NORTHERN
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UNIVERSITY

Ecological Restoration Institute
P.O. Box 15017
Flagstaff, AZ 86011-5017

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Working Papers in Southwestern
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Snags and Forest Restoration

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P.O. Box 15017
Flagstaff, AZ 86011-5017
www.eri.nau.edu

Working Papers in Southwestern Ponderosa Pine Forest Restoration

Ecological restoration is a practice that seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines ecological restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability….Restoration attempts to return an ecosystem to its historic trajectory" (Society for Ecological Restoration International Science & Policy Working Group 2004).

In the southwestern United States, most ponderosa pine forests have been degraded during the last 150 years. Many ponderosa pine areas are now dominated by dense thickets of small trees, and lack their once diverse understory of grasses, sedges, and forbs. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-intensity surface fires—often after thinning dense stands—and reestablishing productive understory plant communities.

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of southwestern ponderosa pine forests. By allowing natural processes, such as fire, to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

The ERI Working Papers series presents findings and management recommendations from research and observations by the ERI and its partner organizations. While the ERI staff recognizes that every restoration project needs to be site specific, we feel that the information provided in the Working Papers may help restoration practitioners elsewhere.

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Written by Kimberly Lowe
Reviewed by Charlie Denton, Dave Egan, Joe Ganey, Dennis Lund, Ann Moote, Don Normandin, John Paul Roccaforte, Diane Vosick, and Catherine Wightman
Photos: David Ostergren, Charlie Denton
Series Editor: Dave Egan

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Introduction

Standing dead trees, also known as snags, are an important component of a thriving forest ecosystem. They are an essential part of the nutrient cycling process and provide crucial wildlife habitat for many species of animals. Although some may consider snags unsightly, they are a natural part of the decomposition process and may be one of the most important legacies of a forest (Tinker and Knight 2004). This publication presents an overview of snags and their relationship to ecosystem health and wildlife habitat, guidelines for maintaining snags in restoration areas, and additional information about how snags affect the level of fire hazard.

Snags Promote Biodiversity and Ecosystem Health

Snags provide nesting and feeding sites for more than 75 species of animals in southwestern forests, making them a crucial component of wildlife habitat (Chambers and Mast 2005). Many of these animal species play important roles in promoting and maintaining ecosystem health by controlling insect populations, dispersing seeds, or serving as prey for other species (Chambers et al. 2002).

Standing snags and downed logs are classified according to their characteristics and level of decomposition (Figure 1). At each stage in the decomposition process, snags play dynamic and important ecological roles. For instance, while standing snags serve as good roosting, perching, and nesting sites for many species of birds, downed snags often become habitat for small mammals. Highly decomposed snags contribute to overall nutrient cycling and aid in the growth of mycorrhizal fungi that help enhance plant diversity and reproduction. For these reasons, it is a good idea to maintain a mixture of snags at various stages in the decomposition process.

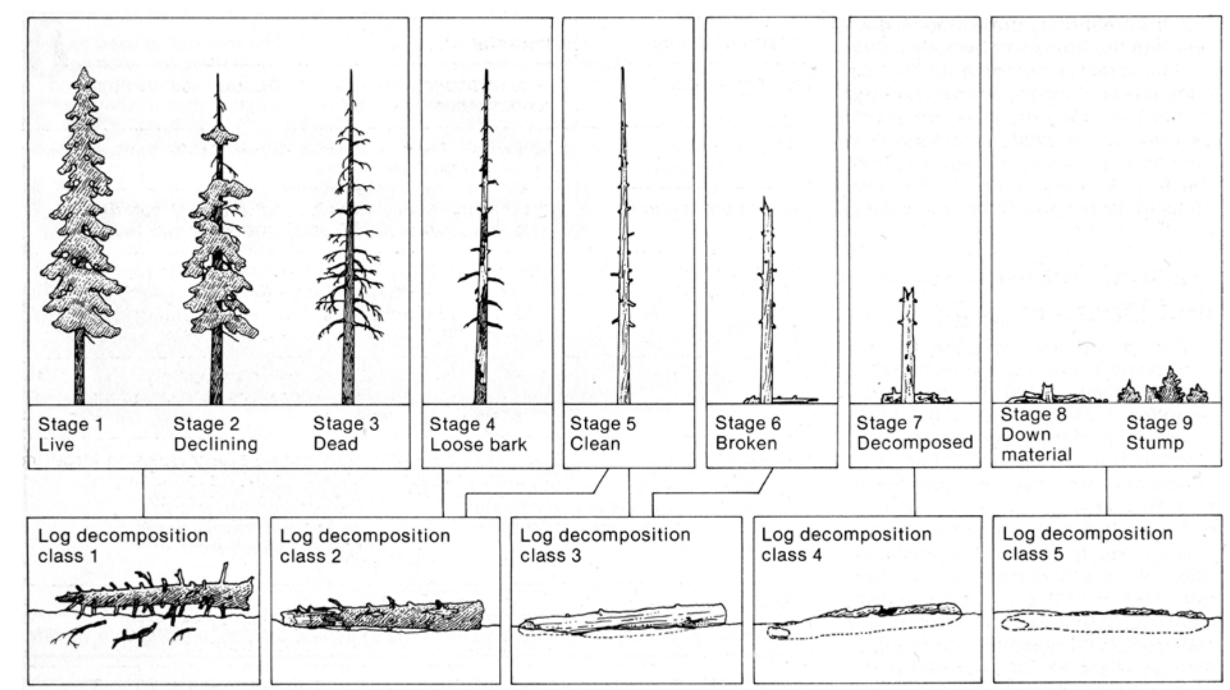

Figure 1. The classification of standing snags and decomposing logs. *Reproduced with permission (Thomas et al. 1979).*

Maintaining Snags in Restoration Treatment Areas

Managers need to actively maintain existing snags because thinning and fire can inadvertently remove snags that are important for wildlife (Bull 1983). Current USDA Forest Service standards in Arizona and New Mexico call for retaining about 2 snags per acre in ponderosa pine forests and 3 snags per acre in mixed conifer forests (USDA Forest Service 1996). These snags should have a minimum diameter at breast height (dbh) of 18 inches and be at least 30 feet tall (USDA Forest Service 1996).

However, research suggests that the quality of a snag may be more important than the number of snags per acre in determining whether cavity nesting wildlife will use a snag (Bull et al. 1997, George and Zack 2001). For instance, in a study of pine-white fir forests on the eastside of the Cascades in northern California, Zack et al. (2002) found that after surveying 1,812 snags there were 6.4 snags per acre but only 2.4 snags with nesting cavities per acre. It appears that the size, age, and spacing of snags as well as their relationship to other habitat elements and the landscape plays a major influence on the selection process of snag-dwelling animals (George and Zack 2001).

When selecting snags, it is important to consider the context of the snag in the landscape as well as the unique attributes of the snag-dependent animal species. In general, the best solution is to leave snags with diverse characteristics in order to accommodate a wide variety of animals. This may be especially important in the Southwest where the majority of the existing snags in ponderosa pine and mixed-conifer forests are small in diameter, which makes them less appealing to many wildlife species (Ganey 1999).

Guidelines for Deciding Snag Longevity and Whether Wildlife Will Use a Snag

Successful retention and recruitment of snags in a restoration treatment requires an understanding of the characteristics that influence snag longevity and the likelihood that wildlife will use a snag (Cunningham et al. 1980, Bull 1983, Smith 1999, Ganey and Vojta 2004).

- **Diameter at breast height.** Priority should be given to maintaining the largest snags. Ponderosa pine snags with a minimum dbh of 18 inches and Gambel oak snags with a minimum dbh of 11 inches are stronger, can better withstand stress from the elements, and tend to attract more wildlife species than smaller-diameter snags.
- **Age.** Snags that have been dead between 5 and 29 years are most frequently used by wildlife and should be maintained during restoration. However, younger and older snags are also vital part of the ecosystem. Younger snags, especially if they are large, can be good replacement snags for other well-established snags that are lost to fire or thinning. Older snags that are highly decomposed or have fallen are essential to nutrient recycling and can serve as habitat for many small mammal species.
- **Height**. Snags that have broken tops generally appeal to wildlife for nesting and roosting. Taller snags serve as good perches for avian species seeking prey. Maintaining a mixture of both in the landscape should be a consideration.
- **Tree species**. In ponderosa pine forests, consideration should be given to ponderosa pine and Gambel oak snags. In mixed conifer forests, value should be placed on white fir, ponderosa pine, and Gambel oak snags. If thinning is necessary, hard snags should be retained because they are good perching posts.

Tinker, D. B. and D. H. Knight. 2004. Snags and coarse woody debris: An important legacy of forests in the greater Yellowstone ecosystem. Chapter 12 *in* L.L. Wallace, ed., After the fires: The ecology of change in Yellowstone National Park. New Haven, CT: Yale University Press.
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Zack, S., T.L. George, and W.F. Laudenslayer, Jr. 2002. Are there snags in the systems? Comparing cavity use among birds in "snag-rich" and "snag-poor" eastside pine forest. Pp 179-191 in W.F. Laudenslayer, Jr., P.J. Shea, B. Valentine, C.P. Weatherspoon, and T.E. Lisle (tech. cords.), Proceedings of the Symposium on the Ecology and Management of Dead Wood in Western Forests. USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW GTR-181.

- **Snag creation.** Snags created by fire or insects generally do not stand as long as snags created by other means, such as drought, lightning, or disease. From a wildlife perspective, researchers have found that different wildlife species tend to be attracted to different types of snags. For example, the white-breasted nuthatch will use dead strips created by lightning strikes, while the hairy woodpecker prefers snags created by fire. In general, woodpeckers like snags created by bark beetles because they contain both food and cavity nesting sites (Shea et al. 2002).
- **Loose bark.** Snags with loose bark are often used by bats and small birds for roosting. These snags can take years to create and provide unique habitat.
- **Decayed wood.** Snags with decayed wood are preferred by cavity nesting birds, especially woodpeckers (Bull et al. 1997, Jackson and Jackson 2004).

On occasion a snag will be a "living snag" because one or more of the tree limbs are still alive (Stage 2 standing). They are often created by lightning, but also by dwarf mistletoe, bark beetles or stress from competition or drought. While there has been little research on the longevity of these snags compared to traditional snags, they are more likely to survive a fire because they tend to retain their insulating bark at the base (Waskiewicz 2003). Forest ecologists suspect that living snags, like traditional snags, contribute to the diversity of the ecosystem by providing habitat, foraging, and roosting sites for wildlife species (Miller and Miller 1980, Ganey 1999, Shea et al. 2002). They also serve as a living legacy when determining reference conditions.

Fire and its Effects on Snags

Fires affect how snags are formed, their density, and their rate of decay (Chambers and Mast 2005). Existing snags are extremely susceptible to fire and may be scorched or even incinerated by low-intensity burns that normally have little effect on mature, live trees. To maintain a continuous assortment of snags within a forest, an inventory of the number and type of snags should be done prior to undertaking restoration activities that include prescribed fire so as to preserve snags that meet appropriate restoration objectives. In many cases, it may be necessary to rake debris away from the bases of desirable snag trees before burning (see ERI Working Paper 3: Protecting Old Trees from Prescribed Fire).

For snags that were created by fire, burn condition and spatial distribution have significant effects on the longevity of a snag and its appeal to wildlife. Ponderosa pine snags that are created by high-intensity fires generally stand for four to seven years before breaking or falling,

What kind of snags do cavity nesting birds prefer?

Reseachers at the Rocky Mountain Research Station in Flagstaff, Arizona determined that cavity nesting birds tend to select snags with the following characteristics (Ganey and Vojta 2004):

- Ponderosa pine, Gambel oak, or aspen
- Large diameter at breast height
- Broken tops or in the advanced stages of decomposition (stages 3-5)
- At least 40-percent bark cover
- Existing cavities

Snags are fairly abundant in many forested landscapes, yet few share all of these traits. Those that do, warrant special attention from land managers during restoration.

while snags created by low-intensity fires may stand for 12 years or more with large-diameter trees standing longer than smaller ones (Chambers and Mast 2005). Like unburned snags, those that are created by fire tend to stand longer if they are surrounded by live or other dead trees that provide protection from the wind. Charred snags may be more difficult for cavity nesting birds to excavate than uncharred snags (Chambers and Mast 2005). However, both burned and unburned snags can be beneficial to wildlife. Some species, including several woodpecker species, seem to prefer burned snags for nesting and foraging (Chambers and Mast 2005).

Replacement snags can be created if a snag is inadvertently destroyed by prescribed fire. However, live trees that are likely to be killed by fire are generally smaller in diameter than most existing snags, and may not form adequate replacement snags for wildlife (Chambers et al. 2002).

Snags and Increased Fire Hazard

Although snags are essential for healthy ecosystems, their presence during any type of fire increases the likelihood of torching and spot fires, and the associated crowning of nearby healthy trees. Both standing snags and downed wood generate a great amount of heat and they increase the length of time a fire burns and the level of suppression required. Standing snags present a physical danger to firefighters due to their tendency to fall as they lose their structural integrity during a fire (Stephens and Moghaddas 2005). These potential hazards should be weighed against the ecological and economic services provided by snags.

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