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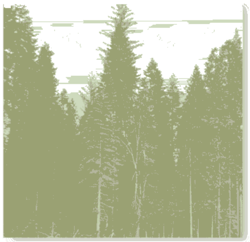

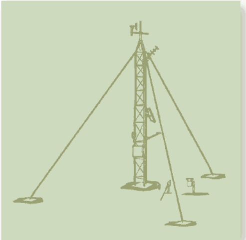

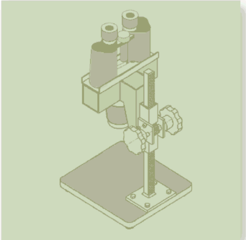

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Snag Management Objectives for Cavity-Using Species on Sierra Pacific Industries' Lands

By Steven Self, Staff Wildlife Biologist

Sierra Pacific Industries
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Introduction

Snags, or dead trees, are an important resource for many wildlife species (USDA 1979, CDFG 1999). In order to retain an adequate number of snags on its lands to maintain healthy populations of wildlife species that rely on snags for shelter and foraging, SPI has developed snag management objectives to be incorporated in its forest management activities. In developing these objectives, it was necessary to understand that how a snag is used by wildlife depends on the animal, the snag's size and state of decay, and the location on the landscape. In addition, it was important to understand that the distribution of snags across the landscape is never uniform. Snags spread uniformly across a landscape would be an anomaly unlikely to best serve resident wildlife populations.

Snags are often described in terms of their state of decay (USDA 1979). Recently dead snags, or *hard snags*, have some or most branches still in place and often have most of their bark. *Soft snags*, in contrast, are standing trees that have been dead for a number of years. They have decayed to the point where they have few to no branches, and little or no bark. Their wood has been softened by weather, insects, and fungal rot.

Snag distribution in forests is usually non-random and non-homogenous. Raphael and White (1984) found that snags occurred in a pattern of "patches" rather than in an even distribution. Their study area had four times as many snags in areas surrounding nests of cavity-using species as they found in random plots. Inventory information gathered by Sierra Pacific Industries confirms this observation, consistently finding that snags of any size occur on less than 30% of inventory plots. This patchy distribution pattern apparently results from the way in which the primary vectors of snag formation (root diseases, insect infestations, and mechanical damage such as wind and snow breakage) occur and/or spread. As a result, researchers recommend that snag retention guidelines call for a "clumpy," non-uniform distribution of snags across the larger landscape instead of snags distributed evenly based on a smaller per-unit-area (USDA 1979; Raphael and White 1984; Ohmann et al. 1994).

Snag Preferences of Cavity-Using Species

Species that use snags can be divided into two distinct categories: primary cavity users, which excavate their own cavities, and secondary cavity users, which use holes abandoned by primary cavity users, natural cavities, cracks, and spaces between bark (USDA 1979; Raphael and White 1984; CDFG 1999).

Primary cavity users use both hard and soft snags. Some species will excavate cavities in hard snags, some in soft snags, and some will use either type of snag. In general, cavity excavators tend to use those portions of snags—whether hard or soft—that have some sort of decay (USDA 1979; Cunningham et al. 1980; Bull et al. 1997). In addition, both primary and secondary cavity users create and/or use cavities in live trees as well as in snags (Raphael and White 1984; Bull et al. 1997; CDFG 1999).

Known Habits of Primary and Secondary Cavity Users

Overall Observations Based on Research Data

Two studies conducted over several years in the Sierra Nevada found that 24% to 37% of primary cavity users created cavities and nested in live trees instead of snags (Raphael and White 1984; SPI 2000). Studies in other areas confirm similar relationships (Balda 1975; Miller and Miller 1976; Cunningham et al. 1980).

Primary and secondary cavity users are selective about the stand conditions they'll use for nesting. Some species choose open forest stand conditions; others prefer closed forest stands composed of either large or small trees. Some prefer riparian stands—stands adjacent to sources of water (Raphael and White 1984; Zarnowitz and Manuwal 1985; Ohmann et al. 1994; Bull et al. 1997; CDFG 1999). This indicates that not all primary or secondary cavity users can be found in any one stand or area, unless the area is big enough to support all of these conditions, and that it is not realistic to attempt to provide snags to support all primary and secondary cavity users in any one stand (Raphael and White 1984). Rather, when developing management objectives for primary and secondary cavity users, managers should account for the fact that species have preferences for certain stand conditions (open, riparian, closed small trees, and closed large trees) and thus won't be found everywhere in the landscape, and also for the fact that most species will also use live trees for some of their needs (Raphael and White 1984; Ohmann et al. 1994).

Cavity-Using Species on SPI Lands

There are over 40 species of vertebrate wildlife that use snags for foraging or nesting on SPI lands.[1] Thirteen of these species are primary cavity users, and about 30 others are secondary cavity users. Table 1 lists the primary cavity-using species and their known snag preferences.

[1] Sources: CRA 1999; CDFG 1999; SPI sighting records.

Table 1. Nest Tree and Nest Stand Conditions for Primary Cavity Species Expected to Use SPI Land [2]

Common Name	Hard or Soft Snag	Live or Dead Tree	Stand Condition
Lewis woodpecker	Soft	Both	Open
Acorn woodpecker	Hard	Both	Open
Red-breasted sapsucker	Hard	Both	Riparian
Williamson's sapsucker	Hard	Both	Riparian
Downy woodpecker	Both	Both	Riparian
Hairy woodpecker	Hard	Both	Open
White-headed woodpecker	Soft	Both	Open
Black-backed woodpecker	Hard	Both	Large Tree Closed
Northern flicker	Both	Both	Open
Pileated woodpecker	Hard	Both	Large Tree Closed
Red-breasted nuthatch	Hard	Both	Small Tree Closed
White-breasted nuthatch	Hard	Both	Large Tree Closed
Pygmy nuthatch	Hard	Dead	Small Tree Closed
Brown creeper[3]	Both	Both	Large Tree Closed

Determining Snag Management Objectives

SPI used a systematic approach based on the best data available for setting snag-management objectives for forestry operations on its lands. This approach involves several steps that include identifying cavity-using species on its lands (presented in Table 1 above); determining exactly how many pairs or individuals of these species could be supported under the most optimal circumstances (i.e., calculating the number of snags needed to provide maximum habitat capacity for these species); stratifying this data for four common stand conditions (since different species tend to prefer different types of habitat); consolidating the snag requirements for these four stand conditions into a single set of requirements that accounts for the needs of all the species (because it is not reasonable to manage for snags at a stand level given their uneven patterns of distribution); and finally to adjust the number of snags to account for the use of live trees by many snag-using species. The result is a set of snag-management objectives that SPI believes will provide moderate to high habitat capability for snag-using wildlife species on its lands.

Calculating Habitat Capability for Primary Cavity-Using Species

After identifying primary cavity using species on SPI lands (those listed in Table 1) and their habitat preferences, it is necessary to calculate the number of snags in each dbh (diameter at breast height) class needed to provide the maximum (100%) habitat capacity for each species. The calculation uses data from available scientific literature about the

[2] Sources: USDA 1979; Raphael and White 1984; Marcot 1992, Ohmann et al. 1994; CDFG 1999; SPI 2000.

[3] Although technically not a primary cavity user, the brown creeper's nesting requirements are so different that Raphael and White (1984) recommend treating it as such.

species, including home range size, number of cavities excavated per year, and number of snags available per excavated snag (USDA 1979; Raphael and White 1984; Marcot 1992; Ohmann et al. 1994). Table 2 presents the numbers of snags, averaged on a per-acre basis, needed to provide maximum habitat capability for the fourteen primary cavity nesting species on SPI lands (including the brown creeper).

Table 2. Snag Numbers Predicted to Provide Maximum (100%) Habitat Capability [4]

Species	No. of Hard Snags per Acre	No. of Soft Snags per Acre
Lewis woodpecker	—	0.48 (15+ inches dbh)
Acorn woodpecker	0.70 (15+ inches dbh)	—
Red-breasted sapsucker	0.45 (15+ inches dbh)	
Williamson's sapsucker	0.33 (15+ inches dbh)	—
Downy woodpecker	0.08 (11+ inches dbh)	0.08 (11+ inches dbh)
Hairy woodpecker	1.92 (15+ inches dbh)	—
White-headed woodpecker	—	0.60 (15+ inches dbh)
Black-backed woodpecker	0.12 (15+ inches dbh)	—
Northern flicker	0.24 (15+ inches dbh)	0.24 (15+ inches dbh)
Pileated woodpecker	0.06 (24+ inches dbh)	—
Red-breasted nuthatch	0.76 (15+ inches dbh)	—
White-breasted nuthatch	0.76 (15+ inches dbh)	—
Pygmy nuthatch	1.08 (15+ inches dbh)	—
Brown creeper	0.40 (15+ inches dbh)	0.40 (15+ inches dbh)

Once the maximum habitat capability for each species has been determined, the information from tables 1 and 2 can be used to prepare a habitat capability chart that lists (stratifies) for each of four stand conditions (open, riparian, small tree closed canopy, and large tree closed canopy) the numbers of snags per acre for each of three size classes needed to satisfy the requirements of all primary cavity-using species on SPI lands (Table 3). A linear relationship is used to calculate the percentages of habitat capacity below 100%. (Using a linear relationship for calculating these levels is believed to be conservative, meaning that it overestimates the number of snags necessary for a given capability level [Raphael and White 1984].) Past approaches did not stratify by stand condition or take into account the use of live trees by cavity users.

[4] Sources: USDA 1979; Raphael and White 1984; Marcot 1992; CDFG 1999.

Table 3. The number of snags per acre required to achieve increasing levels of habitat capacity for primary cavity-using species on SPI lands for a variety of snag sizes and stand conditions

	Open Forest Stand Condition Percentage of Maximum Habitat Capability (snags/acre)						
Snag Size Class (dbh)	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Total > 11"	1.67	2.09	2.51	2.92	3.35	3.76	4.18
Total >15"	1.67	2.09	2.51	2.92	3.35	3.76	4.18
Total >24"	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Riparian Forest Stand Condition Percentage of Maximum Habitat Capability (snags/acre)						
Snag Size Class (dbh)	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Total > 11"	0.38	0.47	0.56	0.66	0.75	0.85	0.94
Total >15"	0.31	0.39	0.47	0.55	0.62	0.70	0.78
Total >24"	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Small Tree Closed Forest Stand Condition Percentage of Maximum Habitat Capability (snags/acre)						
Snag Size Class (dbh))	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Total > 11"	0.74	0.92	1.10	1.29	1.47	1.66	1.84
Total >15"	0.74	0.92	1.10	1.29	1.47	1.66	1.84
Total >24"	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Large Tree Closed Forest Stand Condition Percentage of Maximum Habitat Capability (snags/acre)						
Snag Size Class (dbh)	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Total > 11"	0.70	0.87	1.04	1.22	1.39	1.57	1.74
Total >15"	0.70	0.87	1.04	1.22	1.39	1.57	1.74
Total >24"	0.02	0.03	0.04	0.04	0.05	0.05	0.06

Managing for Combined Stand Levels

Setting management objectives and attempting to track implementation and monitor effectiveness would be extremely difficult if it were attempted by stand condition or some other small unit area. In order to minimize the complexities associated with implementation and monitoring, and to be conservative in providing the necessary numbers of snags, a single table can be developed and applied to all stand conditions by combining the highest level of snags necessary by stand condition and snag size from Table 3. In choosing a level of snag habitat capability for which to manage, it is important to note researchers have stated that providing less than about 40% of total habitat capability could present an unacceptable risk to cavity-using wildlife species (USDA 1979; Raphael and White 1984). Table 4 depicts the result of this combination. The results presented in Table 4 are designed to allow snag management objectives to be efficiently and effectively accomplished at the scale of a Management Inventory Unit[5] (MIU), giving managers the

[5] A Management Inventory Unit (MIU) is an area defined for assessing the potential effects of a particular project or set of projects. A MIU is by definition larger than the project area and is defined by logical groupings of ownership boundaries.

flexibility to provide for the clumpy distribution of snags found in the field and recommended in the literature.

Table 4. Number of Snags Required to Achieve Maximum Habitat Capability

	Percent of Maximum Habitat Capability (snags/acre)						
	40	50	60	70	80	90	100
Total number of snags > 11" dbh	1.67	2.09	2.51	2.92	3.35	3.76	4.18
Total number of snags > 15" dbh	1.67	2.09	2.51	2.92	3.35	3.76	4.18
Total number of snags > 24" dbh	0.02	0.03	0.04	0.04	0.05	0.05	0.06

Accounting for the Use of Live Trees by Cavity-Using Species

The final step in developing snag management objectives is to account for use of live trees by cavity-using species. The available data suggest that primary cavity users nest in live trees from 24 to 37% of the time. By reducing the levels presented in Table 4 by 24% (a conservative estimate), a final set of snag management objectives can be arrived at. These are presented in Table 5.

Table 5. SPI Snag Management Objectives

	Percent of Maximum Habitat Capability (snags/acre)						
	40	50	60	70	80	90	100
Total number of snags >=11" dbh	1.27	1.59	1.91	2.22	2.55	2.86	3.18
Total number of snags >= 15" dbh	1.27	1.59	1.91	2.22	2.55	2.86	3.18
Total number of snags >= 24" dbh	0.02	0.02	0.03	0.03	0.04	0.04	0.05

The capability for the levels of snags included in Table 5 to support cavity using wildlife species is further supported by two analyses conducted by Raphael and White (1984). In the 1st analysis, they found that the density of cavity nesters within their overall study area increased up to about 3.0 snags/acre ≥15" in dbh. After this density of snags was reached, further increases in snag density did not lead to a corresponding increase in density of cavity nesting birds.

In their second analysis, considering only unburned areas of the study, Raphael and White (1984) found equal densities of excavators and creepers in 2 areas with quite different snag densities. While Area 1 (Unburned Plot) had 3.44 snags/acre ≥15" dbh and Area 2

(Goshawk Plot) had 1.40 snags/acre $\geq$15” dbh, both Areas supported identical combined densities of excavators and creepers.

These two analyses indicate that management for the snag levels proposed by SPI has a high probability of maintaining moderate to high population levels of excavator bird species.

Other Management Concerns to Address

- Snags and their residual forms are known to significantly contribute to increased difficulty in controlling the spread and intensity of forest fires (Weatherspoon 1996). Managers must consider the increased risks associated with forest fire management when considering what level of snags to provide within forest ecosystems.
- **Meeting the needs of the secondary cavity nesting species.**
  Another concern that must be addressed is whether providing for the snag needs of primary cavity nesting species will also meet the needs of secondary cavity nesting species. Past snag management recommendations usually assumed that providing adequate habitat for primary cavity users will meet the needs of secondary cavity users. While this seems logical, it is usually considered a relatively untested assumption. The Thomas et al. model (USDA 1979) specifically assumes that if primary cavity users are sufficiently provided for, secondary cavity users will also be provided for. The Marcot model does not address the issue of primary vs. secondary cavity users (Marcot 1992).

  Raphael and White (1984) addressed this issue for secondary cavity nesting birds. They found that, based on measurements of excavator (primary cavity user) and non-excavator (secondary cavity user) nest sites, there was at least one excavator species whose nest and nest-tree characteristics were statistically matched for each non-excavator species. They concluded that excavator management could meet non-excavator needs for nest trees and nest stands. This conclusion is supported by the fact that secondary cavity-using species are known to discriminate less than primary cavity users as to whether a tree is dead or alive (Species Notes, CDFG 1999). This suggests that these species are more flexible in their use of nesting substrates than primary cavity users are. A possible exception to this is the brown creeper. Brown creepers use the widest variety of nesting substrates of any of the cavity-using bird species. They usually nest behind loose bark but are also known to use cracks in trees, natural cavities, and, rarely, abandoned cavities of other species (CDFG 1999). Raphael and White (1984) found that cavities used by this species were not well matched by cavities excavated by the primary cavity-using species in their study area. As recommended by Raphael and White, this species is treated here as a primary cavity nester to ensure meeting its needs.

- **Providing habitat for species other than birds that use cavities.**
  A variety of species other than birds, including mammals, amphibians, and reptiles, are known to use cavities. Although cavities are not believed to be required by these species, they are known to make use of them when available (CDFG 1999). Sierra Pacific Industries has collected data on snag densities in landscapes known to support year-round occupancy and successful reproduction by a number of large-bodied and small-bodied secondary cavity using species (CRA 1999; SPI sighting records). The species specifically known to live and reproduce in these inventoried landscapes are the northern and California spotted owls, pine marten, fisher, and silver-haired bat. These landscapes range in size from 5,000 to over 30,000 acres in size and total over 200,000 acres. They are located on the Northern California coast and in the Klamath Mountains, the southern Cascades, and the Sierra Nevada sections of the Humid Temperate Domain of California (USDA 1997). All of these landscapes have average snag densities greater than or equal to the 50% habitat capability level. Because these non-bird secondary cavity-using species are living and reproducing on these lands, this is additional evidence supporting the assumption that providing for primary cavity users may be adequate to provide for secondary cavity users.

- **Providing for the foraging needs of cavity-using species.**
  Another assumption in past snag management guidelines is that providing sufficient snags for nesting will also provide sufficient snags for foraging needs. This issue was addressed by Raphael and White (1984). They included observations in their study about the foraging habits of the cavity-using species. They found that, in general, snags were used for foraging more than would be expected based upon availability. This finding varied by species, with some species foraging on snags less than would be expected based upon availability. Of the total foraging observations, 30% occurred on snags, over 60% occurred on live trees, with the rest occurring on logs, on the ground, and by hawking insects from the air. These data strongly suggest that, while snags are an important foraging substrate, the overwhelming majority of foraging occurs on substrates other than snags.

SPI Snag Management Implementation

- **In each Management Inventory Unit, SPI will retain enough snags to maintain moderate to high population levels of cavity-dwelling species expected to use the area.**

  For instance, each MIU would contain no less than 1.27 snags per acre that are 15 inches or more in diameter (about 130 snags for every 100 acres). At least 0.02 snags per acre (2 snags for every 100 acres) would be at least 24 inches in diameter. Depending on other management considerations, the actual number of snags on the landscape is usually well above the minimum level, especially of the larger size classes.

The numbers of snags to be retained per acre for habitat capabilities between 40% and 100% (SPI's objectives) are presented in Table 5. SPI will never manage for less than 40% of the maximum habitat capability.

- **Uniform distribution of snags is not required or desirable. Instead, SPI will average the total number of snags over the entire Management Inventory Unit, always retaining enough snags to provide more than 40 percent of maximum habitat capability levels for cavity-using species.**
- **Because different species prefer different types of forest stands, SPI will not attempt to manage for every cavity-using species in every stand. Rather, SPI will manage snags in each stand type to encourage the species that prefer those specific stand conditions, and ensure that across its ownership all species are provided for.**

By adhering to these objectives, Sierra Pacific Industries strives to manage for a level of habitat capability that provides moderate to high habitat capability for snag-using wildlife species while providing the management flexibility to meet other objectives.

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