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Aspen

HABITAT SUITABILITY FOR WILLIAMSON'S SAPSUCKERS IN MIXED-CONIFER FORESTS

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Abstract: Williamson's sapsuckers (*Sphyrapicus thyroideus*) have narrow habitat requirements and are sensitive indicators of change in intensively managed forest habitats of western North America. Thus, we studied habitat suitability for Williamson's sapsuckers at 99 4-ha sites (33 nest sites, 66 non-use sites) in mixed-conifer forests in Arizona during 1991. Nesting success of sapsuckers was high in this habitat (93.2% nest success, 0.0014 daily mortality, $n = 724$ nest days), and they preferred to nest in tall ($P < 0.05$) aspen snags ($P < 0.001$) near the bottom ($P = 0.012$) of snow-melt drainages with 0–20% of the canopies dominated by aspen. Sapsucker nest sites had particularly large ($P < 0.05$) live aspen and aspen snags in the surrounding area. Nest sites also had high ($P < 0.05$) snag densities ($\bar{x} = 7.65$ snags/ha) in the surrounding area, and these snag densities exceeded those commonly used in forest management plans. Effective snag management should concentrate snags in groups within low-lying areas and conserve large-sized snags. A Habitat Suitability Index (HSI) correctly predicted that Williamson's sapsuckers should generally prefer drainages over ridgetops, but the model could not distinguish between use and non-use sites within drainages. Future HSI models for Williamson's sapsucker should continue to stress snag density, but should consider aspen snag density separately from density of other snags, incorporate height and diameter of aspen snags, and use a more liberal definition of aspens contributing to overstory canopy cover.

snag den nest = 3/ac

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Forest managers are faced with trying to maintain viable populations of vertebrates while simultaneously managing for other resource needs such as timber production. This delicate balancing act depends upon knowing the effects of land management practices on habitat suitability for wildlife. The first step in attaining this knowledge is to identify habitat features that influence habitat suitability. Moreover, identification of habitat features that directly affect reproduction and survival is the most effective means of indexing habitat suitability because maintenance of viable populations depends on sustaining these fitness components (Martin 1992).

Cavity-nesting birds are a particularly appropriate group of species for examining effects of land management on habitat suitability because they are often affected by land management practices (Gysel 1961, Haapanen 1965, Hunter 1990). For instance, snags are less abundant in managed than unmanaged forests (Cline et al. 1980), and availability of snags commonly limits populations of cavity-nesting birds by limiting nesting opportunities (for review, see Li and Martin [1991], Martin and Li [1992]). In response, explicit policies for snag conservation have been implemented for managed stands (Hunter 1990). Yet, management for presence of snags is not sufficient; size, species, and age of snags, plus distribution of nest trees and vegetation in surrounding patches can affect presence and even reproductive success of birds (Flack 1976, Raphael and White 1984, Sedgwick and Knopf 1990, Li and Martin 1991). Key habitat features that influence habitat suitability, particularly with regard to reproduction or survival, need to be identified for individual species.

Williamson's sapsucker is the least numerous and most ecologically and genetically specialized species in its genus (Crockett and Hadow 1975, Johnson and Zink 1983). They are most common in middle-elevation forests of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*), 2 forest types that are managed intensively for timber extraction in western North America (Thomas et al. 1979*b*). Within these intensively managed forests, Williamson's sapsuckers have narrow habitat requirements and limited versatility, making them sensitive indicators of environmental changes (Thomas et al. 1979*b*). Consequently, a Habitat

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overstory

and non-use site. Percent canopy dominated by aspen was determined by the proportion of the 30 points where aspen was the dominant canopy species. We established 3 evenly spaced, 25- × 200-m transects in each 4-ha grid accounting for 37.5% (1.5 ha) of the total area of each grid. At nest sites, the actual nest tree determined the center of the middle transect. The center of the non-use sites were determined by pacing 230 m from the nest tree, leaving a 30-m buffer between the 200- × 200-m nest sites and adjacent non-use sites. The dbh and height of all snags and live aspen trees ≥18 cm dbh were noted in each transect. We considered trees ≥18 cm dbh as available nest trees based on previous studies of Williamson's sapsucker nest site selection (Crockett and Hadow 1975).

In addition to average dbh and average height of live and dead aspen trees, we also estimated the number of "suitable" snags per ha and the average dbh of "overstory" aspen trees in both use and non-use sites. "Suitable" snags were defined by the HSI model as dead ponderosa pine trees ≥45.7 cm dbh and soft snags of all other trees ≥30.5 cm dbh that are in advanced stages of decay and deterioration (Sousa 1983). "Overstory" aspen trees were defined by the model as those aspen that are ≥80% of the height of the tallest tree in the stand (Sousa 1983). To examine the distribution of potential nest sites within preferred nesting habitat, we estimated aspen snag densities within the 0.8-ha block of habitat surrounding the nest tree and within the 3.2 ha on the perimeter of the nest plots. We compared snag densities between these 2 zones within nest plots with paired t-tests (SAS Inst. Inc. 1985). We visited sites daily to search for new nests and were very confident that non-use sites did not contain additional nesting pairs of sapsuckers.

We compared differences in use of nest trees versus available trees with a Chi-square goodness-of-fit test (Zar 1984). Pearson product-moment partial correlations (r) and associated significance probabilities (SAS Inst. Inc. 1985) were calculated to examine relationships among habitat variables and between habitat variables and HSI ratings. We tested all variables for normality by examining Shapiro-Wilks' W-statistic and normal probability plots (SAS Inst. Inc. 1985). Tree height, percent canopy cover, number of "suitable" snags, and aspen snag densities within nest plots were normally distributed ($P > 0.01$, Shapiro-Wilks' test). Distributions of all other habitat variables were non-normal ($P < 0.01$, Shapiro-Wilks' test), but unimodal. We used univariate analysis of variance (ANOVA) with Bonferroni multiple comparisons (SAS Inst. Inc. 1985) to examine differences in habitat variables among nest and both types of non-use plots. We used paired t-tests (SAS Inst. Inc. 1985) to examine differences in snag densities within nest plots. Although some of our habitat variables were not normally distributed, we chose to use parametric statistics because these statistics are robust under violations of normality (Boneau 1960, Donaldson 1968, Harris 1985).

RESULTS

Williamson's sapsuckers usually excavated new cavities for nesting (79%, $n = 28$) rather than using old holes. However, nests showed no orientation preference ($\chi^2 = 2.42$, 3 df, $P = 0.50$). Of 66 nests, most (54) were in aspen snags, some (11) were in live aspen trees, and one was in an unidentified snag. Densities of live aspen (9.2 ± 7.4 trees/ha) were greater than aspen snags (3.6 ± 2.2 snags/ha) or other snags (4.1 ± 2.8/ha) on the 99 4-ha sites sampled. Thus, aspen snags were used more ($\chi^2 = 99.49$, 1 df, $P < 0.001$) than expected based on their availability. No nests were found in conifer snags despite similar availability. Percent of canopy dominated by aspen ranged from 0–20% ($\bar{x} = 7 \pm 6\%$) within Williamson's sapsucker nest plots.

0-20% aspen

Nest height averaged 13.1 ± 5.3 m (range = 3–26 m, $n = 31$) and was correlated with nest tree height ($r = 0.69$, $n = 23$, $P < 0.0003$), but not nest tree dbh ($r = 0.19$, $n = 23$, $P = 0.3841$). Live aspens used for nesting (20.7 ± 3.5 m, range = 16–26 m, $n = 6$) were similar ($P > 0.05$) in height to available live aspen trees (21.9 ± 3.0 m, range = 6.1–32.0 m, $n = 530$) within nest plots. In contrast, aspen snags used for nesting (24.9 ± 4.8 m, range = 15–33.5, $n = 24$) were taller ($P < 0.05$) than available aspen snags (19.7 ± 5.7 m, range = 3.4–29 m, $n = 207$) within nest plots. Diameter (dbh) of live aspens used for nesting (36.2 ± 7.4 cm, range = 30–50.8 cm, $n = 6$) did not differ ($P > 0.05$) from dbh of available live aspen trees (37.2 ± 8.2 cm, range = 19–70 cm, $n = 532$) within nest plots. Similarly, dbh of aspen snags used for nesting (38.1 ± 10.6 cm, range = 25–63.5 cm, $n = 23$) did not differ ($P > 0.05$) from dbh of available aspen snags (37.2 ± 8.0 cm, range = 20.3–65 cm, $n = 207$) within nest plots. Thus, live aspen trees used for nesting were generally similar in

MANAGEMENT IMPLICATIONS

With respect to density and distribution of snags, current forest management practices may be insufficient to attain optimal conditions for cavity-nesting birds. Our data indicate that forest management should include conservation of large snags rather than simply producing a set number of snags of any size. Moreover, our data suggest that forest management plans that incorporate snag management should leave snags in clumps and at high densities (>5 snags/ha) within drainages or in low-lying areas. Concentrating snags in groups creates ideal habitat for many woodpeckers and a variety of other snag foragers and cavity-users (Thomas et al. 1979*a*, Raphael and White 1984, Hunter 1990, Sedgwick and Knopf 1990). Certainly, snag management should not attempt to space snags evenly throughout a forest.

The HSI model ranked nest sites higher than non-use sites, but inappropriate ratings were produced for both nest and non-use sites. The model is generous in assigning optimal ratings (≥0.7) to areas that were not used by sapsuckers. Indeed, the majority (64%) of non-use sites received optimal ratings. Total snag density was the largest contributor to an HSI rating. Non-use or suboptimal plots could be more effectively categorized if the HSI model ranked both snags and live aspens by size because the birds preferred areas with particularly large snags and live aspens. Moreover, when assigning suitability ratings for snag densities, we suggest considering aspen snags separately from snags of other species. Distribution of snags within nesting territories is important in nest site selection, and future model versions should give higher ratings to areas with clumped distributions of snags.

Finally, dbh of "overstory" aspen trees had no significant influence on HSI ratings. The model defines an "overstory" aspen tree as any aspen ≥80% of the height of the tallest tree in the stand. This condition was rarely met because our stands included much taller fir trees, so this variable often entered the model as a zero and therefore contributed little. Future model versions should be more liberal in the definition of an "overstory" aspen tree since dbh and height of aspen trees and snags did differ between nest and non-use plots when analyses were not restricted to the "overstory" criteria. Percent overhead cover contributed heavily to the HSI rating, but did not differ between nest and non-use plots and should be de-emphasized in future model versions. We believe the HSI model for Williamson's sapsucker needs revision and should be more conservative in assigning optimal ratings.

overstory

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