 21.5                          | 4.4                  | 2.5                               | 100.0    |

1. Selectivity index computed by dividing % of nests in each tree/health class by % availability of each tree health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).
2. Chi-square statistics computed with a goodness of fit test using % tree availability to generate expected nest values. Critical value for P=0.05,  $\chi^2=9.488$ , df=4.
3. Nest tree availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests in each plot).

Table 22. Nest-tree selection in common secondary cavity nesting birds using number of cavities as an index to nest-tree availability.

| Species                                | Aspen snags | Aspen live | Douglas-fir & White Fir snags | Ponderosa Pine snags | Gambel's Oak & Canyon Maple snags | ALL      |
|--|-------------|------------|-------------------------------|----------------------|-----------------------------------|----------|
| <b>House Wren</b>                      |             |            |                               |                      |                                   |          |
| # of nests                             | 92          | 70         | 5                             | 2                    | 19                                | 188      |
| % of nests                             | 48.9        | 37.2       | 2.7                           | 1.1                  | 10.1                              | 100.0    |
| selection index <sup>1</sup>           | 1.2         | 1.2        | 0.2                           | 0.1                  | 3.4                               |          |
| expected # of nests <sup>2</sup>       | 78.0        | 57.2       | 31.4                          | 15.9                 | 5.6                               |          |
| Chi-square                             | 2.5         | 2.9        | 22.2                          | 12.1                 | 32.2                              | 71.9     |
|  |             |            |                               |                      |                                   | P < 0.01 |
| <b>Mountain Chickadee</b>              |             |            |                               |                      |                                   |          |
| # of nests                             | 91          | 44         | 7                             | 4                    | 12                                | 158      |
| % of nests                             | 57.6        | 27.8       | 4.4                           | 2.5                  | 7.6                               | 100.0    |
| selection index                        | 1.4         | 0.9        | 0.3                           | 0.3                  | 2.6                               |          |
| expected # of nests                    | 65.5        | 48         | 26.4                          | 13.3                 | 4.7                               |          |
| Chi-square                             | 9.9         | 0.3        | 14.3                          | 6.5                  | 11.4                              | 42.4     |
|  |             |            |                               |                      |                                   | P < 0.01 |
| <b>Cavity availability<sup>3</sup></b> |             |            |                               |                      |                                   |          |
| # of cavities                          | 614         | 450        | 247                           | 125                  | 44                                | 1480     |
| % of cavities                          | 41.5        | 30.4       | 16.7                          | 8.4                  | 3.0                               | 100.0    |

1. Selectivity index computed by dividing % of nests in each tree/health class by % availability of cavities in each tree health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).
2. Chi-square statistics computed with a goodness of fit test using % cavity availability within each tree/health class to generate expected nest values. Critical value for P=0.05,  $\chi^2=9.488$ , df=4.
3. Cavity availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests within each plot).

Table 23. Nest-tree selection in less common secondary cavity nesting birds using all snags and live aspen as an index to nest-tree availability.

| Species   | Aspen snags | Aspen live | Non-aspen snags | ALL      |
|---|-------------|------------|-----------------|----------|
| <b>White-breasted Nuthatch</b>                          |             |            |                 |          |
| # of nests  | 10          | 18         | 6               | 34       |
| % of nests  | 29.4        | 52.94      | 17.65           | 100.0    |
| selection index <sup>1</sup>                            | 0.8         | 1.4        | 0.6             |          |
| expected # of nests <sup>2</sup>                        | 11.9        | 12.5       | 9.7             |          |
| Chi-square  | 0.3         | 2.5        | 1.4             | 4.2      |
|   |             |            |                 | P > 0.05 |
| <b>Western Bluebird</b>                                 |             |            |                 |          |
| # of nests  | 10          | 3          | 1               | 14       |
| % of nests  | 71.4        | 21.43      | 7.14            | 100.0    |
| selection index   | 2.0         | 0.6        | 0.3             |          |
| expected # of nests                                     | 4.9         | 5.1        | 4.0             |          |
| Chi-square  | 5.3         | 0.9        | 2.2             | 8.4      |
|   |             |            |                 | P < 0.02 |
| <b>Snag and live aspen<sup>3</sup><br/>availability</b> |             |            |                 |          |
| # of trees  | 248         | 260        | 202             | 710      |
| % of trees  | 34.9        | 36.62      | 28.45           | 100.0    |

1. Selectivity index computed by dividing % of nests in each tree/health class by % availability of each tree health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).

2. Chi-square statistics computed with a goodness of fit test using % tree availability to generate expected nest values. Critical value for P=0.05,  $\chi^2=5.991$ , df=2.

3. Nest tree availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests in each plot).

Table 24. Nest-tree selection in less common secondary cavity nesting birds using all snags and live aspen as an index to nest-tree availability.

| Species                                | Aspen snags | Aspen live | Non-aspen snags | ALL      |
|--|-------------|------------|-----------------|----------|
| <b>White-breasted Nuthatch</b>         |             |            |                 |          |
| # of nests                             | 10          | 18         | 6               | 34       |
| % of nests                             | 29.4        | 52.94      | 17.65           | 100.0    |
| selection index <sup>1</sup>           | 0.7         | 1.7        | 0.6             |          |
| expected # of nests <sup>2</sup>       | 14.1        | 10.3       | 9.6             |          |
| Chi-square                             | 1.2         | 5.7        | 1.3             | 8.2      |
|  |             |            |                 | P < 0.02 |
| <b>Western Bluebird</b>                |             |            |                 |          |
| # of nests                             | 10          | 3          | 1               | 14       |
| % of nests                             | 71.4        | 21.43      | 7.14            | 100.0    |
| selection index                        | 1.7         | 0.7        | 0.3             |          |
| expected # of nests                    | 5.8         | 4.3        | 3.9             |          |
| Chi-square                             | 3.0         | 0.4        | 2.2             | 5.6      |
| <b>Cavity availability<sup>3</sup></b> |             |            |                 |          |
| # of cavities                          | 614         | 450        | 416             | 1480     |
| % of cavities                          | 41.5        | 30.4       | 28.1            | 100.0    |

1. Selectivity index computed by dividing % of nests in each tree/health class by % availability of cavities in each tree health class (values greater than 1 indicate positive selection, values less than 1 indicate negative selection).
2. Chi-square statistics computed with a goodness of fit test using % cavity availability within each tree/health class to generate expected nest values. Critical value for P=0.05,  $\chi^2=5.991$ , df=2.
3. Cavity availability from counts of snags (all species) and live aspen along transects established within each nest-search plot (transects sampled 25 - 38% of the area searched for nests within each plot).

Table 25. Average nest density of common cavity-nesting birds at different topographic locations within snow-melt drainages on the Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Species <sup>2</sup>        | Topographic Location <sup>1</sup> |           |           |
|-----------------------------|-----------------------------------|-----------|-----------|
|                             | Lower                             | Middle    | Upper     |
| House Wren                  | 0.492                             | 0.129     | 0.044     |
|                             | 0.065                             | 0.035     | 0.014     |
|                             | a                                 | b         | b         |
| Mountain Chickadee          | 0.258                             | 0.079     | 0.098     |
|                             | 0.047                             | 0.021     | 0.025     |
|                             | a                                 | b         | b         |
| Pygmy Nuthatch              | 0.237                             | 0.087     | 0.088     |
|                             | 0.038                             | 0.018     | 0.029     |
|                             | a                                 | b         | b         |
| Red-breasted Nuthatch       | 0.272                             | 0.213     | 0.077     |
|                             | 0.037                             | 0.057     | 0.016     |
|                             | a                                 | a         | b         |
| Red-naped Sapsucker         | 0.122                             | 0.075     | 0.025     |
|                             | 0.028                             | 0.036     | 0.014     |
|                             | a                                 | ab        | b         |
| Northern Flicker            | 0.310                             | 0.134     | 0.042     |
|                             | 0.044                             | 0.032     | 0.014     |
|                             | a                                 | b         | b         |
| Williamson's Sapsucker      | 0.127                             | 0.034     | 0.048     |
|                             | 0.025                             | 0.014     | 0.015     |
|                             | a                                 | b         | b         |
| Sub-plots <sup>3</sup>      | 26                                | 13        | 26        |
| Plot area (min - max in ha) | 2.0 - 7.4                         | 2.4 - 6.5 | 2.2 - 8.7 |
| Total area (ha)             | 112.3                             | 51.5      | 110.9     |

1. Topographic location based on drainage bottoms and lower 1/3 of side slopes, middle 1/3 of side slopes, and upper 1/3 of side slopes plus ridge-tops.
2. Average nest density (nests/ha, top number), SE (middle number), and results of Tukey's multiple comparisons (different letter indicated differences in nest density between topographic locations within species,  $P < 0.05$ ). Mean nest density in each topographic category calculated from average yearly nest density within topographic category within each nest-search plot.
3. Number of subplots used in analyses (top), range of sub-plot sizes (middle), and total area within each topographic class (bottom).

Table 26. Average density of live aspen and snags (trees/ha) on Ponderosa Pine dominated ridge-tops and in fir/aspen dominated snow-melt drainages on the Coconino and Sitgreaves National Forests, Coconino County, Az, 1993.

| Topographic <sup>1</sup><br>Location | # of <sup>2</sup><br>blocks | Live <sup>3</sup><br>aspen | Snags |                            |                   |                 |                 | Total |
|--------------------------------------|-----------------------------|----------------------------|-------|----------------------------|-------------------|-----------------|-----------------|-------|
|                                      |                             |                            | Aspen | Douglas-fir<br>& White Fir | Ponderosa<br>Pine | Canyon<br>Maple | Gambel's<br>Oak |       |
| Bottom                               | 513                         | 32.16                      | 9.36  | 3.17                       | 0.19              | 0.34            | 0.29            | 45.52 |
|                                      |                             | 2.06                       | 0.88  | 0.47                       | 0.10              | 0.15            | 0.14            | 2.46  |
| Lower third                          | 565                         | 21.15                      | 9.73  | 6.02                       | 0.49              | 0.66            | 0.66            | 38.72 |
|                                      |                             | 1.61                       | 0.83  | 0.54                       | 0.16              | 0.20            | 0.20            | 2.02  |
| Middle third                         | 504                         | 17.96                      | 5.80  | 8.38                       | 0.35              | 0.20            | 0.69            | 33.38 |
|                                      |                             | 1.71                       | 0.74  | 0.83                       | 0.15              | 0.12            | 0.23            | 2.17  |
| Upper third                          | 698                         | 5.62                       | 2.36  | 8.42                       | 1.33              | 0.04            | 1.29            | 19.05 |
|                                      |                             | 0.73                       | 0.43  | 0.63                       | 0.24              | 0.04            | 0.26            | 1.20  |
| Ridge-top                            | 330                         | 2.65                       | 0.91  | 8.26                       | 1.21              | 0.00            | 0.53            | 13.56 |
|                                      |                             | 0.84                       | 0.41  | 1.03                       | 0.31              | 0.00            | 0.25            | 1.58  |
| Total                                | 2610                        | 16.21                      | 5.81  | 6.84                       | 0.72              | 0.26            | 0.75            | 30.58 |
|                                      |                             | 0.70                       | 0.32  | 0.31                       | 0.09              | 0.06            | 0.10            | 0.89  |

1. Topographic location within snow-melt drainage. Lower, middle, and upper indicate topographic location on the slope (sides) of the drainage.
2. Block= 20m x 20m area (400 m<sup>2</sup>) in which live aspen and snags were counted.
3. Average tree density per ha within 20m x 20m blocks (above) and SE (below) along transects established within each nest search plots.

Table 27. Average density of live aspen and snags (trees/ha) containing at least one cavity on Ponderosa Pine dominated ridge-tops and in fir/aspen dominated snow-melt drainages on the Coconino and Sitgreaves National Forests, Coconino County, Az, 1993.

| Topographic <sup>1</sup><br>Location | # of <sup>2</sup><br>Blocks | Live <sup>3</sup><br>aspen | Snags |                            |                   |                 |                 | ALL  |
|--------------------------------------|-----------------------------|----------------------------|-------|----------------------------|-------------------|-----------------|-----------------|------|
|                                      |                             |                            | Aspen | Douglas-fir<br>& White Fir | Ponderosa<br>Pine | Canyon<br>Maple | Gambel's<br>Oak |      |
| Bottom                               | 513                         | 4.87                       | 3.70  | 0.63                       | 0.10              | 0.00            | 0.05            | 9.36 |
|                                      |                             | 0.60                       | 0.48  | 0.19                       | 0.07              | 0.00            | 0.05            | 0.80 |
| Lower third                          | 565                         | 2.70                       | 3.98  | 1.50                       | 0.22              | 0.09            | 0.13            | 8.63 |
|                                      |                             | 0.42                       | 0.45  | 0.26                       | 0.10              | 0.06            | 0.08            | 0.70 |
| Middle third                         | 504                         | 3.72                       | 2.48  | 1.93                       | 0.20              | 0.10            | 0.00            | 8.43 |
|                                      |                             | 0.64                       | 0.48  | 0.32                       | 0.10              | 0.07            | 0.00            | 0.91 |
| Upper third                          | 698                         | 0.61                       | 1.00  | 1.97                       | 0.50              | 0.00            | 0.32            | 4.41 |
|                                      |                             | 0.18                       | 0.23  | 0.29                       | 0.13              | 0.00            | 0.12            | 0.48 |
| Ridge top                            | 330                         | 0.38                       | 0.30  | 0.91                       | 0.45              | 0.00            | 0.08            | 2.12 |
|                                      |                             | 0.20                       | 0.15  | 0.26                       | 0.21              | 0.00            | 0.08            | 0.41 |
| Total                                | 2610                        | 2.47                       | 2.38  | 1.47                       | 0.30              | 0.04            | 0.13            | 6.78 |
|                                      |                             | 0.20                       | 0.18  | 0.12                       | 0.05              | 0.02            | 0.04            | 0.32 |

1. Topographic location within snow-melt drainage. Lower, middle, and upper indicate topographic location on the slope (sides) of the drainage.

2. Block= 20m x 20m area (400 m<sup>2</sup>) in which live aspen and snags were counted.

3. Average tree density per ha within 20m x 20m blocks (above) and SE (below) along transects established within each nest search plots.

Table 28. Average number of cavities (cavities/ha) in live aspen and snags on Ponderosa Pine dominated ridge-tops and in fir/aspen dominated snow-melt drainages on the Coconino and Sitgreaves National Forests, Coconino County, Az, 1993.

| Topographic <sup>1</sup><br>Location | # of <sup>2</sup><br>Blocks | Live <sup>3</sup><br>aspen | Snags |                            |                   |                 |                 | ALL   |
|--------------------------------------|-----------------------------|----------------------------|-------|----------------------------|-------------------|-----------------|-----------------|-------|
|                                      |                             |                            | Aspen | Douglas-fir<br>& White Fir | Ponderosa<br>Pine | Canyon<br>Maple | Gambel's<br>Oak |       |
| Bottom                               | 513                         | 8.92                       | 9.50  | 1.22                       | 0.15              | 0.73            | 0.00            | 20.52 |
|                                      |                             | 1.24                       | 1.45  | 0.40                       | 0.11              | 0.73            | 0.00            | 2.09  |
| Lower third                          | 565                         | 4.03                       | 9.60  | 2.65                       | 1.33              | 0.35            | 0.09            | 18.05 |
|                                      |                             | 0.70                       | 1.28  | 0.50                       | 0.92              | 0.24            | 0.06            | 1.80  |
| Middle third                         | 504                         | 6.70                       | 6.40  | 2.83                       | 1.04              | 0.00            | 0.10            | 17.06 |
|                                      |                             | 1.23                       | 1.62  | 0.50                       | 0.59              | 0.00            | 0.07            | 2.31  |
| Upper third                          | 698                         | 0.82                       | 2.29  | 3.12                       | 1.61              | 0.50            | 0.00            | 8.35  |
|                                      |                             | 0.30                       | 0.59  | 0.52                       | 0.54              | 0.27            | 0.00            | 1.09  |
| Ridge top                            | 330                         | 0.83                       | 0.68  | 1.36                       | 1.97              | 0.23            | 0.00            | 5.08  |
|                                      |                             | 0.47                       | 0.47  | 0.44                       | 0.97              | 0.23            | 0.00            | 1.25  |
| Total                                | 2610                        | 4.24                       | 5.88  | 2.37                       | 1.20              | 0.38            | 0.04            | 14.11 |
|                                      |                             | 0.39                       | 0.54  | 0.22                       | 0.30              | 0.17            | 0.02            | 0.80  |

1. Topographic location within snow-melt drainage. Lower, middle, and upper indicate topographic location on the slope (sides) of the drainage.
2. Block= 20m x 20m area (400 m<sup>2</sup>) in which live aspen and snags were counted.
3. Average tree density per ha within 20m x 20m blocks (above) and SE (below) along transects established within each nest search plots.

Table 29. Linear regression<sup>1</sup> of nest density (nests/ha) by aspen snag density on nest-search plots located in the Sitgreaves and Coconino National Forests.

| Bird species           | Y-Intercept | Slope | R <sup>2</sup> | df   | F-ratio | P-value |
|------------------------|-------------|-------|----------------|------|---------|---------|
| House Wren             | 0.000       | 0.041 | 0.448          | 1,62 | 50.3    | <0.001  |
| Mountain Chickadee     | 0.040       | 0.020 | 0.253          | 1,63 | 21.2    | <0.001  |
| Pygmy Nuthatch         | 0.066       | 0.014 | 0.149          | 1,63 | 11.1    | 0.001   |
| Red-breasted Nuthatch  | 0.061       | 0.020 | 0.302          | 1,63 | 27.2    | <0.001  |
| Red-naped Sapsucker    | 0.006       | 0.011 | 0.199          | 1,63 | 15.6    | <0.001  |
| Northern Flicker       | 0.043       | 0.021 | 0.263          | 1,63 | 22.5    | <0.001  |
| Williamson's Sapsucker | 0.018       | 0.010 | 0.209          | 1,63 | 16.6    | <0.001  |

1. Regression calculated using nest and aspen density in 3 subplots determined within each nest-search plots (subplots based on topographic location within drainage= drainage bottoms and lower slopes, mid-slope, and upper slope and ridge-tops). Only subplots > 2 ha in size were included in analyses. Nest density was averaged over a 3 year period. Aspen density estimated from aspen snag availability transects running through each subplot.

Table 30. Linear regression of nest density (nests/ha) by aspen snag density on the bottom and lower slopes of snow-melt drainages located in the Sitgreaves and Coconino National Forests.

| Bird species           | Y-Intercept | Slope | R <sup>2</sup> | df    | F-ratio | P-value   |
|------------------------|-------------|-------|----------------|-------|---------|-----------|
| House Wren             | 0.048       | 0.046 | 0.285          | 1, 23 | 9.2     | P = 0.006 |
| Mountain Chickadee     | -0.085      | 0.036 | 0.337          | 1, 24 | 12.2    | P = 0.002 |
| Pygmy Nuthatch         | 0.175       | 0.007 | 0.017          | 1, 24 | 0.4     | P = 0.524 |
| Red-breasted Nuthatch  | 0.158       | 0.012 | 0.062          | 1, 24 | 1.6     | P = 0.220 |
| Red-naped Sapsucker    | 0.165       | 0.020 | 0.303          | 1, 24 | 10.4    | P = 0.004 |
| Northern Flicker       | 0.215       | 0.010 | 0.029          | 1, 24 | 0.7     | P = 0.402 |
| Williamson's Sapsucker | -0.040      | 0.017 | 0.274          | 1, 24 | 9.0     | P = 0.006 |

1. Regression calculated using nest and aspen density within the bottoms and lower slopes of drainages. Nest density was averaged over a 3 year period. Aspen density estimated from aspen snag availability transects running through each nest-search plot.

Table 31. Linear regression of nest density (nests/ha) by aspen snag density on upper slopes of snow-melt drainages and on adjacent ridge-tops located in the Sitgreaves and Coconino National Forests.

| Bird species           | Y-Intercept | Slope  | R <sup>2</sup> | df    | F-ratio | P-value   |
|------------------------|-------------|--------|----------------|-------|---------|-----------|
| House Wren             | 0.019       | 0.013  | 0.188          | 1, 24 | 5.6     | P = 0.027 |
| Mountain Chickadee     | 0.095       | 0.002  | 0.001          | 1, 24 | <0.1    | P = 0.880 |
| Pygmy Nuthatch         | 0.040       | 0.0260 | 0.168          | 1, 24 | 4.9     | P = 0.037 |
| Red-breasted Nuthatch  | 0.047       | 0.016  | 0.215          | 1, 24 | 6.6     | P = 0.017 |
| Red-naped Sapsucker    | 0.028       | -0.002 | 0.003          | 1, 24 | 0.1     | P = 0.797 |
| Northern Flicker       | 0.006       | 0.019  | 0.371          | 1, 24 | 14.1    | P = 0.001 |
| Williamson's Sapsucker | 0.017       | 0.127  | 0.119          | 1, 24 | 3.3     | P = 0.084 |

1. Regression calculated using nest and aspen density on the upper slopes and ridge-tops of adjacent drainages. Nest density was averaged over a 3 year period. Aspen density estimated from aspen snag availability transects running through each nest-search plot.

Table 32. Summary of nest-site use and nest-site selection in primary cavity-nesting birds (excavators) breeding in shallow snow-melt drainages on the Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Bird Species                  | % use of new cavities | Nest-tree species and condition |                 |                | Nest-tree selection relative to availability                          |  |             | Notes   |
|-------------------------------|-----------------------|---------------------------------|-----------------|----------------|---|--|-------------|---|
|                               |                       | Primary                         | Secondary       | Tertiary       | Positive  | Negative                                 | Neutral     |   |
| Acorn Woodpecker <sup>a</sup> | 55%                   | 58% aspen snags                 | 25% live aspen  | 17% pine snags | insufficient data   |  |             |   |
| Downy Woodpecker              | 83%                   | 96% aspen snags                 |                 |                | aspen snags   | live aspen non-aspen snags               |             | prefer 20-30cm DBH snags                              |
| Hairy Woodpecker              | 69%                   | 53% aspen snags                 | 47% live aspen  |                | aspen snags & live aspen showing evidence of heart rot                | non-aspen snags                          |             |   |
| Pygmy Nuthatch                | 55%                   | 74% aspen snags                 | 10% live aspen  | 8% dead pine   | aspen snags pine snags  | live aspen, fir snags, oak & maple snags |             |   |
| Northern Flicker              | 43%                   | 64% aspen snags                 | 28% live aspen  | 6% dead pine   | aspen snags, live aspen showing evidence of heart rot, and pine snags | fir, oak & maple snags                   |             |   |
| Red-breasted Nuthatch         | 69%                   | 60% aspen snags                 | 29% fir snags   |                | aspen snags   | live aspen, oak & maple snags            | fir snags   | fir snags with broken tops supported 23% of all nests |
| Red-naped Sapsucker           | 86%                   | 70% live aspen                  | 30% aspen snags |                | live aspen  | non-aspen                                | aspen snags |   |
| Williamson's Sapsucker        | 84%                   | 90% aspen snags                 | 9% live aspen   |                | aspen snags   | non-aspen snags, live aspen              |             |   |

Table 33. Summary of nest-site use and nest-site selection in secondary cavity-nesting birds (non-excavators) breeding in shallow snow-melt drainages on the Coconino and Sitgreaves National Forests, Coconino County, AZ, 1992-1994.

| Bird Species            | Nest-site type  | Nest-tree species and condition |                |                 | Nest-tree selection relative to availability             |                                |                                       | Notes   |
|-------------------------|---|---------------------------------|----------------|-----------------|--|--------------------------------|---------------------------------------|---|
|                         |   | Primary                         | Secondary      | Tertiary        | Positive   | Negative                       | Neutral                               |   |
| Brown Creeper           | space between the trunk and loose bark of dead and dying trees    | 69% aspen snags                 | 16 % fir snags |                 | aspen snags  | live aspen                     |                                       | no selection for snags of a particular age  |
| Cordilleran Flycatcher  | rock crevices, niches formed by scars in aspen trunks, tree roots | Rock crevice 27%                | live aspen 23% | aspen snags 12% | no availability data                                     |                                |                                       |   |
| House Wren              | previously excavate and natural cavities                          | 42% aspen snags                 | 32% live aspen | 12% live maple  | cavities in aspen (live or dead),cavities in maple snags | cavities in pine and firs      |                                       | probable selection for cavities in live maple but no availability data                |
| Mountain Chickadee      | previously excavate and natural cavities                          | 56% aspen snags                 | 27% live aspen |                 | cavities in aspen snags and dead and dying maple         | cavities in pine and fir snags | cavities in live aspen                |   |
| White-breasted Nuthatch | previously excavate and natural cavities                          | 46% live aspen                  | 26% dead aspen | 13% live oak    | cavities in live aspen                                   |                                | cavities in aspen and non-aspen snags | probable selection for natural cavities in live Gambel's oak but no availability data |
| Western Bluebird        | previously excavate cavities                                      | 72% dead aspen                  | 21% live aspen |                 | insufficient data  |                                |                                       |   |