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Short-Term Effects of Fuel Reduction on Pileated Woodpeckers in Northeastern Oregon—A Pilot Study

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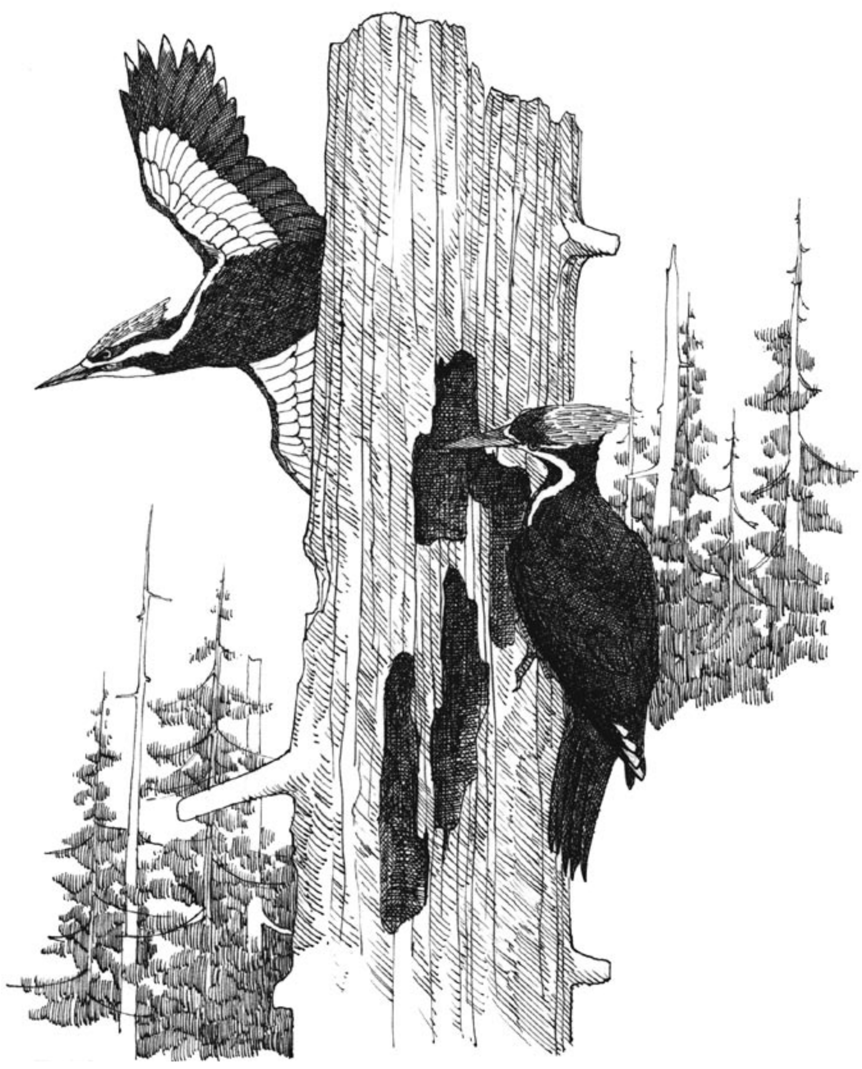

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Cover illustration by Susan Lindstedt.

Abstract

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To determine the short-term effects (1 to 3 years posttreatment) of fuel reduction on pileated woodpeckers (*Dryocopus pileatus*) in northeastern Oregon, we compared measures of abundance of logs, snags, stumps, and of woodpecker foraging in mixed-conifer stands that had undergone the following treatments: prescribed burning after mechanical fuel reduction, mechanical fuel reduction without prescribed burning, or no treatment. Pileated woodpecker foraging was significantly more abundant in the stands that were not treated or had mechanical fuel reduction only. Ants, the primary prey of pileated woodpeckers, were also significantly more abundant in these stands.

Keywords: Fuel reduction, prescribed burns, pileated woodpecker, northeastern Oregon, ants, snags, logs.

Summary

With the increased emphasis on fuel reductions within forests of the Pacific Northwest, it is important to know how these altered forest stand structures will affect wildlife. The pileated woodpecker (*Dryocopus pileatus*) is a management indicator species that depends on snags and hollow trees for roosting; snags for nesting; and logs, snags, and live trees for foraging. The objective of this study was to compare the use of logs, snags, and stumps by pileated woodpeckers and other woodpeckers within three treatments: stands treated with mechanical fuel reduction without burning, the same treatment but with burning, and untreated controls in northeastern Oregon. Pileated woodpeckers foraged significantly more in the stands that were untreated or had mechanical fuel reduction only. Ants, the primary prey of pileated woodpeckers, were also significantly more abundant in these stands. At least in the short term, prescribed burn treatments (1 to 3 years old) resulted in a loss of foraging habitat and prey for pileated woodpeckers.

Introduction

Widespread outbreaks of the western spruce budworm (*Choristoneura occidentalis*) and Douglas-fir beetle (*Dendroctonus pseudotsugae*) in the 1980s and early 1990s caused heavy tree mortality in stands with grand fir (*Abies grandis* (Dougl. ex D. Don) Lindl.) and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) in northeastern Oregon (Gast et al. 1991). The outbreaks resulted in high tree mortality that increased the fuel loading and the risk of stand-replacement wildfires (Gast et al. 1991). The increase in wildfires nationally in the early part of this century resulted in an increased emphasis on reducing fuels within forest stands. Currently, the primary methods of reducing fuels are the mechanical removal of trees and coarse woody debris (standing or down dead wood) and prescribed burning.

Certain wildlife species in northeastern Oregon, including small mammals, amphibians, rubber boas (*Charina bottae*), martens, bears, and woodpeckers, depend heavily on the coarse woody debris that is removed during these fuel reduction treatments (Tiedemann et al. 2000). American martens (*Martes americana*) frequently capture prey in accumulations of logs, and use rest and den sites in logs and snags (Bull and Heater 2000). Ants found in dead wood are the primary prey of pileated woodpeckers (*Dryocopus pileatus*) (Bull et al. 1992, Torgersen and Bull 1995). Other log-dwelling and log-associated insects, mainly ants and yellowjackets, comprise 24 percent of black bear (*Ursus americanus*) diet in northeastern Oregon (Bull et al. 2001).

Inadequate amounts and kinds of dead wood could affect the beneficial role that foliage-foraging ants and other forest-floor arthropods have in maintaining forest health. Ants also serve an important role in forest health in preying on the western spruce budworm, one of the most important forest-defoliating insects in the Pacific Northwest (Torgersen et al. 1990). Many other species of forest-floor arthropods are predators of the western spruce budworm, and some parasites of the western spruce budworm depend on the forest floor for a portion of their life cycle (Tiedemann et al. 2000). Populations of all forest-floor arthropods were significantly lower in areas that had been harvested and burned in comparison to adjacent undisturbed forests 3 years after treatment (Fellin 1980). Prescribed burning severely affected groups of forest-floor fauna by directly killing the organism or by removing woody material and forest floor that are required by these insects for food and shelter (Fellin 1980).

Although few studies directly have investigated the results of fuel reduction treatments on wildlife in the Pacific Northwest, evidence suggests that some species are negatively affected by this type of management, at least in the short term, whereas others are unaffected or benefit. Numbers of red squirrels (*Tamiasciurus hudsonicus*), snowshoe hares (*Lepus americanus*), and southern red-backed voles

(*Clethrionomys gapperi*) decreased in abundance, and chipmunks (*Tamius* spp.) increased after a mechanical fuel reduction treatment in lodgepole pine (*Pinus contorta* Dougl. ex Loud.) stands (Bull and Blumton 1999). Abundance of northern flying squirrels (*Glaucomys sabrinus*) in northeastern Oregon decreased after thinning treatments to reduce dwarf mistletoe (*Arceuthobium* spp.), whereas numbers of red squirrels remained constant or increased with this treatment (Bull et al. 2004). A better understanding of how fuel reduction treatments, particularly prescribed burning, affect forest communities is essential for effective management of habitat for wildlife (Kotliar et al. 2002).

The pileated woodpecker is a management indicator species for the Forest Service in the Pacific Northwest Region and is strongly dependent on coarse woody debris for foraging (Bull 1987, Bull and Jackson 1995). The effects of fuel reduction treatments on this species and its prey base are unknown. Given the lack of information available, our overall goal is to look at fuel reduction over time. In this pilot study, we investigated the short-term (1 to 3 years) response of pileated woodpeckers to fuel reduction treatments in stands with past insect outbreaks because these areas were determined to be at high risk for fire without some removal of fuel. We conducted this study in an area with a known density of pileated woodpeckers to determine if an adequate sample size of foraging sites could be located in fuel reduction treatments to justify a more comprehensive long-term study over a larger geographic area. The specific objective of this study was to compare the use of logs, snags, and stumps by pileated woodpeckers in stands treated within 1 to 3 years with mechanical fuel reduction without burning, the same treatment with burning, and in untreated controls on the Starkey Experimental Forest and Range (Starkey).

Methods

Study Area, Stand Treatment and Selection

The study was conducted on Starkey (11 400 ha), located within the La Grande Ranger District of the Wallowa-Whitman National Forest, 50 km southwest of La Grande, Oregon. In the 1980s, outbreaks of spruce budworm and subsequent Douglas-fir bark beetle outbreaks in the 1990s resulted in extensive mortality of grand fir and Douglas-fir in the 1990s on Starkey. Based on preliminary inquiries from geographic information system (GIS) and field work, at least 75 percent of the grand fir stands in existence in 1989-90 now have low canopy closure (<30 percent) because of extensive mortality on Starkey. These same stands contained 95 to 100 percent canopy closure in the 1970s. This change in canopy closure and stand condition prompted the La Grande Ranger District in collaboration with the Pacific

Northwest Research Station to implement fuel reduction treatments to reduce the amount of coarse woody debris in the stands. Starkey is a critical research area for a host of long-term scientific studies that require special protection. Starkey offers a unique research opportunity for this study because 50 stands were treated with fuel reduction methods (mechanical and mechanical with prescribed burning), stands with no treatment were available within close proximity, and home range locations of pileated woodpeckers were known based on past research (Bull and Holthausen 1993). The proximity of the stands allowed a comparison of pileated woodpecker use among three treatments within the home range of the same pair of pileated woodpeckers (407 ha; Bull and Holthausen 1993).

Fuel reduction treatments were conducted on 50 stands that were in a mature, multilayered structure in either a grand fir/Douglas-fir/larch (*Larix occidentalis* Nutt.) forest type or a Douglas-fir/grand fir/ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) type based on soil surveys (Burr 1960). The mechanical fuel reduction was a thinning from below conducted between 2001 and 2003 by using whole tree logging with a rubber tired skidder or by using a cut-to-length harvester with a forwarder. The objective was to retain 18.4 m^2/ha basal area of live trees with an emphasis on ponderosa pine and western larch; green trees larger than 51 cm diameter at breast height (d.b.h.) were not removed. District guidelines specified the retention of 10 to 15 snags larger than 51 cm d.b.h. (if available) and 250 to 350 m of logs in each hectare. Logs were to be >30 cm in small-end diameter and >6 m long. Material that was removed included ladder fuels, some green trees 10 to 51 cm d.b.h., dead trees larger than 10 cm d.b.h., grand fir with Indian paint fungus (*Echinodontium tinctorium*), trees with mistletoe brooms unless a tree was >15 m from other trees of the same species, and downed material. Downed material (>8 cm in diameter) in excess of 33 626 to 56 043 kg/ha was to be removed from the site. The amount of fuels removed during harvesting and burning is shown in table 1.

Forty-three of the 50 harvested stands were broadcast burned in the fall between 2001 and 2003. The seven burned stands used in this study were burned when maximum daily temperature was between 12 and 24° C, and minimum relative humidity was 15 to 55 percent. The percentage of fuel moisture of 1-hour fuels was 4 to 11, of 10-hour fuels was 7 to 9, and of 1,000-hour fuels was 11 to 15. The units were ignited by hand with drip torches. Strategic ignition patterns were used to protect snags by not igniting near the base of snags, downslope from snags, or upwind from snags.

Logs, snags, stumps, and recent woodpecker foraging activity were quantified in three types of treatments: (1) stands treated with mechanical fuel reduction only

Table 1—Weight of fuels in units based on photointerpretation on the Starkey Experimental Forest and Range, 2001–2003[a b]

	Pretreatment		Posttreatment		Postburn	
Unit	All fuels	Logs >8 cm	All fuels	Logs >8 cm	All fuels	Logs >8 cm
			Kilograms per hectare			
47C	77 114	52 680	50 214	26 900	26 228	17 934
61	101 997	78 460	56 043	29 142	19 503	11 208
65	89 556	61 647	59 630	26 900	29 815	20 175
69	161 850	140 106	63 888	39 230		

[a] Estimates were obtained prior to treatment (pretreatment), after the mechanical removal harvest (postharvest), and after the prescribed burn (postburn).
[b] Fuel weights were not available for the remainder of the units nor for the postburn in unit 69; fuel weight data are on file at the La Grande Ranger District, La Grande, OR 97850.

(mechanical removal), (2) stands broadcast burned after mechanical fuel reduction (prescribed burn), and (3) stands with no treatment (control). Only seven stands that had fuels mechanically removed were not burned; consequently, this treatment limited the sample size to seven sets of the three treatments (i.e., 21 stands). We selected the nearest seven unharvested stands for control treatments and the nearest seven with a prescribed burn (table 2). The nearest stands (within 2 km) were selected so there was a high likelihood that the same pair of pileated woodpeckers had the opportunity to forage in the three stands with the different treatments. Therefore, randomization of stand selection was not desired. The seven areas were 0.5 to 5 km apart. The stands ranged in size from 9 to 35 ha and were surveyed in August 2004.

Log, Snag, and Stump Quantification

We used a 1-ha plot (100 by 100 meters) in each stand to determine snag and stump density and 1000 m of transects within the plot to determine relative abundance of logs. It was not our intent to determine absolute log density because relative abundance of logs among treatments provided the desired information. It was also not necessary to know conditions prior to treatment because the amount of woody material currently available, rather than the percentage of original material removed, is the parameter relevant to woodpecker foraging opportunities (McClelland 1979). Control plots provided insight into current conditions without fuel reductions.

Log transects consisted of 10 parallel 100-m transects 11 m apart. Plot location was randomly assigned by walking to the middle of the unit and looking at the second hand on a watch. The observer then walked the number of paces indicated by the second hand and in the direction the second hand pointed (using the face of the watch as a compass), and that point was the corner of the plot. The three plots associated with the first area (replicate group) all had the transects run north and

Table 2—Units surveyed in 2004 for pileated woodpecker foraging in three treatments (mechanical removal without burning, mechanical removal with prescribed burning, and controls) and the year the units were treated on the Starkey Experimental Forest and Range

Mechanical removal			Prescribed burning			Controls	
Unit no.	**Size**	**Treatment year**	**Unit no.**	**Size**	**Treatment year**	**Unit name**	**Size**
	ha			*ha*			*ha*
15	21	2003	74	8	2001	Meadow	15
35	9	2001	37	3	2002	Trap	14
44	24	2002	63	9	2003	Sardine	22
47G	5	2003	47C	39	2003	Battle Flat	20
61	22	2002	61	12	2003	Little Bear	19
68	19	2002	65	35	2002	Tin Trough	16
69	13	2002	69	11	2003	Bluff	13

south, and the transects in the subsequent three plots ran east and west. The direction of the transects alternated among the rest of the areas.

The 1-ha plots were established by using a measuring tape, compass, and flagging. We quantified all snags (defined as dead standing wood ≥15 cm d.b.h. and ≥3 m tall) and stumps (≥15 cm d.b.h. and 1 to 2.9 m tall) in the 1-ha area, and all logs ≥15 cm in large-end diameter and ≥1 m long that crossed one of 10 transects. Logs that did not cross any transect were not tallied, and logs that crossed more than one transect were tallied only once. Tree species, large-end diameter of log, d.b.h. of snags and stumps, wood condition, and length or height were recorded for each log, snag, and stump. Wood condition was classified as sound, moderate decay, or extensive decay. The presence of charred wood and the presence and genus of ants observed along the length of each log that crossed a transect and in the basal 2 m of each snag in the unit were recorded. The presence of fresh dust created by ant excavation was recorded as an indication that ants were colonizing the log. If ants were actually seen, the genus of ant was classified as *Camponotus* spp. (carpenter ants), *Formica* spp. (red forest ants), and other, which included small brown ants of several genera including *Lasius*, *Tapinoma*, *Leptothorax*, and *Aphaenogaster* (Torgersen and Bull 1995). The log was disturbed to encourage movement of ants to facilitate an identification.

Woodpecker Foraging Activity

Our objective was to quantify all woodpecker foraging in logs, snags, and stumps within the 1-ha plots. To measure pileated woodpecker use, we quantified each log, snag, and stump that had been used for foraging within each unit. Logs, snags, and stumps with recent foraging by pileated woodpeckers located anywhere in the plot were marked with flagging, and the same variables listed above were quantified (tree species, diameter, length, wood condition, charring, and ant presence). We noted if a log with foraging was on a transect or not. Recent foraging excavations were defined as sites where foraging chips characteristic of pileated woodpeckers were present on top of the existing substrate. There may have been some recent litter covering the chips, but the chips were not embedded in the substrate or buried by other material. Old foraging excavations were not measured because they probably occurred before the fuel reduction or burning treatment occurred. Pileated woodpecker foraging was identified as (1) large rectangular excavations where pileated woodpeckers were typically in pursuit of *Camponotus* ants, (2) large surface excavations that reach into sapwood or heartwood where pileated woodpeckers were after wood-boring beetle larvae, (3) very shallow excavations where pileated woodpeckers were after bark beetles, (4) small isolated shallow excavations in sapwood where pileated woodpeckers located isolated ants or beetles, and (5) small, isolated, deep excavations where pileateds were after isolated wood-borers (Raley and Aubry 2004). Recent foraging activity by other woodpeckers, typically in the form of bark scaling, was identified on the basis of size of chips (<2 cm), smaller flakes of bark, smaller scat, and smaller indentations in the wood. The woodpeckers other than pileated woodpeckers most likely foraging in snags and logs in these stands would include hairy (*Picoides villosus*) and black-backed (*P. arcticus*) woodpeckers (referred to as *Picoides* spp.) (Bull et al. 1986). White-headed woodpeckers (*P. albolarvatus*) are now rare on Starkey, and the majority of foraging by northern flickers (*Colaptes auratus*) and sapsuckers (*Sphyrapicus* spp.) on Starkey does not include excavation or bark scaling (Bull et al. 1986).

Analysis

The relative abundance of logs and the actual density of snags and stumps were compared among the treatments with chi-square analyses. The same analyses were used to compare substrates with woodpecker foraging among the treatments. Large-end diameter and length of logs, d.b.h., and height of snags were compared by using analysis of variance and a post-hoc Tukey's B test (Zar 1999). Tree species, wood condition, and ant presence (for all ant genera combined and for each genus) in logs, snags, and stumps were compared among treatments by using chi-square tests. In addition, the amount of charring on logs and snags with and without ants and with and without pileated woodpecker foraging was compared by using t-tests and Levene's test for equality of variances (Zar 1999). A probability of 0.05 was used for significance.

Results

The objective of the fuel reduction treatments was to decrease stem density and coarse woody debris, so it was logical that significant differences occurred in the number of logs, snags, and stumps among the three treatments ($X^2 = 208.01$, 4 df, $P < 0.01$) with the highest number of each occurring in the control stands (fig. 1).

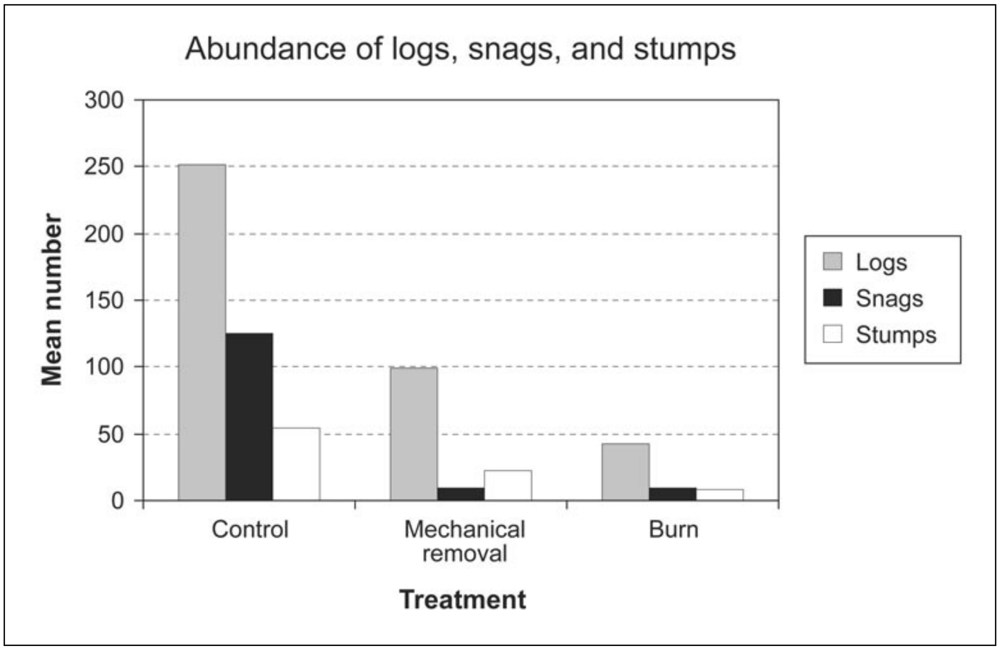

Figure 1—Mean number of logs on 1000 m of transects in seven stands and the mean number of snags and stumps in a 1-ha plot in seven stands in control, mechanical removal, and prescribed burn treatments on the Starkey Experimental Forest and Range in northeastern Oregon, 2004.

Logs

We tallied 1,764 logs in the control plots, 693 in the mechanical removal plots, and 299 in the prescribed burn plots. Significant differences occurred among the treatments in log large-end diameter ($F = 20.59$, $P < 0.01$), length ($F = 329.16$, $P < 0.01$), species ($X^2 = 48.36$, $P < 0.01$), and wood condition ($X^2 = 49.84$, $P < 0.01$). Logs remaining after the mechanical removal treatment were significantly larger (mean = 33 cm, standard error = 0.54) than in either the control (mean = 29 cm, standard error = 0.31) or burn treatments (mean = 29 cm, standard error = 0.75). Logs in the control treatment were significantly longer (mean = 9 m, standard error = 0.12) than those in the burn and mechanical removal treatments (burn: mean = 5 m, standard error = 0.29; mechanical: mean = 4 m, standard error = 0.13). In all treatments, 83 to 91 percent of the logs were in the intermediate decay class, with the highest proportion of logs with advanced decay (16 percent) occurring in the mechanical removal treatment.

Snags

We tallied 879 snags in the control plots, 65 in the mechanical removal plots, and 63 in the prescribed burn plots; there were no significant differences in snag numbers between the two fuel reduction treatments (fig. 1). Significant differences occurred in snag diameter ($F = 40.66$, $P < 0.01$), height ($F = 13.51$, $P < 0.01$), species ($X^2 = 16.29$, $P < 0.01$), and condition ($X^2 = 10.51$, $P < 0.01$) among the treatments. Although the stands with either fuel reduction treatment had fewer snags than the control, a higher percentage of the snags that occurred in these treatments were larger than 50 cm d.b.h. compared to the control treatments. Snag d.b.h. differed significantly among all the treatments. The mean d.b.h. of snags was 35 cm (standard error = 0.63) in the control treatments, 46 cm (standard error = 2.88) in the prescribed burn treatments, and 55 cm (standard error = 3.17) in the mechanical removal treatments. Sixty-three percent of the snags in the control treatments were less than 35 cm d.b.h., whereas 35 percent of those in the prescribed burn treatments and 25 percent of those in the mechanical removal treatments were this size. Snags in the control treatment were significantly shorter (mean = 9.3 m, standard error = 0.17) than those in the prescribed burn/mechanical removal treatments (mean = 12.4 m, standard error = 0.90) or the mechanical removal treatments (mean = 11.3 m, standard error = 0.87), which is consistent with snags in the control treatments being smaller in diameter. Wood condition differed significantly among the treatments where the burn treatments contained 11 percent of recently dead trees compared with 2 percent and 4 percent in the mechanical removal and control treatments, respectively.

Stumps

We tallied a total of 379 stumps in the control plots, 154 in the mechanical removal plots, and 57 in the prescribed burn plots (fig. 1). Significant differences occurred in stump diameter ($F = 14.74$, $P < 0.01$), height ($F = 8.35$, $P < 0.01$), and species ($X^2 = 27.28$, $P < 0.01$) among the treatments. Although the stands with either fuel reduction treatment had fewer stumps, the average diameter was 38 cm (standard error = 2.24) in the prescribed burn treatments, 41 cm (standard error = 1.78) in the mechanical removal, and 32 cm (standard error = 0.80) in the control treatments. Stumps in the control stands were significantly taller (mean = 2.2 m, standard error = 0.04) than those in the prescribed burn treatments (mean = 2.0 m, standard error = 0.11) or the mechanical removal (mean = 1.9 m, standard error = 0.06) largely because most of the stumps in the treated stands were a result of the harvesting treatment.

Presence of Woodpecker Foraging and Ants

Pileated Woodpeckers—We detected 534 dead wood substrates (i.e., logs, snags, and stumps) with pileated foraging. The majority (71 percent) of the foraging activity in all substrates involved large rectangular or deep excavations where pileated woodpeckers appeared to be foraging on ants or wood-boring beetle (cerambycids and buprestids) larvae, 17 percent were shallow excavations where bark beetles likely had been present, and the remainder were small, isolated shallow excavations.

Overall, we detected 216 logs with recent pileated woodpecker foraging; 200 of those logs were on transects and 16 did not cross a transect. The majority of these logs with foraging occurred in the control treatment (fig. 2). Pileated foraging in logs was significantly more abundant in the control and mechanical removal treatments than in the prescribed burn treatments (control versus prescribed burn: $X^2 = 4.34$, 1 df, $P = 0.04$; mechanical removal versus prescribed burn: $X^2 = 3.82$, 1 df, $P = 0.05$). Pileated woodpeckers selected substrates with ants. Forty-three percent of transect logs had ants, whereas 62 percent of logs with pileated woodpecker foraging had ants ($X^2 = 33.83$, 1 df, $P < 0.01$). Ants were significantly more abundant in logs in the control and mechanical removal treatments than in the prescribed burn treatments ($X^2 = 28.92$, $P < 0.01$). Ants occurred in 46 percent of transect logs in the control, 44 percent in the mechanical removal treatments, and in 29 percent in the prescribed burn treatments. The presence of charring on logs influenced the occurrence of ants and pileated woodpecker foraging activity. Logs with ants had

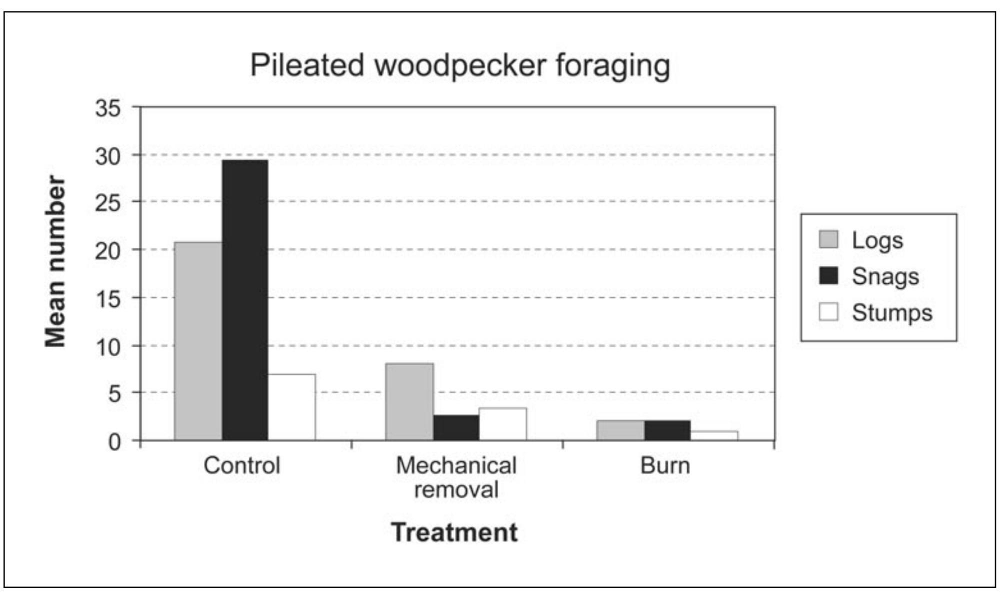

Figure 2—Mean number of logs, snags, and stumps with pileated woodpecker foraging in 1-ha plots in seven stands in control, mechanical removal, and prescribed burn treatments on the Starkey Experimental Forest and Range in northeastern Oregon, 2004.

significantly less charring than logs without ants (t = 3.56, 2,758 df, P < 0.01). The percentage of charring on logs with pileated foraging was significantly less than on logs without pileated foraging (t = 2.80, 306 df, P < 0.01).

Eighty-six percent of an overall total of 239 snags with recent pileated woodpecker foraging occurred in the control treatment with <10 percent in the other treatments (fig. 2). Pileated woodpeckers selected snags with ants, as 33 percent of all snags had ants, whereas 59 percent of snags with pileated woodpecker foraging had ants (X^2 = 99.79, 1 df, P < 0.01). Thirty-four percent of the snags in control treatments, 29 percent in the mechanical removal treatments in contrast to only 14 percent of the snags in the prescribed burn treatments, contained ants. No statistical differences occurred in the percentage of charring and the occurrence of ants and pileated foraging in snags.

We detected a total of 79 stumps with recent pileated woodpecker foraging where 62 percent of the stumps in the control treatments had foraging activity, 29 percent in the mechanical removal treatments, and 9 percent in the prescribed burn treatments (fig. 2). Although significantly more stumps in the control treatments contained ants (X^2 = 6.07, 2 df, P = 0.05), there was no significant difference in the number of stumps with foraging among the treatments with 12 to 15 percent of the stumps in each treatment containing pileated woodpecker foraging. No statistical differences occurred in the percentage of charring and the occurrence of ants and pileated foraging in stumps.

Ant species—We identified *Camponotus* in 112 logs, snags, and stumps; *Formica* in 399; and other in 58. The occurrence of *Camponotus* and *Formica* ants differed significantly among treatments with the highest percentage occurring in the control treatments (X^2 = 8.48, 2 df, P = 0.01; X^2 = 11.90, 2df, P < 0.01, respectively). Of the *Camponotus*, 81 percent occurred in the control treatments, 15 percent in the mechanical removal treatments, and 4 percent in the prescribed burn treatments. Of the Formica ants, 76 percent occurred in the control treatments, 18 percent in the mechanical removal treatments, and 6 percent in the prescribed burn treatments. No significant differences occurred among treatments in the presence of other ants.

***Picoides* foraging**—We detected evidence of foraging by *Picoides* woodpeckers in 3 percent of 2,779 logs on transects, in 23 percent of 1,007 snags, and in 11 percent of 590 stumps. Evidence of foraging by *Picoides* woodpeckers in logs, snags, and stumps did not differ significantly among treatments, although the majority of *Picoides* foraging occurred in snags in the control treatments (fig. 3). Significant differences occurred in the presence of *Picoides* foraging in snags (X^2 = 4.03, 1 df,

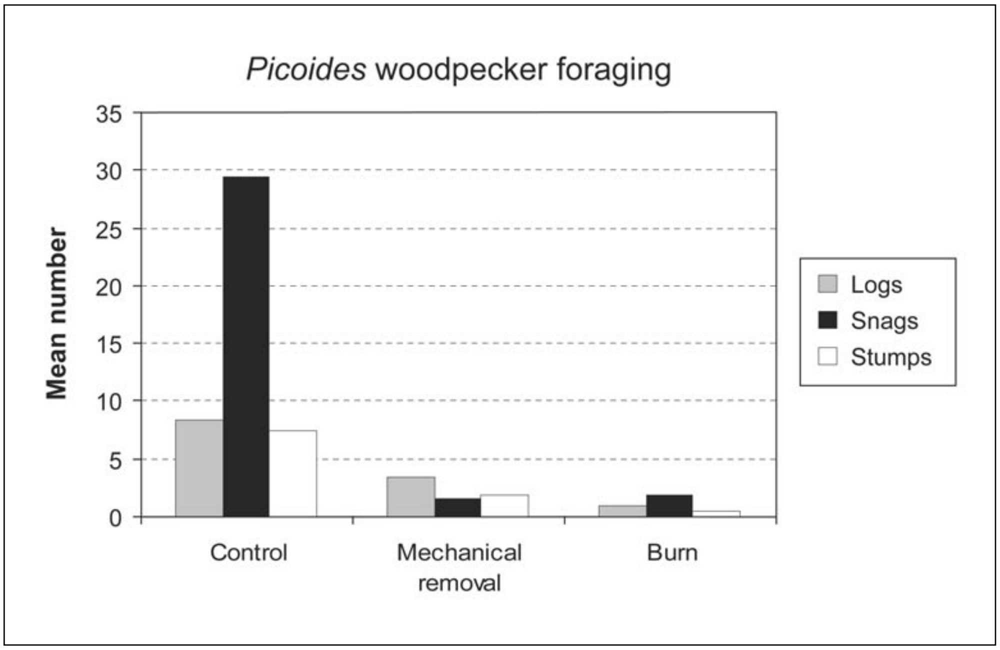

Figure 3–Mean number of logs on 1000 m of transects in seven stands and the mean number of snags and stumps in a 1-ha plot with foraging evidence of *Picoides* woodpeckers in control, mechanical removal, and prescribed burn treatments on the Starkey Experimental Forest and Range in northeastern Oregon, 2004.

$P = 0.04$) and stumps ($X^2 = 6.04$, 1 df, $P = 0.01$) with and without evidence of ants. *Picoides* foraged more in snags and stumps without ants than snags and stumps with ants. In snags, 62 percent of the foraging occurred with no evidence of ants versus 38 percent with ants. In stumps, 56 percent of the foraging occurred with no evidence of ants versus 44 percent with ants. *Picoides* foraging in logs did not differ with or without evidence of ants. The percentage of charring in the prescribed burn treatments differed significantly between stumps with *Picoides* foraging (mean of 22 percent charring) and stumps without *Picoides* foraging (mean of 56 percent charring) ($t = 3.21$, 40 df, $P < 0.01$).

Discussion

Both the control treatments and the mechanical removal treatments provided significantly more foraging habitat for pileated woodpeckers, whereas the prescribed burn treatments provided significantly less. The higher incidence of ants in the control treatments and mechanical removal treatments explains the greater use by these woodpeckers. In this study area, pileated woodpeckers are known to forage primarily on ants, specifically *Camponotus* and *Formica* (Bull et al. 1992). The higher incidence of pileated woodpecker foraging in substrates with ants suggests that their foraging is not random and that they were able to detect ants in substrates. Consequently, their foraging is more efficient than random selection of substrates, and the energy they expend foraging is therefore minimized.

A significant difference in foraging habitat of the smaller *Picoides* woodpeckers was not detected among the treatments (fig. 3), except in their avoidance of charred stumps in the prescribed burn treatments. Unlike the pileated woodpecker, these woodpecker species do not concentrate their foraging extensively on ants, likely because the *Camponotus* and *Formica* ants are inside dead wood, which would be largely unavailable to these woodpeckers. Both the black-backed and hairy woodpeckers forage extensively by bark scaling and pecking on trees in Starkey and seldom excavate in the interior wood (Bull et al. 1986). Black-backed woodpeckers are frequently associated with recent stand-replacement fires (Hutto 1995, Kotliar et al. 2002, Saab and Dudley 1998), and recent mortality of trees killed by burning would result in an increase in bark beetles and wood-boring beetles, which the *Picoides* species of woodpeckers forage on. Black-backed woodpeckers feed extensively on larvae of wood-boring beetles (buprestids, cerambycids), engraver beetles, and bark beetles (scolytids; Dixon and Saab 2000, Murphy and Lehnhausen 1998). Hairy woodpeckers forage on larvae of bark beetles, codling moth, pupae of cecropia (*Hyalophora cecropia*), as well as ants (Jackson et al. 2002).

In a comparison of prescribed burning and harvesting in southeastern British Columbia, Machmer (2002) found no difference in woodpecker foraging among treatments after partial harvesting and burning in the short term (1 to 2 years). After treatments, she detected increases in insect species diversity in Buprestidae, Cerambycidae, and Scolytidae, which are all species that inhabit dead and dying wood and serve as prey for woodpeckers. The increase in insects was most pronounced in the burn only treatment, followed by harvest and burning, and then by harvest only. Prescribed burns in northern Idaho resulted in most of the small woody fuels and 15.5 t/acre (34 746 kg/ha) of large woody fuels being consumed (Reinhardt et al. 1991). In spruce (*Picea* spp.) ecosystems in Alaska, Werner (2002) found that both fire and timber harvest attracted woodborers and bark beetles the first year after disturbance, but populations then decreased to levels below those in undisturbed sites.

The absence of management activities in the control treatments in our study resulted in an abundance of logs, snags, and pileated woodpecker foraging (figs. 1 and 2). Because no logs or snags were removed from the control treatments, the average diameter and height or length of snags and logs were smaller than in the fuel reduction treatments where the smaller snags and logs were targeted for removal. However, the control treatments actually contained a larger number of large-diameter snags and logs compared to the fuel reduction treatments. The control treatments also contained the highest number of logs and snags with all species of ants, including *Camponotus* and *Formica*, which provided the most foraging habitat for pileated woodpeckers.

Although foraging by pileated woodpeckers in mechanical removal treatments was not as common as in the control treatments, there was significantly more foraging than in the prescribed burn treatments. The presence of *Camponotus* and *Formica* ants in the mechanical removal treatment provided prey for pileated woodpeckers. The removal of standing trees alone did not prevent pileated woodpeckers from using the stands. The larger diameter logs and snags found in these stands, as well as in the burn treatment, were retained during harvesting owing to management guidelines and to their low susceptibility to wildfire and high value to wildlife. The shorter length of logs and the higher incidence of logs in the advanced decay class found in this treatment likely resulted from the logging equipment running over the logs and breaking them.

The lower occurrence of ants in logs, snags, and stumps in the prescribed burn treatment suggests that the burning either directly eliminated the ants or rendered the habitat unsuitable for ants. In the burn treatment, the logs in the advanced decay class would probably have been consumed. Our observation that logs with ants had less charring than logs without ants suggests that charring on logs may make the logs less attractive to ants or that ants were extirpated from the general area by fire. The lower abundance of ants in the burn treatments resulted in significantly less pileated woodpecker foraging activity.

In our study, the average number of snags was about the same in both fuel reduction treatments (fig. 1), although the higher number of recently dead snags in the prescribed burn treatments suggests that some live trees were killed and some existing snags were consumed. Trees continued to die more than a year after the burn owing to woodborer and bark beetle activity in them. The recent mortality of live trees created foraging habitat for *Picoides* woodpeckers because woodborers were present in the dead and scorched live trees in the 2003 prescribed burn treatments. We did not detect woodborers still present in the 2001 or 2002 prescribed burn treatments.

Prescribed burning in this study area did not allow the degree of control in retaining coarse woody debris that the mechanical reduction treatment allowed. In one of the 43 burned stands on Starkey, more than 10 pileated woodpecker nest trees located in a previous study (Bull and Holthausen 1993) were consumed by the fire in an 18-ha area. A snag used by great gray owls (*Strix nebulosa*) for nesting was burned in one of the stands used in this study. Although some combustible fuel was removed from the base of some snags as recommended by Conner and Locke (1979), the nest trees burned. Weather conditions can change rapidly and reduce the amount of control that managers have over a prescribed burn and result in the loss of logs, snags, and live trees that were designated for retention.

The results of this pilot study indicate that it is feasible to determine the effect of fuel reductions on pileated woodpecker foraging in relatively small plots. It would be beneficial to conduct a similar study over a much larger geographic area to determine if the results of this study are applicable on a landscape scale and over the long term. It would be beneficial to know when *Camponotus* and *Formica* colonize areas that had prescribed burn treatments. If maintaining biodiversity and management indicator species is an objective, it is important to know the consequences of fuel reduction treatments on specific wildlife species, particularly those that depend on the coarse woody debris that is removed during these treatments. Alternative measures may be available to ensure the retention of structures that specific wildlife species depend on and allow managers to meet multiple objectives simultaneously. Additional research is needed on the long-term effects of fuel reduction treatments on specific wildlife species, amounts and kinds of fuels to retain for wildlife, and additional measures that can be taken to protect specific habitat structures.

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English Equivalents

When you know:	Multiply by:	To find:
Centimeters (cm)	0.394	Inches
Meters (m)	3.28	Feet
Kilometers (km)	.62	Miles
Hectares (ha)	2.47	Acres
Kilograms per hectare (kg/ha)	.89	Pounds per acre
Square meters per hectare (m^2/ha)	4.37	Square feet per acre
Celsius (°C)	1.8 + 32	Fahrenheit

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