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USDA United States Department of Agriculture
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Rocky Mountain Research Station
Research Paper RMRS-RP-11
September 1998

Responses of Cavity-Nesting Birds to Stand-Replacement Fire and Salvage Logging in Ponderosa Pine/Douglas-Fir Forests of Southwestern Idaho

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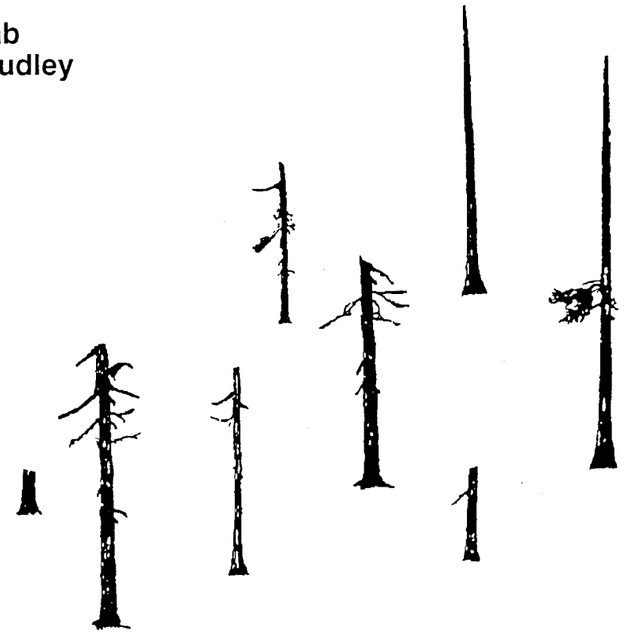

Abstract

Saab, Victoria A.; Dudley, Jonathan G. 1998. Responses of cavity-nesting birds to stand-replacement fire and salvage logging in ponderosa pine/Douglas-fir forests of southwestern Idaho. Res. Pap. RMRS-RP-11. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 17 p.

In spring 1994, the Intermountain Research Station (now Rocky Mountain Research Station), Boise National Forest, and Region 4 of the Forest Service initiated long-term studies on bird responses to different fire conditions in ponderosa pine/Douglas-fir forests of southwestern Idaho. The first phase of the project is to evaluate effects of high-intensity wildfire on cavity-nesting birds and their associated habitats. During spring/summer 1994-1996 we monitored 695 nests of nine cavity-nesting bird species (including three Forest Service Sensitive Species: Black-backed, White-headed, and Lewis' woodpeckers) and measured vegetation at nest sites and at 90 randomly located sites. The burned forests used for study areas were created in 1992 and 1994 by primarily high-intensity wildfire, thus most standing trees were snags. Nests and vegetation were monitored in three treatments: standard-cut salvage logged, wildlife-prescription salvage logged, and unlogged controls. Tree densities for small diameter trees (>23 cm to ≤53 cm [>9" to ≤20"] diameter breast height [dbh]) in the unlogged units averaged 81 snags per ha (33 per acre) and for larger trees (>53 cm dbh [>20"]) averaged 17 snags per ha (7 per acre). In salvage-logged units about 50% of the trees were harvested, tree densities for small trees averaged 43 snags per ha (17 per acre) and for large trees averaged 5 snags per ha (2 per acre). Lewis' Woodpecker was the most abundant (208 nests) and successful cavity nester on the 2-4 year-old burns, while Black-backed and White-headed woodpeckers were rare (23 nests). Lewis' Woodpecker and American Kestrel experienced the highest nesting success in the salvage-logged units, whereas Northern Flicker and Hairy Woodpecker were most successful in the unlogged units. All bird species selected nest sites with higher tree densities than that measured at random sites, and cavity nesters as a group selected clumps of snags rather than snags that were retained in uniform, evenly-spaced distributions. Among bird species, Black-backed Woodpeckers used nest sites with the highest tree densities, while Lewis' Woodpeckers selected relatively open nest sites. Cavity-nesters as a group selected larger diameter and more heavily decayed snags than that expected based on availability of such snags. Snags with the highest probability (>85%) of being classified as nest trees were characterized by heavy decay and broken tops that pre-dated the wildfire. We discuss management implications of stand-replacement fire and post-fire salvage logging for cavity-nesting birds. Future plans are outlined, including bird and plant responses to different fire conditions (stand-replacement fire, fire suppression, and prescribed fire). The intent of this work is to provide information on the action and no action alternatives to the Forest Health Initiative.

Keywords: Lewis' Woodpecker, Black-backed Woodpecker, White-headed Woodpecker, American Kestrel, Northern Flicker, Hairy Woodpecker, Western Bluebird, Mountain Bluebird, salvage logging, stand-replacement fire, Forest Health Initiative

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Appendix 3. Bird species observed within the Foothills Fire and Star Gulch Fire study areas during 1994-1998

Common name[a,b]	Scientific name
Turkey Vulture(S)	*Cathartes aura*
Golden Eagle(S)	*Aquila chrysaetos*
Bald Eagle(R)	*Haliaeetus leucocephalus*
Northern Harrier(S)	*Circus cyaneus*
*Sharp-shinned Hawk(S)	*Accipiter striatus*
*Cooper's Hawk(S)	*Accipiter cooperii*
*Northern Goshawk(S)	*Accipiter gentilis*
Swainson's Hawk(L)	*Buteo swainsoni*
*Red-tailed Hawk(S)	*Buteo jamaicensis*
*American Kestrel(S)	*Falco sparverius*
Chukar(R)	*Alectoris chukar*
*Blue Grouse(R)	*Dendragapus canadensis*
Ruffed Grouse(R)	*Bonasa umbellus*
*Wild Turkey(R)	*Meleagris gallopavo*
California Quail(R)	*Callipepla californica*
*Mourning Dove(S)	*Zenaida macroura*
Flammulated Owl(L)	*Otus flammeolus*
*Great Horned Owl(R)	*Bubo virginianus*
Northern Pygmy-Owl(R)	*Glaucidium gnoma*
*Long-eared Owl(S)	*Asio otus*
Northern Saw-whet Owl(R)	*Aegolius acadicus*
Common Nighthawk(L)	*Chordeiles minor*
*Common Poorwill(L)	*Phalaenoptilus nuttallii*
White-throated Swift(S)	*Aeronautes saxatalis*
Calliope Hummingbird(L)	*Stellula calliope*
Black-chinned Hummingbird(L)	*Archilochus alexandri*
Broad-tailed Hummingbird(L)	*Selasphorus platycercus*
*Lewis' Woodpecker(S)	*Melanerpes lewis*
*Red-naped Sapsucker(L)	*Sphyrapicus nuchalis*
*Downy Woodpecker(R)	*Picoides pubescens*
*Hairy Woodpecker(R)	*Picoides villosus*
*White-headed Woodpecker(R)	*Picoides albolarvatus*
*Three-toed Woodpecker(R)	*Picoides tridactylus*
*Black-backed Woodpecker(R)	*Picoides arcticus*
*Northern Flicker(S)	*Colaptes auratus*
*Pileated Woodpecker(R)	*Dryocopus pileatus*
Olive-sided Flycatcher(L)	*Contopus borealis*
Western Wood-Pewee(L)	*Contopus sordidulus*
Dusky Flycatcher(L)	*Empidonax oberholseri*
Hammond's Flycatcher(L)	*Empidonax hammondii*
Violet-green Swallow(L)	*Tachycineta thalassina*
Steller's Jay(R)	*Cyanocitta stelleri*
Clark's Nutcracker(R)	*Nucifraga columbiana*
Black-billed Magpie(R)	*Pica pica*
American Crow(R)	*Corvus brachyrhynchos*
*Common Raven(R)	*Corvus corax*

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Responses of Cavity-Nesting Birds to Stand-Replacement Fire and Salvage Logging in Ponderosa Pine/Douglas-Fir Forests of Southwestern Idaho

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Introduction

Wildfire has been an important ecological process in shaping landscapes and bird distributions of western North America (Hejl 1992, Hejl 1994). Forests affected by fire, and subsequent salvage logging, are increasingly prevalent across much of the Intermountain West. Since 1986 on the Boise National Forest alone, nearly 600,000 acres (240,000 ha) of forest and shrublands have burned as a result of wildfire compared with only 30,000 acres (12,000 ha) in the previous decade (1976-1985) (Morelan et al. 1994). This recent increase in wildfires (especially of high intensity) has been attributed to several years of drought and primarily to the past 60 years of management for fire suppression, which resulted in high fuel loads, insect outbreaks, and disease (e.g., Arno 1980, Sampson et al. 1994).

In the Northern Rocky Mountains/Intermountain West, ponderosa pine (scientific names for woody vegetation are listed in the Appendix 1) forests of presettlement landscapes were typically maintained by frequent (at 3-30 yr intervals), low-intensity ground fires that favored larger, older trees in open, park-like conditions (Arno 1980, Steele et al. 1986, Steele 1988, Habeck 1988, Habeck 1990, Keane et al. 1990, Sloan 1994). The exclusion of these frequent fires has allowed open forests to become much denser with understory invasions by shade tolerant conifers such as Douglas-fir. These changes in fire regimes and subsequent alterations in the composition and structure of western forests have also affected bird communities (Hejl 1992, Hejl 1994). Postfire habitats and subsequent insect outbreaks are known to attract cavity-nesting birds (e.g., Blackford 1955, Koplin 1969, Raphael and White 1984, Raphael et al. 1987, Hutto 1995, Caton 1996). Little is known, however, about bird responses to fire suppression, stand-replacement fires, or silvicultural treatments designed to mimic presettlement conditions (e.g., "forest health" treatments of tree thinning with prescribed fire). Information about influences of fire processes on bird communities is needed for incorporation into ecosystem management strategies. Cavity-nesting species may respond differently to fire's effects because nesting and foraging requirements vary among species. For the long-term persistence of avian communities that evolved in fire-maintained landscapes of the Intermountain West, a better understanding is needed of bird and plant responses to different fire conditions.

In 1994, Intermountain Research Station (now Rocky Mountain Research Station), Boise National Forest, and Region 4 of the Forest Service initiated long-term studies on bird and plant responses to different fire conditions in ponderosa pine/Douglas-fir forests: high intensity stand-replacement fire; fire suppression; and prescribed, low-intensity, ground fire ("forest health" treatments).

Objectives

The purpose of this project is to provide management recommendations on the associations of bird communities with fire influenced habitats and landscapes. The primary goal of the studies is to provide information to National Forest managers on the action and no action alternatives (required for National Environmental Policy Act [NEPA] analysis) associated with the Forest Health Initiative (USDA 1994a) and with postfire salvage logging. This report summarizes some preliminary results from the first phase of this project regarding influences of stand-replacement wildfire and postfire salvage logging on the cavity-nesting bird community. Specific objectives include:

1. Examine nest-site selection by cavity-nesting birds in postfire [stand-replacing] conditions under three treatments: (a) standard-cut salvage-logged units, (b) wildlife-prescription salvage-logged units, and (c) unlogged units [controls].

Appendix 1. Tree and shrub species sampled within the Foothills Fire and Star Gulch Fire study areas during 1994-1996

Common name	Scientific name
Subalpine Fir	*Abies lasiocarpa*
Rocky Mountain Maple	*Acer glabrum*
Mountain Alder	*Alnus incana*
Western Serviceberry	*Amelanchier alnifolia*
Big Sagebrush	*Artemisia tridentata*
Creeping Oregongrape	*Berberis repens*
Redstem Ceanothus	*Ceanothus sanguineus*
Mountain Balm	*Ceanothus velutinus*
Gray Rabbitbrush	*Chrysothamnus nauseosus*
Green Rabbitbrush	*Chrysothamnus vicidiflorus*
Red-osier Dogwood	*Cornus stolonifera*
Black Hawthorn	*Crataegus douglasii*
Mock Orange	*Philadelphus lewisii*
Mallow Ninebark	*Physocarpus malvaceus*
Lodgepole Pine	*Pinus contorta*
Engelman Spruce	*Picea engelmannii*
Ponderosa Pine	*Pinus ponderosa*
Black Cottonwood	*Populus trichocarpa*
Quaking-aspen	*Populus tremuloides*
Bittercherry	*Prunus emarginata*
Common Chokecherry	*Prunus virginiana*
Douglas Fir	*Pseudotsuga menziesii*
Bitterbrush	*Purshia tridentata*
Golden Currant	*Ribes aureum*
Squaw Currant	*Ribes cereum*
Missouri Gooseberry	*Ribes setosum*
Wood's Rose	*Rosa woodsii*
Red Raspberry	*Rubus idaeus*
Thimbleberry	*Rubus parviflorus*
Elderberry	*Sambucus cerulea*
Scouler Willow	*Salix scouleriana*
White Spirea	*Spirea betulifolia*
Mountain Snowberry	*Symphoricarpos oreophilus*

Wildfire intervals typically ranged from 5-22 years before European settlement, with dry sites burning more frequently and at lower intensities than moist forests (Steele et al. 1986). More detailed descriptions of the study areas are reported in Saab (1995).

Three general treatments were applied to the Foothills Fire: standard-cut salvage logging (see description below), half the standard-cut salvage logging (wildlife prescription for big game security cover), and no logging (controls) (USDA 1992). We selected two replicates in each treatment for a total of six study sites that each average 500 ha (1,235 acres) in size. The study sites average 70% forested and 30% open shrub/grasslands. Rattlesnake Creek and Elk Creek were selected for treatments of standard-cut salvage logging; Tipton Flat and Grape Mountain for the wildlife prescription; and, Devil's Creek for one of the unlogged-control sites in 1994 (Fig. 1). The study sites with salvage-logged treatments (Rattlesnake Creek, Elk Creek, Grape Mountain, and Tipton Flat) are of relatively low elevation (1,200 m-1,970 m)(4,000'-6,500') and dominated by ponderosa pine, whereas the unlogged-control site in the Foothills Fire, Devil's Creek, is relatively high elevation (1,667 m-2,333 m) (5,500'-7,700') of mixed coniferous forest dominated by Douglas-fir. Because the unlogged Devil's Creek site was not a good representation of the logged sites within the Foothills Fire, we selected two study sites within the Star Gulch Fire that are more representative of the treated areas in Foothills. The two study sites within the Star Gulch Fire are centered around Virgil Gulch in the North Fork Cottonwood Creek drainage and Stove Gulch in the Cottonwood Creek drainage (Fig. 1). Each site is relatively low elevation (1,273 m-1,970 m) (4,200'-6,500') dominated by ponderosa pine, and burned at moderate to high intensity. These characteristics are better examples of the logged areas in the Foothills and proposed areas for "forest health" treatments (Saab 1995), and thus provide better comparisons.

Methods

Silvicultural Prescriptions

The standard-cut, salvage-logged prescription on the Foothills Fire included: (1) on north slopes, all merchantable trees >25 cm (10 inches) diameter at breast height (dbh) were harvested with a snag retention requirement of 15 snags/ha (6 snags/acre) and of those snags at least three were required to be >51 cm (20 inches) dbh, two between 30-51 cm (12-20 inches) dbh, and one between 25-30 cm (10-12 inches) dbh; and (2) on south slopes, 66% of merchantable trees >30 cm (12 inches) were harvested, and requirements for snag retention were met in the 33% that was not harvested on south slopes. For the wildlife, salvage-logged prescription, 50% of all merchantable trees >30 cm (12 inches) were harvested and the snag retention requirement was met in the 50% not harvested. In addition to these broad treatments, most of the study area was seeded with a mixture of native and non-native plants to enhance revegetation, and contour felling was used to reduce erosion. Ponderosa pine seedlings were planted in selected areas. Details of prescriptions for timber harvest and fire rehabilitation are on file at the Supervisor's Office and the Mountain Home District of the Boise National Forest (USDA 1992, other documents).

Bird Surveys and Monitoring

Nest surveys for nine cavity-nesting birds (Lewis', Black-backed, and White-headed woodpeckers [Forest Service Sensitive Species in Regions 1, 4, or 6], Hairy Woodpecker, Northern Flicker, Mountain Bluebird, Western Bluebird, American Kestrel, and European Starling) (scientific names listed in Appendix 3) were conducted by walking variable-width transects that were established every 200 m (656 ft), so we came within 100 m (328 ft) of all places within each study site. There are 26-43 transects in each study site and transect lengths average 1.6 km (1.0 mile). For more detailed methods of nest surveys, see Saab (1995). Nests were monitored every three to four days to determine status and fate of all nests.

Vegetation Sampling at Random Points

Ninety random stations (30 in each treatment: standard salvage-logged, wildlife salvage-logged, and unlogged), that were located at least 250 m (820 ft) apart, were used to monitor vegetation, and determine topographic measurements (Fig. 2) and surrounding landscape features. We selected these plots to describe the habitats available to birds for the analysis of habitat selection. Methods follow those described for BBIRD (Martin and Guepel 1993, Montana Cooperative Wildlife Research Unit 1994, Ralph et al. 1993) with some modifications. Each random location encompasses four, 11.3 m-radius (37.1-ft) circular plots (0.10 acres) for a total of 360 circular plots, where microhabitat variables that may be critical for successful nesting are measured. Those vegetation measurements include herbaceous ground cover, downed-woody debris, shrub and tree densities, canopy cover, and species composition of woody plants (Appendix 2). Appendix 2 and Saab (1995) describe structural habitat variables, physical factors and methods in more detail.

All snags >1.4 m (4.5 ft) tall were measured. A random sample of 105 circular plots were selected to evaluate snag longevity in a stand-replacement fire

breeding season, (2) examining landscape influences on population sources by determining if the proximity to and amount of unburned (logged and unlogged) and burned/logged forest has affected bird recolonization and reproductive success within the large-scale burns, (3) continue monitoring of cavity nesters and permanently marked vegetation plots (random sites) to evaluate plant and bird responses to the rapid changes in the first five years after wildfire, (4) continue monitoring of tagged trees to evaluate snag longevity in salvage-logged compared to unlogged units and determine how that affects the length of time a burn is suitable for cavity-nesting birds, and (5) examining the data collected on insect assemblages in the different treatments and determine if any relationships can be detected between avian communities and insect assemblages.

The Forest Health Initiative (USDA 1994a) is receiving widespread attention by land management agencies and the public. We do not know the implications of broad scale, prescribed fire (with timber harvest, "forest health" prescription) for wildlife resources. Thus, we need to gather information on the forest health action and no action alternatives to understand the trade-offs associated with future decisions in green areas for resources other than tree growth and mortality. Data presented in this report provide information on conditions associated with stand-replacement wildfire, considered a no action alternative to forest health. Fire suppression of green forests, thought to be outside their range of variability, is another no action alternative. We plan (dependent on funding) to evaluate bird and plant responses to three different fire conditions in ponderosa pine/mixed coniferous forests that characterize the no action and action alternatives to Forest Health: (1) high-intensity, stand-replacement fire; (2) fire suppression; and (3) prescribed, low-intensity, ground fire with stand management. We hope to test our predictions about cavity-nesting bird responses to the different fire conditions (Table 7), which will provide information to managers about possible conflicts for sensitive bird species.

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Table 7—Predicted responses by cavity-nesting birds to different fire conditions compared to unburned ponderosa pine/Douglas-fir forests with regular fire intervals every 10-30 years.[a]

	High intensity stand-replacement	Fire suppression	Prescribed fire with stand management
American Kestrel	+	–	+
Lewis' Woodpecker[b]	+	–	+
Red-naped Sapsucker	–	0	+
Downy Woodpecker	–	0	+
Hairy Woodpecker	+	0	+
Black-backed Woodpecker[b]	+	–	0
White-headed Woodpecker[b]	–	–	+
Northern Flicker	+	+	–
Pileated Woodpecker	–	+	–
Western Bluebird	+	–	+
Mountain Bluebird	+	–	+

[a] Predictions based on information reported from the following: Koplin (1969), Davis (1976), Taylor and Barmore (1980), Harris (1982), Raphael and White (1984), Raphael et al. (1987), Breininger and Smith (1992), Bull and Holthausen (1993), Greenberg et al. (1995), Hutto (1995), Caton (1996).

[b] Species in bold are Forest Service Sensitive Species in one or more Regions (1, 2, 4, and/or 6).

Table 1—Number of cavity-nesting birds monitored in burned forests of southwestern Idaho during 1994-1996.

	Standard salvage	Wildlife salvage	Unlogged controls	Total
American Kestrel	32	14	6	52
Lewis' Woodpecker	118	84	6	208
Downy Woodpecker	0	0	1	1
Hairy Woodpecker	23	11	57	91
White-headed Woodpecker	2	0	4	6
Black-backed Woodpecker	2	2	13	17
Northern Flicker	44	16	39	99
European Starling	18	2	0	20
Western Bluebird	52	32	19	103
Mountain Bluebird	18	19	61	98
Total	309	180	206	695

Table 2—Number of hectares surveyed for cavity-nesting birds in burned forest of southwestern Idaho during 1994-1996. Acres are reported in parentheses.

	Standard salvage	Wildlife salvage	Unlogged controls	Total
1994	1261 (3116)	816 (2016)	435 (1075)	2512 (6207)
1995	862 (2130)	344 (850)	974 (2407)	2180 (5387)
1996	374 (924)	239 (591)	974 (2407)	1587 (3922)

Table 3—Relative abundance of nests per km for nine cavity-nesting bird species surveyed in three treatments during 1994-1996. The sample size (N) is the number of sites within each treatment. Nest abundances per km increased significantly with increasing years since the fire (df = 3, F = 5.85, $p = 0.01$). Abundances did not statistically differ among treatments (df = 2, F = 0.62, $p = 0.55$).

	No. Nests/km					
Year	Standard salvage[a]	Wildlife salvage[a]	Unlogged controls[b]			
after fire	Foothills	Foothills	Foothills	Star Gulch	N	$\bar{X}$ (± SE)
1				1.06	(2)	1.06(0.08)[c]
2	0.84	0.99	1.10	2.72	(7)	1.45(0.36)[c]
3	3.81	4.17			(4)	3.99(1.08)[d]
4	5.03	4.50			(2)	4.76(0.26)[d]
$\bar{X}$ (± SE)	2.87(0.86)	2.96(1.17)	1.73(0.41)			

[a] Salvage treatments are located in the 1992 Foothills Fire.

[b] Unlogged control sites were changed after the first year of data collection from the 1992 Foothills Fire to the 1994 Star Gulch Fire; see methods section for explanation.

[c] Year 1 and 2 after fire were not significantly different, based on a pairwise comparison Tukey test (SAS Institute, Inc. 1990).

[d] Year 3 and 4 after fire were not significantly different, based on a pairwise comparison Tukey test (SAS Institute, Inc. 1990).

Lazuli Buntings and Chipping Sparrows appeared to be the most widespread and abundant species.

The amount of area surveyed for birds has been reduced since 1994 (Table 2), while nesting densities have significantly increased over time (Table 3). The number of field personnel has remained the same but less area has been monitored due to increases in the number of nests from 1994-1996. In 1996, we monitored only one replicate in each of the salvage-logged units (west side units) and continued to monitor both replicates in the unlogged sites on the Star Gulch Burn (Fig. 1).

Lewis' Woodpecker was the most abundant cavity nester in the burns, however, they were rarely found nesting in the unlogged controls (Table 4). These are the highest nesting densities ever recorded for the species. This woodpecker is strongly associated with fire-maintained, old-growth ponderosa pine and has experienced long-term population declines

(standard, df = 4, G = 253, p <0.001; wildlife, df = 4, G = 111.5, p <0.001; unlogged controls, df = 4, G = 102.7, p <0.001; Fig. 9). Heavy decay in larger trees (>53 cm [20"] dbh) was also important to cavity nesters as a group (standard, df = 3, G = 22.7, p <0.001; wildlife, df = 3, G = 7.6, p = 0.05; unlogged controls, df = 3, G = 21.7, p <0.001; Fig. 6). Among the cavity nesters, White-headed Woodpeckers nested in the most heavily decayed snags, whereas Black-backed Woodpeckers excavated the hardest snags available (df = 8, F = 9.29, p <0.001; Fig. 10).

Based on tree top conditions (broken before the fire, broken after the fire, or intact) and decay class (light [0,1], medium [2,3], or heavy [4,5]) of 695 occupied nest trees from 1994-1996 (Table 1), 83% of nest trees (n = 695) were correctly classified as occupied nest trees and 28% of random trees (n = 2,165) were predicted as suitable nest trees. Trees (snags) with the highest probability (>85%) of being nest trees were those with the combined characteristics of broken tops before the fire and with heavy decay. Nest trees of Black-backed Woodpeckers had the lowest probabilities (<35%) of being correctly classified as occupied nest trees, and were not characteristic of the other cavity nesters in the study areas. Blackbacks typically nested in trees with light to medium decay (Fig. 10) and often with intact tops. This species has strong excavator morphology (Spring 1965) and is able to

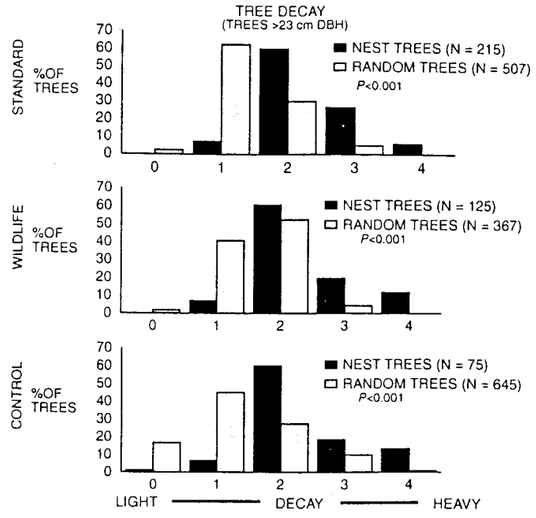

Figure 9—Proportion of nest and random trees in each of 5 decay classes for trees >23 cm (9") dbh during 1994-1995. The decay class '0' indicates live trees, while decay class '4' indicates the most heavily decayed snags. P-values were derived from G-tests, see Results section.

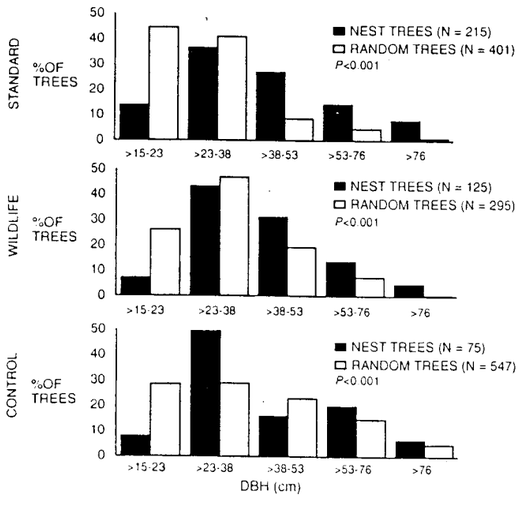

Figure 8—Percentages of nest and random trees in five size classes during 1994-1995. P-values were derived from G-tests, see Results section.

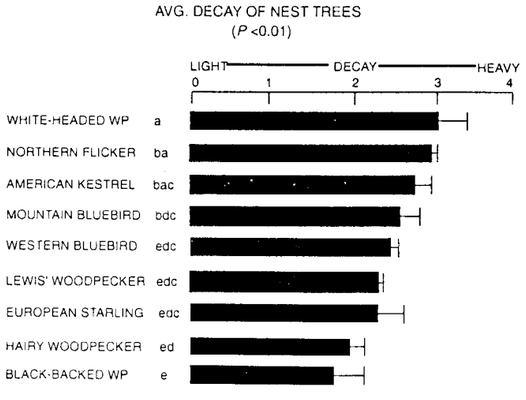

Figure 10—Average decay of nest trees during 1994-1995. Species with the same small-cased letters have an average tree decay that is not significantly different. T-bars represent 1 SE, see Results secions for test statistics.

Table 6—Percent nesting success (calculated using the Mayfield method) and number of nests (N) in each treatment for years 1994-1996. The program CONTRAST (Sauer and Williams 1989) was used to test for differences (p-value) in daily nesting survival between salvaged-logged (standard and wildlife combined) and unlogged treatments.

	Overall nesting	Standard salvage	Wildlife salvage	Unlogged	P-Value[a]
	% success (N)				
Lewis' Woodpecker	81 (206)	87 (118)	72 (82)	100 (6)	—
Hairy Woodpecker	75 (91)	61 (23)	39 (11)	92 (57)	0.01
Northern Flicker	70 (97)	62 (42)	82 (16)	75 (39)	0.49
Western Bluebird	70 (100)	66 (51)	80 (31)	60 (18)	0.46
Mountain Bluebird	51 (96)	42 (17)	46 (19)	56 (60)	0.46
American Kestrel	84 (40)	90 (26)	63 (11)	100 (3)	—
White-headed Woodpecker	100 (6)	100 (2)	—	100 (4)	—
Black-backed Woodpecker	100 (15)	100 (2)	100 (2)	100 (11)	—

[a] P-values corrected from 1997 progress report.

woodpeckers, who were rare in our study areas. Traditional methods of nesting success revealed that Black-backed and White-headed woodpeckers were equally successful in all treatments; however, we caution that these sample sizes are too low for drawing conclusions. Nest predation was the most common cause of nesting failures, accounting for 97% of recorded failures (n = 124). The remaining nest failures were classified as unknown or weather related.

Vegetation at Random Sites and Nest Sites

Our studies on the 1992 Foothills Fire started two years after the burn in spring 1994, at which time the salvage logging was completed. Most trees (>90%) standing after the Foothills Fire were snags because Foothills was a high-intensity crown fire. Tree densities for small diameter trees (>23 cm to ≤53 cm [>9" to ≤20"] diameter breast height [dbh]) in the unlogged units averaged 81 snags per ha (33 per acre) and for larger trees (>53 cm dbh [>20"]) averaged 17 snags per ha (7 per acre) (Fig. 3). In salvage-logged units about 50% of the trees were harvested, tree densities for small trees averaged 43 snags per ha (17 per acre) and for large trees averaged 5 snags per ha (2 per acre). About 70% of trees >53 cm dbh were harvested (Fig. 3), based on the average densities of standing trees in all unlogged units (see Fig. 1).

Based on the 1994 vegetation sampling, number of trees (primarily snags) per ha did not statistically differ between the standard treatment and the wildlife prescription for any dbh size class (Fig. 3). Tree densities were significantly higher in the unlogged controls compared to the salvage-logged treatments (>23-38 cm [9-15"] dbh, df = 2, F = 4.40, p = 0.02; >53 cm [20"] dbh, df = 2, F = 3.41, p = 0.04), except in the mid-diameter size class (>38-53 cm [15-20"] dbh, df = 2, F = 2.54, p = 0.09) (Fig. 3). Two years after the Foothills Fire, average shrub densities (see Appendix 1 for species composition) did not statistically differ among treatments (stem sizes 2-8 cm [0.78"–3.14"] diameter; unlogged controls, $\bar{x}$ = 40,631.25 ± 9,283.75 stems per ha [16,052.5 ± 3,713 stems per acre]; wildlife, $\bar{x}$ = 30,018.75 ± 4,923.75 stems per ha [12,007.5 ± 1,969.5 stems per acre]; standard, $\bar{x}$ = 26,546.25 ± 4,765.0 stems per ha [10,618.5 ± 1,906.0 stems per acre]; df = 2, F = 1.14, p = 0.33). Thus, after the salvage logging was completed on the Foothills Burn in 1994, tree and shrub densities were statistically similar between the logging treatments (standard and wildlife).

The remainder of the results in this report are based on data collected during 1994-1995 for nest (n = 416) and random sites (n = 165), unless noted otherwise. All bird species selected nest sites with higher tree densities than that measured at random sites (standard, df = 7, F = 4.91, p < 0.001; wildlife, df = 6, F = 7.21, p <0.001; unlogged controls, df = 6, F = 7.05, p < 0.001;

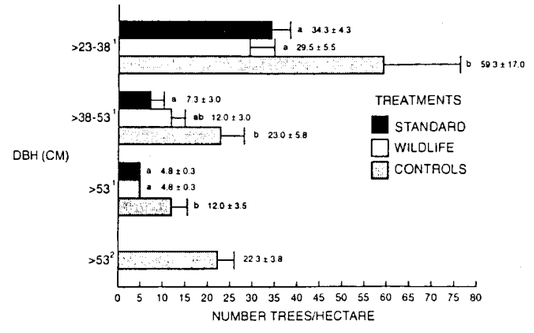

Figure 3—Average number of trees (primarily snags) per ha in three treatments after salvage logging was completed. T-bars represent 1 SE. Bars with the same small case letters are not significantly different, see Results section. ¹Represents 2 years postfire in Foothills study area. ²Represents 1 year postfire in Star Gulch study area.