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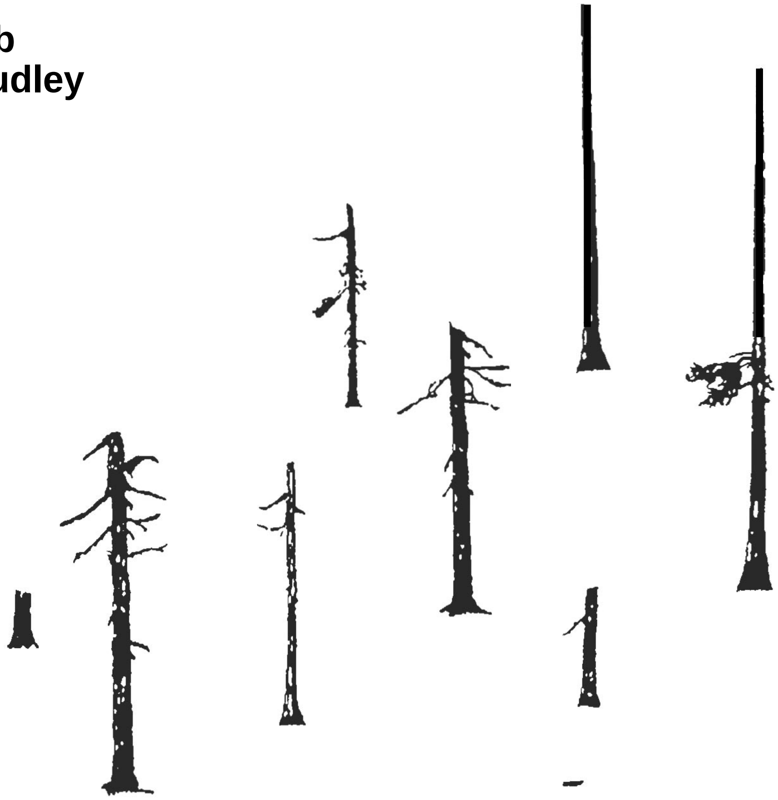
Responses of Cavity-Nesting Birds to Stand-Replacement Fire and Salvage Logging in Ponderosa Pine/Douglas-Fir Forests of Southwestern Idaho

Victoria A. Saab
Jonathan G. Dudley



Preface

In spring 1994, the Rocky Mountain Research Station in Boise (formerly Intermountain Research Station), Boise National Forest, and Region 4 of the Forest Service initiated long-term studies on how cavity-nesting birds respond to different fire conditions in ponderosa pine/Douglas-fir forests of western Idaho. The work was started in response to the high-intensity wildfires of 1992 and 1994 on the Boise National Forest. This publication provides information to managers and biologists on the effects of stand-replacement wildfire (a no-action alternative to the Forest Health Initiative [USDA 1994a]) and salvage logging on cavity-nesting birds.

Cavity-nesting birds were selected for these studies because many are (1) dependent on fire processes and patterns over large landscapes for their dispersal and movements, (2) designated as sensitive species by Federal or State agencies, and (3) responsive to fire and timber management activities. We know little about the implications of fire suppression, stand-replacement wildfire, or prescribed fire with timber management for sensitive bird species. 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 sensitive cavity-nesting birds, and to identify possible conflicts for sensitive species management.

The first phase of the project was to evaluate effects of high-intensity, stand-replacement wildfire on cavity-nesting birds and their associated habitats. This paper summarized results from 1994 to 1996 and was first distributed as a progress/interim report in 1997 (Study No. 4202-1-7-7, Progress Report 94-96, April 1997). We encourage managers and biologists to provide comments on this ongoing project.

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Abstract

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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

Rocky Mountain Research Station
324 25th Street
Ogden, UT 84401

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The Authors

Victoria A. Saab is a Research Wildlife Biologist with the Rocky Mountain Research Station at the Forestry Sciences Laboratory in Boise, ID. She completed a B.S. degree in wildlife ecology at Oklahoma State University, an M.S. degree in fish and wildlife management at Montana State University, and a Ph.D. Degree in biology at the University of Colorado at Boulder. She joined the Forest Service in 1989.

Jonathan G. Dudley is a Wildlife Biologist with the Rocky Mountain Research Station at the Forestry Sciences Laboratory in Boise, ID. He received his B.S. degree in wildlife biolgy from Washington State University in 1988.

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., "foresthealth" 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].

2. Determine yearly trends in nesting densities and reproductive success in relation to salvage-logged and unlogged units.

3. Conduct vegetation sampling and analyses to evaluate differences in structural habitat features between salvage-logged and unlogged units.

4. Provide recommendations for postfire management to meet stand level requirements for the long-term persistence of cavity-nesting birds.

Study Area

The study areas are in the Foothills (USDA 1992) and Star Gulch fires (USDA 1994b) on the Boise National Forest in southwestern Idaho (Elmore and Ada Counties) (Fig.1). The Foothills experienced a moderate to high-intensity crown fire during August/September 1992 that burned 104,328 ha (257,690 acres), of which 54% was on National Forest lands. The Star Gulch Fire occurred in August 1994 and burned 28,000 ha (70,000 acres) at varying intensities, creating a patchy mosaic of green and burned forest.

Pre-fire, overstory vegetation was dominated by ponderosa pine community types at lower elevations and southerly aspects, whereas Douglas-fir community types dominated at higher elevations and northerly aspects. At lower elevations, trees were often widely spaced creating an open forest and many stands were patchily distributed with large openings of shrubs (e.g., big sagebrush and redstem ceanothus) and grasses (e.g., bluebunch wheatgrass [*Agropyron spicatum*]). Forest stands were more contiguous on north slopes and at higher elevations. Potential vegetation characterized by habitat types for the Foothills and Star Gulch study areas include ponderosa pine/bluebunch wheatgrass, and dry, open-forest phases of Douglas-fir/elk sedge (*Carex geyeri*), Douglas-fir/pinegrass (Calamagrostis rubescens), and Douglas-fir/ninebark at primarily lower elevations and the south end of the Foothills Fire (Steele et al. 1981; K. Geier-Hayes pers. comm.). A mix of wet and dry phases of Douglas-fir [elk sedge; pinegrass; white spirea; and ninebark] occurs at higher elevations and the north end of the Foothills Fire (Steele et al. 1981; K. Geier-Hayes pers. comm.).

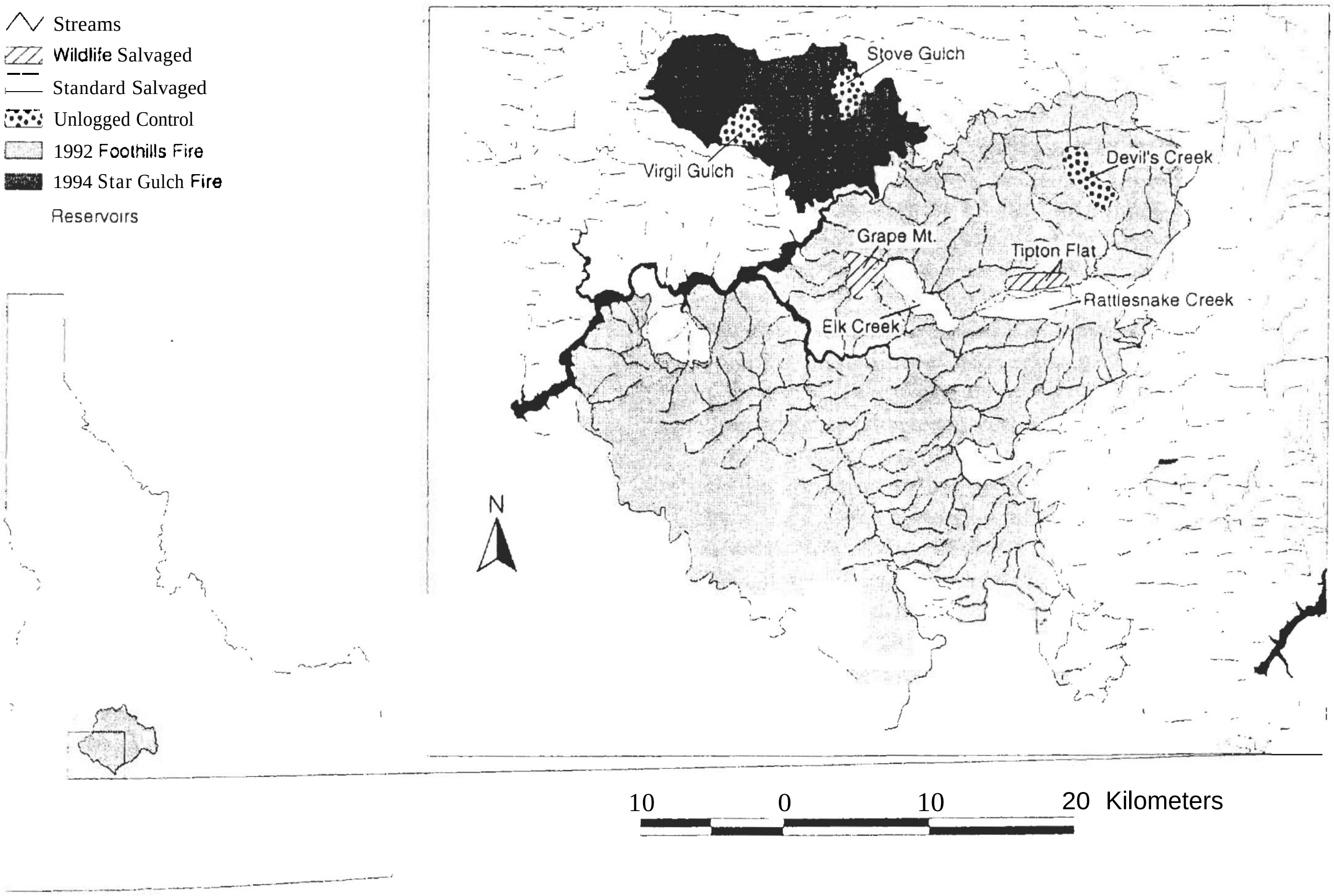

Figure 1—Study area locations for bird/postfire studies in ponderosa pine/Douglas-fir forests, 1994-1996.

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 61, 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 fur 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

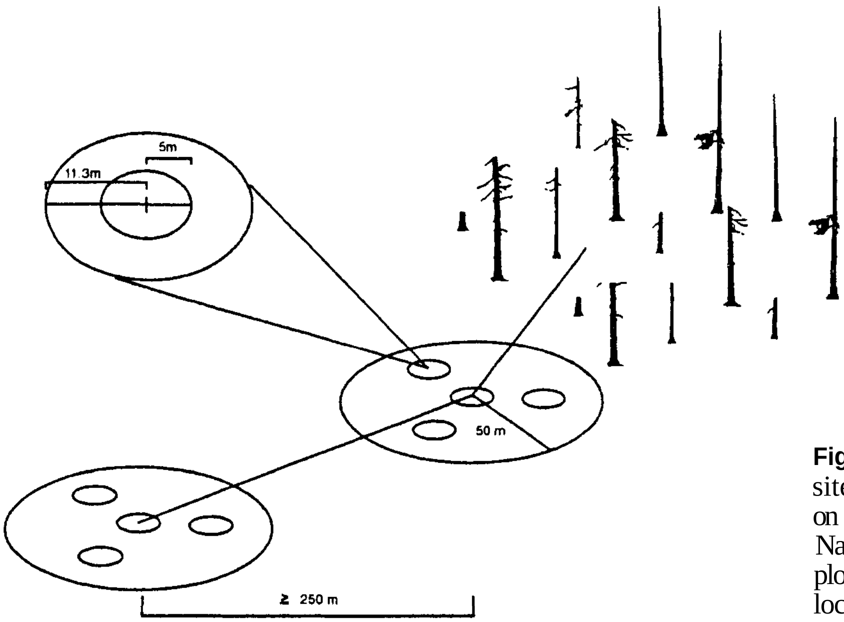

Figure 2—Design for vegetation sampling at random sites that were located at least 250 m (820 ft) apart on the Foothills and Star Gulch burns on the Boise National Forest. Four, 11.3 m-radius (37.1-ft) circular plots (0.10 acre) were established at each of 90 random locations.

under logged, partially logged, and unlogged conditions. Each snag was marked with numbered plastic tags. Plots used for the snag longevity study are sampled every year to compare decay rates and falling rates among tree species and to evaluate management goals for snag retention.

Nest Site Characteristics

Nest trees were measured in the manner described for snags (Appendix 2). In addition, we recorded nest height, cavity age, species that excavated the cavity, orientation of the cavity, stump (<1.4 m tall) (<4.5 ft), log, or other (cf. Raphael and White 1984).

Habitat characteristics and topographic measurements surrounding a nest tree were sampled with the methods described for the random stations using one, 11.3 m-radius (37.1 ft) circular plot centered at the nest. On each plot, we recorded vegetation type (subjectively classified as ponderosa pine, Douglas-fir, pine-fir, open pine, aspen, coniferous riparian, deciduous riparian, and subalpine fir). Habitat conditions for vegetation types were indicated as one or more of the following: unburned, crown-fire burned, understory burned, logged, partially logged, and unlogged.

Data Analysis

Type IV sums of squares, analysis of variance (ANOVA, SAS Institute, Inc. 1990) and multiple analysis of variance (MANOVA) were used to test for nonrandom selection of habitats by comparing nesting habitat variables with random habitat variables, and for comparisons of habitat characteristics among species to evaluate interspecific similarities and differences. Paired comparisons for the three treatments were evaluated by Tukey tests (SAS Institute, Inc. 1990). To test for nonrandom selection of categorical habitat characteristics (e.g., tree decay class, tree diameter class), we computed the proportion of each category used by a species and compared that to the proportion available in that category using the log-likelihood ratio G-test (Williams 1976). Logistic regression (SAS Institute, Inc. 1990) was used to derive the percentages of nest and random trees that were correctly classified as a suitable nest tree for cavity nesters. Nesting success was estimated using the Mayfield method (Mayfield 1961, 1975) for species with a sample size of 10 or more nests per treatment. The program CONTRAST (Sauer and Williams 1989) was used to test for differences in daily nesting survival between salvage-logged (standard and wildlife combined) and unlogged treatments. Means are followed by one standard error (±1 SE). Differences in habitat measurements and nesting success were considered significant at $p < 0.05$.

Results and Discussion

Bird Surveys and Monitoring

We monitored 695 nests of nine cavity-nesting species during 1994-1996 on the Foothills and Star Gulch burns (Table 1). Eighty-seven bird species were recorded in the study areas and 67% of those species were Neotropical migrants (Appendix 3, includes scientific names). Coincidental to surveys for cavity nesters, we observed nests of 43 species (Appendix 3). Of the songbird migrants recorded in the study areas,

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

Table 4—Number of nests per km surveyed in each treatment for years 1994-1996. Nests per mile are reported in parentheses.

	No. Nests/km (mile)		Unlogged
	Standard salvage	Wildlife salvage	controls
Lewis' Woodpecker	0.94 (1.51)	1.20 (1.95)	0.05 (0.08)
Hairy Woodpecker	0.18 (0.29)	0.16 (0.26)	0.48 (0.77)
Northern Flicker	0.35 (0.56)	0.23 (0.37)	0.33 (0.53)
Western Bluebird	0.42 (0.67)	0.46 (0.74)	0.16 (0.26)
Mountain Bluebird	0.14 (0.23)	0.27 (0.44)	0.51 (0.82)
American Kestrel	0.26 (0.41)	0.20 (0.33)	0.05 (0.08)
European Starling	0.14 (0.23)	0.03 (0.05)	0.00
White-headed Woodpecker	0.02 (0.03)	0.00	0.03 (0.05)
Black-backed Woodpecker	0.02 (0.03)	0.03 (0.05)	0.11 (0.18)

throughout its range (Tobalski 1997). Based on population trends, habitat loss, and vulnerability to management activities, Lewis' Woodpecker was identified as a species of management concern in the Columbia River Basin (Saab and Rich 1997). This species is generally not found in burned forests until 10-30 years after fire (Bock 1970, Raphael and White 1984), yet Lewis' Woodpecker was the most abundant cavity-nesting species in the 2-4 year-old Foothills Burn. Conditions created shortly after this fire were apparently highly suitable for nesting Lewis' Woodpecker. Those conditions were most likely postfire increases in arthropod populations, shrubby understories, open canopies, and nest cavities created by strong excavators (see Saab and Dudley 1995).

Although sample sizes were small for nests of Black-backed Woodpeckers, their densities were more than doubled in the unlogged units (Table 4). Nesting numbers of Black-backed Woodpeckers have been significantly reduced in burned, logged stands compared to burned, unlogged stands in Montana and Wyoming forests (see Harris 1982, Caton 1996, Dixon and Saab, in prep.).

From 1994-1996, an increasing trend in number of nests was observed for most species (Table 5) and, for all species combined, nesting densities have significantly increased (Table 3). Woodpecker populations are known to increase after forest wildfires, up to 3-5 years postfire (Blackford 1955, Bock and Lynch 1970, Taylor and Barmore 1980, Harris 1982, Caton 1996). Nesting densities doubled per km surveyed from 1995 to 1996 for Hairy and Black-backed woodpeckers, and Western and Mountain bluebirds (Table 5). Densities of Northern Flicker and American Kestrel appeared stable from 1995 to 1996, while densities were slightly down for Lewis' Woodpecker (Table 5).

Daily nesting survival did not statistically differ between treatments for any species, except Hairy Woodpecker (Table 6). Hairy Woodpeckers were highly successful in the unlogged units (92%) compared to logged units (61% and 39%) and this was statistically significant (p = 0.01). Statistical comparisons were limited by sample sizes for Lewis' Woodpecker and American Kestrel, who nested almost exclusively in the salvaged units, and by Black-backed and White-headed

Table 5—Number of nests per km surveyed in all treatments for years 1994-1996. Nests per mile are reported in parentheses.

	No. Nests/km (mile)		
	1994	1995	1996
Lewis' Woodpecker	0.31 (0.50)	1.04 (1.66)	0.70 (1.14)
Hairy Woodpecker	0.12 (0.19)	0.28 (0.44)	0.58 (0.94)
Northern Flicker	0.19 (0.31)	0.39 (0.63)	0.40 (0.65)
Western Bluebird	0.13 (0.22)	0.33 (0.53)	0.63 (1.02)
Mountain Bluebird	0.17 (0.28)	0.23 (0.37)	0.64 (1.04)
American Kestrel	[a]—	0.27 (0.43)	0.29 (0.47)
European Starling	0.00	0.09 (0.15)	0.13 (0.20)
White-headed Woodpecker	0.02 (0.03)	0.02 (0.03)	0.03 (0.04)
Black-backed Woodpecker	0.03 (0.05)	0.05 (0.07)	0.10 (0.16)

[a] Not surveyed in 1994.

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;

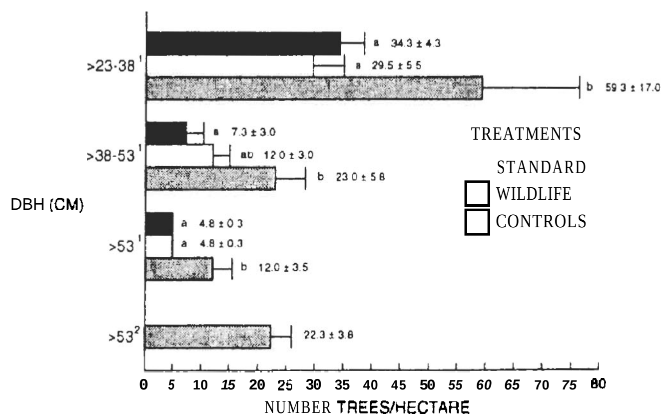

Figure 3—Average number of trees (primarily snags) per ha in three treatments after salvage logging was completed. T-bars represent 1 SE. Bars with the same small case letters are not significantly different, see Results section. [1]Represents 2 years postfire in Foothills study area. [2]Represents 1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

Fig. 4). Among bird species, Black-backed Woodpeckers selected nest sites with the highest tree densities $\bar{x}$ = 122.5 ± 28.3 trees (>23 cm dbh) per ha (49.0 ± 11.4 trees [>9" dbhl per acre), whereas Lewis' Woodpeckers used the most open nest sites $\bar{x}$ = 61.75 ± 6.0 trees (>23 cm dbh) per ha (24.7 ± 2.3 trees [>9" dbh] per acre) (Fig. 4). Lewis' Woodpecker is an aerial insectivore requiring openings for foraging maneuvers, which might explain why their nest sites were relatively open. This species, however, selected nest sites with higher tree densities than that measured at random in the unlogged controls (Fig. 4). The unlogged controls were not used by nesting Lewis' Woodpeckers during 1994 or 1995, suggesting that the controls did not provide suitable foraging habitat or nesting habitat. Tree densities in the unlogged controls were uniformly high compared to logged areas. In the salvage-logging prescriptions, trees were retained in evenly-spaced, uniform distributions, while within those treatments, cavity-nesting birds were using clumps of trees for their nest sites. This suggests that we can improve the prescriptions to favor cavity-nesting birds by changing the distribution of trees retained (from uniform to clumped), even when the same number of trees are harvested.

Higher densities of large snags, >53 cm (20") dbh, tended to surround nest trees compared to random sites (standard, df = 7, F = 2.03, p = 0.05; wildlife, df = 6, F = 5.03, p <0.001; unlogged controls, df = 6, F = 2.15, p = 0.05; Fig. 5), although this was statistically significant only in the wildlife treatment. Lewis' Woodpecker and Northern Flicker, the largest woodpecker species nesting in the burns, used nest sites with the highest densities of large trees. Nest-site use of larger trees is dependent on the decay stage, and larger diameter trees generally take longer to decay than smaller diameter trees (Bull et al. 1997, Morrison and Raphael 1993). Most large snags (>20" dbh) in our study areas were not heavily decayed (Fig. 6), which is not surprising because decay had occurred only for 2-4 years since the fires. Large trees are critical for foraging and nesting use in the future, as decay attracts insects and creates softer snags that are easily excavated. Larger diameter trees will stand longer because their falling rates are slower than smaller diameter trees (Bull et al. 1997, Morrison and Raphael 1993). This is particularly true for shorter, large diameter trees (Morrison and Raphael 1993).

Nest trees selected by Black-backed Woodpeckers averaged the smallest diameter ($\bar{x}$ = 32.3 cm ± 2.8 [12.7" ± 1.1]) compared with other cavity nesters (df = 8, F = 6.61, p <0.001; Fig. 7). Among woodpecker species, the average diameter of actual nest trees was largest for Lewis' Woodpecker and Northern Flicker, averaging about 43.7 cm (17.2") dbh. Nest trees selected by cavity nesters as a group had significantly larger diameters than random trees in all treatments (standard, df = 4, G = 108.4, p <0.001; wildlife, df = 4, G = 36.8, p <0.001; unlogged controls, df = 4, G = 24.9, p = 0.001; Fig. 8). Nest trees for cavity nesters as a group were also more heavily decayed than trees measured at random plots

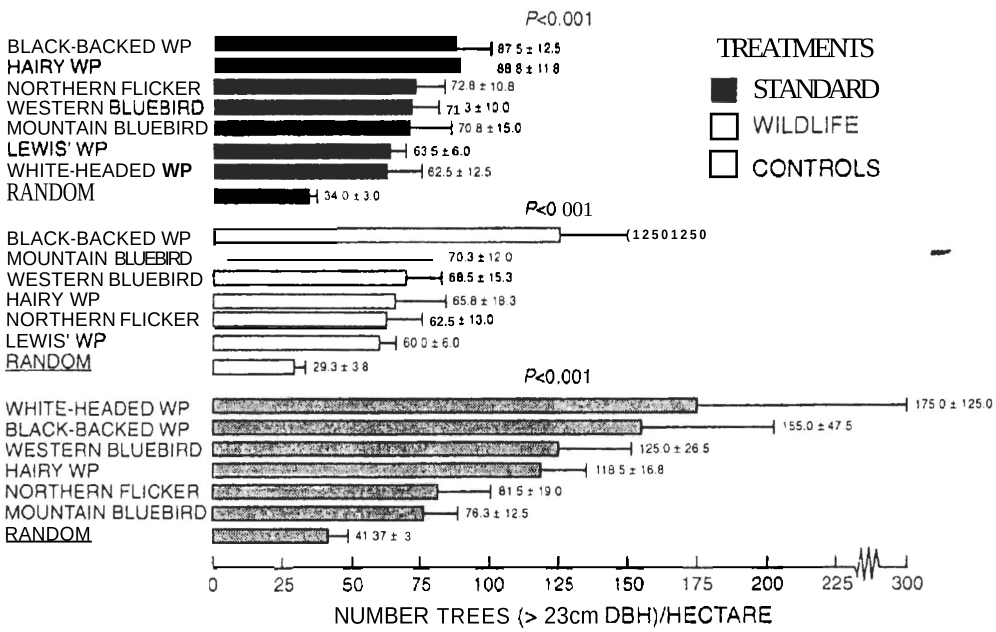

Figure 4—Average number of trees (>23 cm [9"] dbh) per hectare surrounding nest trees and random trees during 1994-1995. P-values were derived from MANOVA for each treatment, see Results section. T-bars represent 1 SE.

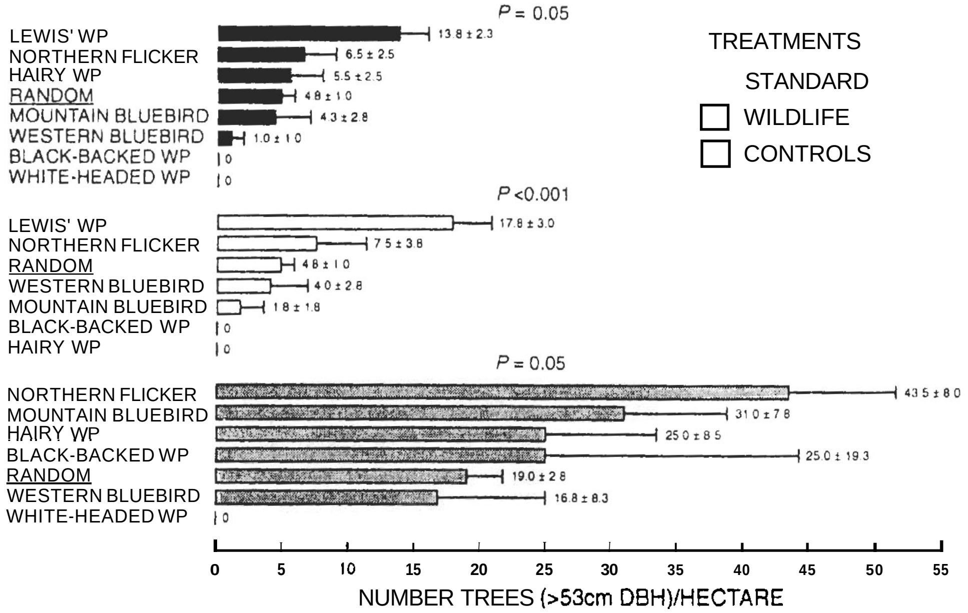

Figure 5—Average number of trees (>53 cm [20"] dbh) per hectare surrounding nest trees and random trees during 1994-1995. P-values were derived from MANOVA for each treatment, see Results section. T-bars represent **1** SE.

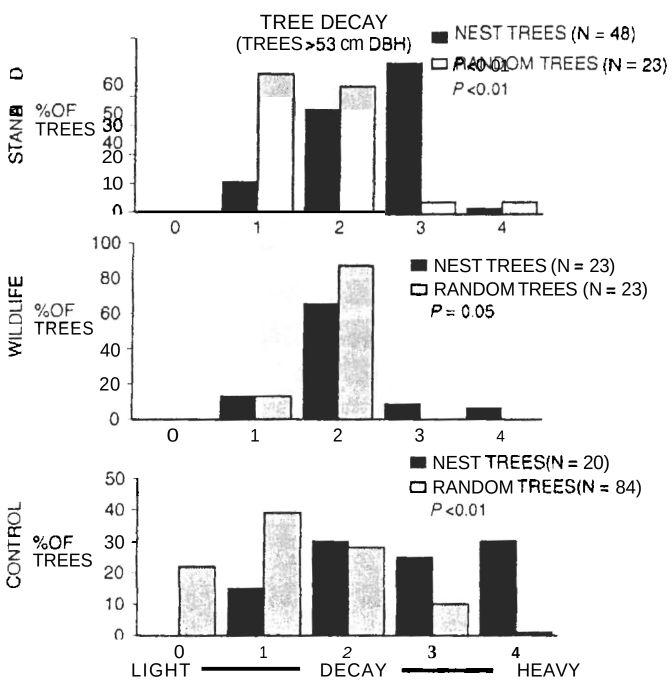

Figure 6—Proportion of nest and random trees in each of 5 decay classes for trees >53 cm (20") dbh during 1994-1995. The decay class '0' indicates live trees, while decay class '4' indicates the most heavily decayed snags. P-values were derived from G-tests, see Results section.

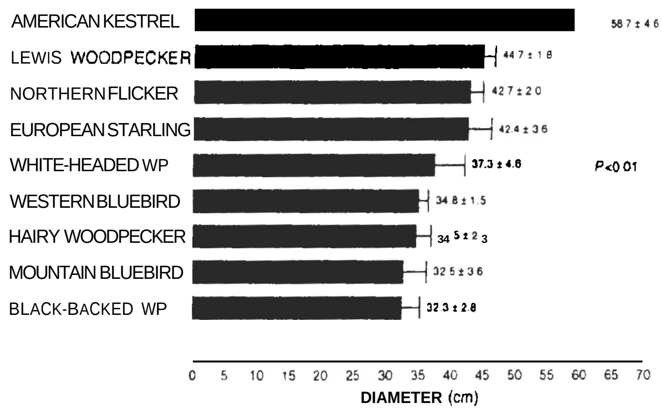

Figure 7—Average diameter at breast height of nest trees during 1994-1995 for nine cavity-nesting species. See Results section for test statistics.

(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

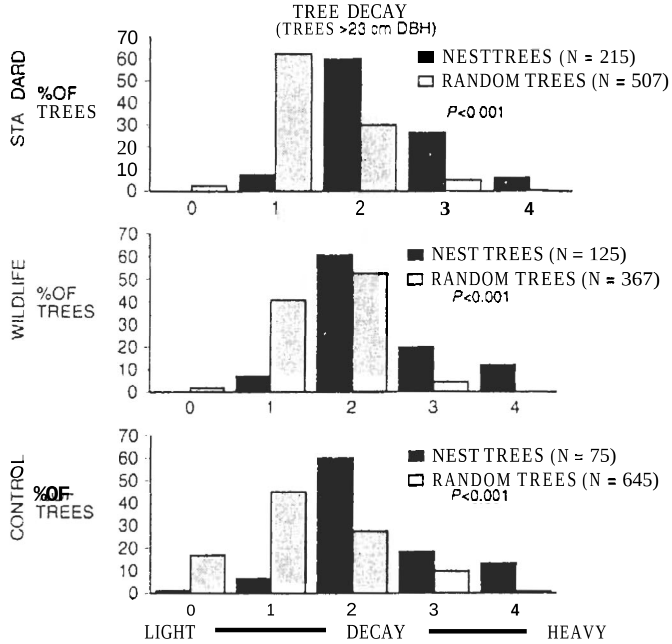

Figure 9—Proportion of nest and random trees in each of 5 decay classes for trees >23 cm (9") dbh during 1994-1995. The decay class '0' indicates live trees, while decay class '4' indicates the most heavily decayed snags. P-values were derived from G-tests, see Results section.

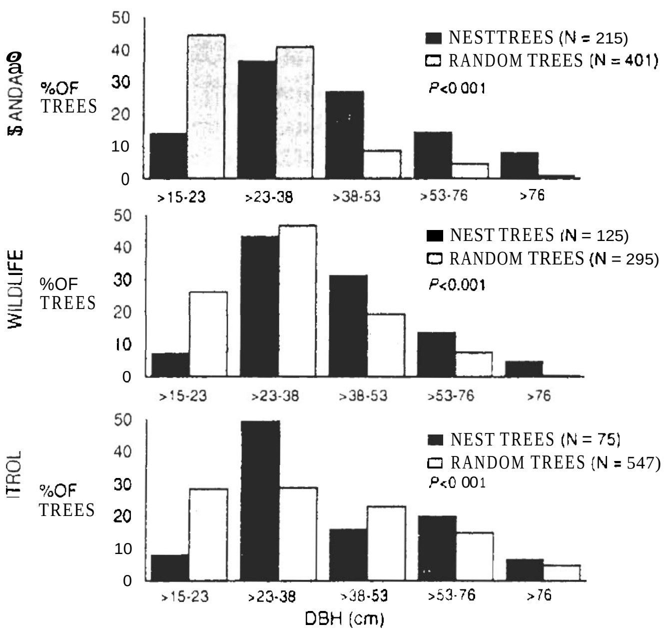

Figure 8—Percentages of nest and random trees in five size classes during 1994-1995. P-values were derived from G-tests, see Results section.

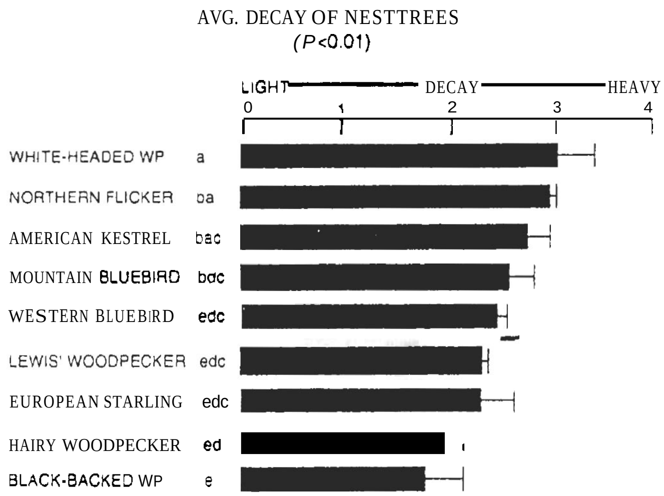

Figure 10—Average decay of nest trees during 1994-1995. Species with the same small-cased letters have an average tree decay that is not significantly different. T-bars represent 1 SE, see Results secions for test statistics.

excavate relatively hard snags and live trees. For other cavity nesters in the burns, retaining broken-topped snags in green forests is critical for providing nest trees in the first few years after fires when most snags are hard and not easily excavated.

Conclusions

Our preliminary findings show that nesting densities have continued to increase up to four years after fire. Among treatments (standard salvage, wildlife salvage, unlogged), overall densities were similar although species composition differed. Lewis' Woodpecker was the most abundant and successful species in the salvaged units, whereas Black-backed Woodpeckers favored the unlogged controls. Nesting success was highest in the unlogged controls for Hairy Woodpecker and Mountain Bluebird, highest in the standard salvage for Lewis' Woodpecker and American Kestrel, and highest in the wildlife salvage for Northern Flicker and Western Bluebird. Black-backed and White-headed woodpeckers experienced 100% nest success in all treatments. Sample sizes, however, were very low, 17 and 6 nests, respectively.

Two years after the Foothills Fire, tree and shrub densities did not differ statistically between the salvage-logged treatments. Nesting success for all species, except Hairy Woodpecker, was not statistically different between the logged and unlogged treatments. We will analyze other habitat characteristics of the salvage prescriptions to determine whether these treatments should be considered different.

Tree (primarily snags) densities were highest at Black-backed Woodpecker nest sites and lowest at random sites. Among cavity nesters, tree densities were lowest at Lewis' Woodpecker nest sites, yet densities were still higher than those in the random, unlogged controls. Cavity nesters as a group selected clumps of trees rather than uniformly-spaced trees.

Cavity-nesting birds used heavily decayed, larger snags more than in proportion to availability. Northern Flicker, American Kestrel, Lewis' and White-headed woodpeckers used the largest, most decayed snags, whereas Black-backed Woodpeckers selected the smallest, hardest snags available. Heavily decayed, broken-topped snags that pre-dated the fire had the highest probability of being a nest tree compared to snags characterized by light or medium decay, broken-topped after the fire, or intact-topped trees.

Implications for Management

Management for a variety of conditions in burned pine forests is needed for successful nesting of the cavity-nesting bird community. A range of stand conditions characteristic of Black-backed and Lewis' woodpeckers would most likely incorporate local habitat features necessary for successful nesting of other members in the bird community. Unlogged units with high tree densities (2123 snags [>23 cm dbhl per ha; [≥50 snags (>9" dbh) per acre]) of relatively small, hard snags were typical of Black-backed Woodpecker nest sites, while partially logged units (averaging 62 sriags [>23 cm dbhl per ha; [25 snags (>9" dbh) per acre]) with clumps of relatively large, soft snags characterized Lewis' Woodpecker nest sites. Retaining clumps of trees rather than uniformly distributed trees would benefit the entire cavity-nesting bird community. We hope this finding will be experimentally tested with different sized clumps on National Forests within the Interior Columbia River Basin. Management for snag recruitment (particularly broken-topped snags) in green forests, with high risks of stand-replacement fire, will provide nest trees during the first few years after wildfire when other trees are not easily excavated. In burned forests, retaining more large (>53 cm [20"] dbh) snags should lengthen the time a burn is suitable for foraging and nesting because such snags are known to have greater longevity than smaller snags (e.g., Morrison and Raphael **1993,** Bull et al. 1997). Our studies on snag longevity in logged and unlogged forests will assist with decisions regarding the level of snag retention needed to lengthen the time that post-burn habitats are suitable for cavity nesters.

We will be developing a predictive model to assess bird population responses to alternative activities related to postfire management. The model will incorporate microhabitat (local vegetation characteristics at nest and random sites), macrohabitat (forest stand level), and landscape (surrounding vegetation types and land uses) variables. Information generated from the model can be applied directly to understanding the effects of salvage logging on the long-term persistence (and viability) of cavity-nesting birds in burned forests. The model will be useful for evaluating alternatives in Forest planning and other NEPA documents. This phase (stand-replacement fire) of the project also provides information on a no action alternative to the "Forest Health Initiative" (see Future Plans below), and will help managers display trade-offs associated with future decisions in green areas for wildlife resources.

Future Plans

Our data have provided some answers to questions regarding postfire management. Continued efforts in burned conditions will focus on (1) increasing sample sizes for Black-backed Woodpeckers, who appear to be the most sensitive to postfire management activities, and estimating their home range size during the 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).

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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*

Appendix 2. Descriptions of habitat variables measured at nest and random sites in burned forest of southwestern Idaho on the Boise National Forest during 1994-1996

Variable	Measurement/Characteristic	Description
Ground Cover	% Shrub Cover % Herbaceous Cover % Bare Ground/Rock % Litter % Vegetation (Shrub+ Herbaceous) Cover	Mean of ten ocular tube estimates within 5 m (16.4ft) radius subplot 0.008 ha (0.02 ac) (James and Shugart 1970)
Downed-Woody Debris	Total Number of Small and Medium Debris	Debris <2.54 cm (1.0") and >2.54-8.1 cm (1.0-3.2") intersecting four 9.8x6.6ft planes (Brown 1974)
	Total Number of Large Sound or Rotten Debris by Size Class	Debris 3.2-5.1", >5.1-6.3", >6.3-9.5", >9.5-15.4", >15.4-21.3", >21.3-40.2", >40.2 intersecting four 37.1x6.6ft planes
Shrubs	Total Number of Shrub Stems by Species and Size Class	Live stems <2.5, >2.5-5, >5-8, >8-12 cm (<1.0, >1.0-2.0", >2.0-3.2", >3.2-4.7") within 5 m (16.4ft) radius subplot 0.008 (0.02 ac) (Martin and Guepel 1993)
Snags/Live Trees	Live or Dead	
	Total Number >Breast Height (1.37 m) (4.5ft)	Within 11.3 m (37.1ft) radius plot (0.04 ha) (0.1 acre)
	Decay Class	0 (live) to 5 (most decayed) based on presence or absence of limbs and bark, top condition, height, diameter, sapwood and heartwood condition (Cline et al. 1980)
	Top Condition	Intact, broken before fire, broken after fire, or forked
	Diameter at Breast Height (DBH)	Diameter tape (0.25 cm) (0.1")
	Height	Clinometer estimate (0.5 m) (1.6ft)
	Presence of Wood-boring Insects	Visual inspection for insects, pitch tubes, frass, or entrance/exit holes
	Presence of Woodpecker Foraging	Visual inspection for foraging woodpeckers, bark drilling, or bark flaking
	Presence of Cavities	Visual inspection for excavated or natural cavities
	Tree Tags	Subsample tagged for snag longevity
Overstory Cover	% Upper Canopy by Species	Mean of four estimates (N,S,E,W) using spherical densiometer
Physical Factors	Aspect	Compass direction of slope (0-359°)
	% Slope	Clinometer (°)
	Position on Slope	Upper, middle, or lower
	Elevation (ft)	Geographic Positioning System (GPS)
	Topographic Position	Latitude/Longitude (GPS)

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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Common name[a,b]	Scientific name
*Black-capped Chickadee(R)	*Parus atricapillus*
*Mountain Chickadee(R)	*Parus gambeli*
*Red-breasted Nuthatch(R)	*Sitta canadensis*
*White-breasted Nuthatch(R)	*Sitta carolinensis*
*Brown Creeper(S)	*Certhia americana*
*Rock Wren(S)	*Salpinctes obsoletus*
*House Wren(L)	*Troglodytes aedon*
Golden-crowned Kinglet(R)	*Regulus satrapa*
Ruby-crowned Kinglet(S)	*Regulus calendula*
*Western Bluebird(S)	*Sialia mexicana*
*Mountain Bluebird(S)	*Sialia currucoides*
Townsend's Solitaire(R)	*Myadestes townsendi*
Swainson's Thrush(L)	*Catharus ustulatus*
Hermit Thrush(L)	*Catharus guttatus*
*American Robin(S)	*Turdus migratorius*
*European Starling(R)	*Sturnus vulgaris*
Cassin's Vireo(L)	*Vireo cassinii*
*Warbling Vireo(L)	*Vireo gilvus*
*Orange-crowned Warbler(L)	*Vermivora celata*
Nashville Warbler(L)	*Vermivora ruficapilla*
Yellow-rumped Warbler(S)	*Dendroica coronata*
Townsend's Warbler(L)	*Dendroica townsendi*
*MacGillivray's Warbler(L)	*Oporornis tolmiei*
*Western Tanager(L)	*Piranga ludoviciana*
*Black-headed Grosbeak(L)	*Pheucticus melanocephalus*
*Lazuli Bunting(L)	*Passerina amoena*
*Spotted Towhee(S)	*Pipilo erythrophthalmus*
*Chipping Sparrow(S)	*Spizella passerina*
Fox Sparrow(S)	*Passerella iliaca*
*Song Sparrow(S)	*Melospiza melodia*
Lincoln's Sparrow(L)	*Melospiza lincolnii*
White-crowned Sparrow(S)	*Zonotrichia leucophrys*
*Dark-eyed Junco(S)	*Junco hyemalis*
Western Meadowlark(S)	*Sturnella neglecta*
Brewer's Blackbird(S)	*Euphagus cyanocephalus*
Brown-headed Cowbird(S)	*Molothrus ater*
Cassin's Finch(S)	*Carpodacus cassinii*
Red Crossbill(R)	*Loxia curvirostra*
Pine Siskin(S)	*Carduelis pinus*
American Goldfinch(S)	*Carduelis tristis*
Evening Grosbeak(R)	*Coczothraustes vespertinus*

[a] An asterisk preceeding a species name indicates confirmed nesting within the study areas.

[b] Letters in parentheses after the common name indicate migratory status: L = long-distance neotropical migrant; S = short-distance neotropcal migrant; R = resident.

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.

From 1994 to 1996, researchers monitored 695 nests of nine cavity-nesting bird species and measured vegetation at nest sites and at 90 randomly located sites in burned ponderosa pine forests of southwestern Idaho. Site treatments included two types of salvage logging, and unlogged controls. All bird species selected nest sites with higher tree densities, larger diameter trees, and more heavily decayed snags than that expected based on availability of such trees. This publication is an updated version of a 1997 progress/interim report, and the study is one in a series of long-term studies on bird response's to different fire conditions in ponderosa pine/Douglas-fir forests. This study provides information on bird and vegetation responses to a no action alternative of 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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