Final Report to the Joint Fire Science Program
Project # 01-1-3-25

Title of Project: Prescribed fire strategies to restore wildlife habitat in ponderosa pine forests of the Intermountain West

Project Location: Idaho, Montana, Oregon, Washington, South Dakota, Colorado, Arizona, New Mexico

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EXECUTIVE SUMMARY

OVERVIEW

The goal of this project was to help evaluate the effectiveness of prescribed fire in reducing fuels, and to assess the effects of fuel reduction on habitats and populations of birds in ponderosa pine forests throughout the Interior West. Known as the Birds and Burns Network, we have study areas located on National Forest and The Nature Conservancy lands in seven states (Arizona, Colorado, Idaho, Montana, New Mexico, Oregon, and Washington). As of 2005, study areas in Arizona and New Mexico (Southwest region; SW), and Idaho and Washington (Northwest region; NW) received prescribed fire treatments. At these locations, we analyzed changes in downed wood, forest structure (trees and snags), and bird populations measured within one year after fire treatments. The information produced resulted in a better understanding of "*… the effects of fuels manipulation/reduction methods and techniques on future landscape characteristics in terms of fire severity, wildlife population and habitat structure dynamics* . . ." (Task 3, RFP 2001-1).

Data were collected on fuels, habitat characteristics, songbird population densities, and nest survival of cavity-nesting birds for 1 – 2 years prior to prescribed fire treatments, during the year of burning treatments, and one year after prescribed fire. We also collected information on burn severity one year after the prescribed fire treatments were completed. In addition, we initiated an evaluation of the ecological trade-offs for selected wildlife species of managing for different fire conditions (wildland fire vs. prescribed fire vs. fire exclusion) by using data from our ongoing, long-term studies of wildland fire effects on habitats and populations of cavity-nesting birds.

Results

Downed Wood

Nearly half of large downed wood was consumed by prescribed fire in both regions. Drought conditions, followed by low wood moistures prior to fire treatments, may have contributed to the large loss of downed wood. Efforts to retain these large structures may require seasonal adjustments for burning times when moisture contents are higher and fire severity effects are lower. Maintenance of large, downed wood is important ecologically because these structures provide foraging habitat, thermal cover, and concealment for many sensitive wildlife taxa.

Snags

We observed apparent increases in snag densities, including the large diameter size class in both regions. While prescribed fire consumed some wildlife snags (snags >23 cm dbh), it also recruited snags. This pattern was not statistically significant; however, the result has implications for the creation of wildlife snags using prescribed fire. Several authors suggest protecting nest trees by removing combustible materials around their base prior to burning to reduce losses of suitable nest/roost snags. We suggest that these methods are too labor intensive and cost prohibitive for large-scale prescribed fire programs, unless snag protection is required for Threatened and Endangered species.

Burn Severity

Burn severity as a result of prescribed fire was generally low on all study units. Most units had overall Composite Burn Index (CBI) scores < 1, indicating low severity fires. Understory CBI scores were consistently higher compared to overstory CBI scores on all units. This suggests that these prescribed fire applications were successful in maintaining relatively cool, ground fires while minimizing large tree mortality due to crown fire.

Numerical Responses of Birds to Prescribed Fire

Prescribed fires at all units in the Northwest and partial units in the Southwest were conducted during spring breeding season, which may have caused direct mortality to nestlings and fledglings. However, direct effects of prescribed burning on songbird population numbers appeared to be short-term. In both regions, nearly half of the species monitored (19 species in the NW; 18 species in the SW) showed a numerical response (both positive and negative) during the year of treatments compared to about a third in the year following treatments. While this suggests short-term effects of prescribed fire on birds, additionally years of monitoring are needed to fully understand the temporal effects of fire on bird populations. Longer-term monitoring is particularly important for the species that showed no response during the year of fire treatments (migrants Red-breasted Nuthatch, Gray Flycatcher, and Townsend's Solitaire) but their densities declined in response to fire one year after treatment. More Neotropical migrants responded negatively to fire compared to resident species, which generally responded postively or neutrally to fire treatments.

We also calculated nesting densities of cavity-nesting birds before and after fire treatments in both regions. In the NW, we observed nesting by black-backed woodpeckers and three-toed woodpeckers in locations that were not used by these species until after burning treatments. Post-fire nesting by these two species is an ecologically significant finding because both are designated as Sensitive Species by state and federal agencies and they are strongly associated with fire-maintained habitats.

Consistencies for species occurring in both regions whose population and nest densities increased after fire treatments were Hairy Woodpecker (Management Indicator Species), Northern Flicker, and Western Bluebird, all of whom are cavity-nesting birds. Yellow-rumped Warbler (Neotropical migrant) was the only species occurring in both regions whose densities consistently declined after prescribed fire treatments. Foliage insectivores were the only foraging guild that did not contain species responding positively to the burns. All bark insectivores responded positively or neutrally to fire in the year of the burn.

Nest Survival Responses to Prescribed Fire

An analysis of nest survival was conducted for the three most common species Hairy Woodpeckers, Northern Flickers, and Western Bluebirds. Nest survival estimates for all three species on control and treatments before and after burning overlapped considerably. Results from the Northwest indicated little or no effect of prescribed fire on nest survival of these species. In the Southwest, nest survival for both Northern Flickers and Hairy Woodpeckers declined on the controls while nest survival increased on the treatments after prescribed fire, suggesting a positive effect of prescribed fire. However, confidence limits for survival estimates overlapped. Nest survival of Western Bluebirds declined on both treatments and controls between the pre and postfire periods. The decline was greater on treatment units but confidence limits overlapped for all estimates, indicating no statistically significant differences.

Nest Numbers in relation to Different Fire Conditions

At our Northwest study areas, we report on nesting numbers of four species (Black-backed, White-headed, Hairy, and Lewis's woodpeckers) that have been designated as Management Indicator Species and Sensitive Species in three different forest conditions (wildfire burned, unburned, prescribed burned). Nesting numbers of White-headed Woodpecker were relatively low under all forest conditions but their highest numbers were in the unlogged wildfire locations of Idaho and Oregon. Black-backed Woodpecker nesting numbers were clearly highest at the unlogged wildfire locations. This species was not found nesting on unburned units in Idaho, Washington, or Montana, two were found nesting in unburned forests of Oregon, and five were found nesting on units in Idaho and Washington treated with prescribed fire. Hairy Woodpeckers, unlike Black-backed Woodpeckers, were found nesting on unburned controls in Idaho, Washington, Oregon, and Montana but their highest numbers were also found in the unlogged wildfire units. Lewis's woodpeckers were relatively rare at all locations except the partially-salvaged logged wildfire units in Idaho.

Conclusions and Management Implications

- In response to prescribed burning, some bird species showed increases in densities, while others decreased. In general, densities of foliage gleaning species responded negatively, while bark insectivores and cavity nesters showed positive responses.
- Neotropical migrants responded in varying ways to prescribed fire, according to species. Most responses—both positive and negative—were detected during the year of burning treatments. Because fewer species responded one year after treatments, this suggests that responses were short-term. Longer-term monitoring is needed to better understand response time of migrants.
- With our prescribed burn treatment, down wood was significantly reduced. Retaining these structures may require conducting prescribed burns at times when moisture contents are higher.
- Rather than solely destroying snags, we found that prescribed burn treatments also recruited snags of all sizes.
- We suggest that protecting nest trees from fire is labor-intensive and likely cost-prohibitive for large-scale prescribed fire programs.
- Nest survival estimates for cavity-nesting birds before and after prescribed fire showed little change; however, nest survival of Northern Flicker and Hairy Woodpecker appeared to increase in response to prescribed fire treatments in the Southwest.
- Nesting numbers of MIS and Sensitive Species in the Northwest were generally highest in recently burned forests affected by wildfire, followed by forests treated with prescribed fire and lastly in unburned forests.
- Fuels managers play a role in affecting wildlife habitat. Treatments implemented by fuel managers can result in positive or negative effects on habitats and populations of birds.

Deliverables

Proposed	***Accomplished/Status***
Annual Progress Reports, Digital Photographs, & Data summaries posted on our Birds and Burns Network Website.	Completed: Annual Progress Reports, posted photographs and data summaries on our project website, http://www.rmrs.nau.edu/lab/4251/birdsnburns/
Instructions for surveying and monitoring cavity-nesting birds and their habitats before and after prescribed fire and in stand-replacing burns	Completed: Dudley, J. G., V. A. Saab 2003. A field protocol to monitor cavity-nesting birds. Res.Pap.RMRS-RP-44. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Research Station.16 p.
"Birds in Burns" color leaflet and companion poster	In Preparation, collaborating with PNW publications/communications staff Jamie Barbour, Rachel White, and Cindy Miner to produce a PNW GTR to be printed in October 2006: Saab, V. and W. Block. 2006. Birds and Burns of the Interior West: Descriptions, Habitats, and management in western forests. USDA Forest Service, PNW-GTR.
Peer-reviewed publications	Completed: • Bock, C., and W. Block. 2005. Fire and birds in the southwestern United States. Studies in Avian Biology 30:14-32. • Saab, V. A., and H. Powell (eds.). 2005. Fire and avian ecology in North America. Studies in Avian Biology No. 30:1-193. • Saab, V. A., H.D.W. Powell, N.B. Kotliar, and K.R. Newlon. 2005. Variation in fire regimes of the Rocky Mountains: implications for avian communities and fire management. Studies in Avian Biology 30: 76-96. • Saab, V. A. and H.D.W. Powell. 2005. Fire and Avian Ecology in North America: Process influencing pattern. Studies in Avian Biology 30: 1-13. In Review: • Saab, V.A., R. Russell, and J. Dudley. *In review*. Nest densities of cavity-nesting birds

	in relation to post-fire salvage logging and time since fire. Condor.
General Technical Reports and other non-peer-reviewed publications	<u>Completed</u>: • Bock, C., and W. Block. 2005. Response of birds to fire in the American Southwest. Proceedings of Third International Partners in Flight Conference, Asilomar, California, on 23 March 2002, Ralph, Rich and Long (editors). USDA Forest Service Gen. Tech. Rep. PSW-GTR-191. • Dickson, B. G., W. M. Block, and T. D. Sisk. 2004. Conceptual framework for studying the effects of fuels treatments on avian communities in ponderosa pine forests of northern Arizona. Pages 193-200 *in* Proceedings of the 6^{th} Biennial Conference of Research on the Colorado Plateau, Flagstaff, AZ. • Jentsch, S. A. 2005. Associations among breeding birds and characteristics of gambel oak in ponderosa pine forests. M.S., thesis, University of Arizona, Tucson. • Saab, V., N. Kotliar, and W. Block. 2005. Relationships of fire ecology and avian communities in North America. Pages 1083-1085 *In* Proceedings of Third International Partners in Flight Conference, Asilomar, California, on 23 March 2002, Ralph, Rich and Long (editors). USDA Forest Service Gen. Tech. Rep. PSW-GTR-191. <u>In Press</u>: • Saab, V., L. Bate, J. Lehmkuhl, B. Dickson, S. Story, S. Jentsch, and W. Block. *In press*. Changes in downed wood and forest structure after prescribed fire in ponderosa pine forests. In: Proceedings of the 1^{st} Fire Behavior and Fuels Conference: Fuels Management-How to Measure Success, USDA RMRS-Proceedings, sponsored by the International Association of Wildland Fire, 28-30 March 2006, Portland, OR.

Presentations at scientific conferences	• Block, W. M., and T. D. Sisk. 2002. (*Invited*) Understanding fire effects on wildlife: where do we go from here? Fire Conference 2002: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern United States, 2-5 December, 2002; San Diego, CA. • Block, W.M., B. E Strohmeyer, J. K. Dwyer, K. A., Covert, K.A, and L. Doll. 2003. Fire effects on ponderosa pine birds in the American Southwest: Are they going up in smoke? 3rd International Wildlife Management Congress, Christchurch, New Zealand • Block, W.M., B. E Strohmeyer, J. K. Dwyer, K. A., Covert, K.A, and L. Doll. 2005. Fire effects on ponderosa pine birds in the American Southwest: Are they going up in smoke? 12th Annual Meeting of The Wildlife Society, Madison, WI. • Bock, C., and W. Block. 2002. Effects of fire on birds in southwestern ecosystems. Third International Partners in Flight Meeting, Asilomar, California, 20-24 March 2002. • Dickson, B. G., H. M. Hampton, J. W. Prather, and T. D. Sisk. 2003. Modeling the effects of prescribed fire treatments as a forest restoration alternative: a landscape-level approach. Southwest Fire Initiative Conference, Flagstaff, AZ. • Dickson, B. G., J. Prather, Y. Xu, S. Jentsch, H. Hampton. W. Block, T. Sisk. 2004. Modeling multi-scale patterns of avian species occurrence: implications for fuels management and restoration treatments in the Southwest. 6th Biennial Conf. of Research on the Colorado Plateau, Flagstaff, Arizona. • Prather, J. W., T. D. Sisk , Y. Xu, H. M. Hampton, S. S. Rosenstock, B. G. Dickson,

	K. Griffis-Kyle, W. M. Block, and C. L. Chambers. 2005. Modeling the influence of forest structure and composition on avian communities in northern Arizona ponderosa pine forests. 123rd meeting of the American Ornithologists Union. Santa Barbara, CA, August 23-27. • Reed, S., and D. Huebner. 2005. A cavity viewer for small budgets: a cheaper peeper? The 38th Joint Annual Conference, AZ and NM Chapters, The Wildlife Society, AZ and NM Chapter, American Fisheries Society, Gallup, NM. • Russell, R. E., V. A. Saab, W. M. Block, J.F.Lehmkuhl, S.Story, B.G. Dickson, and S. Jentsch. 2005. Role of prescribed fire in maintaining breeding bird diversity in ponderosa pine forests of the western United States. Ecological Society of America (90th Annual Meeting) and the IX International Congress of Ecology, 7-12 August 2005, Montreal, Quebec, Canada. • Saab, V. A., N. B. Kotliar, and W. M. Block. 2002. How processes influence pattern: fire and avian communities in North America. Third International Partners in Flight Meeting, Asilomar, California, 20-24 March 2002. • Story, S., V. Saab, and A. Hansen. Nest survival of two woodpecker species in ponderosa pine forests: Does survival vary with location? Meeting of the Northwest Section of The Wildlife Society, Boise, Idaho, 7-10 March 2006.
Thesis and Dissertation In Progress	<u>To be completed by August 2006</u>: • Dickson, B. 2006. Influence of prescribed fire on patterns of occupancy by birds and invasive plants. Ph.D. Dissertation, Colorado State University, Fort Collins. • Story, S. 2006. Nest-site selection and

	nest survival of two primary cavity-nesting birds in ponderosa-pine dominated forests. M.S. thesis, Montana State University, Bozeman.
Planned future journal publications	Planned Future publications: • Block, W. M. Associations between fire severity and populations of breeding and nonbreeding birds following wildfire in ponderosa pine forests. • Block, W. M. Population viability of secondary cavity-nesting birds following wildfire: implications for pre-fire management. • Jentsch, S. A., W. Block, and W. Mannan. Effects of prescribed fire on use of gambel oak by birds in pine-oak forests of the American Southwest. • Pope, T., and W. Block. Effects of prescribed fire on wintering populations of bark-foraging birds in ponderosa pine forests of northern Arizona. • Russell, R. V. Saab, J. Lehmkuhl, W. Block, B. Dickson, and others. Influence of prescribed fire and habitat characteristics on songbird densities in ponderosa pine forests. • Saab, V., R. Russell, J. Rotella, J. Lehmkuhl, W. Block and others. Influence of prescribed fire on nest survival of cavity-nesting birds. • Saab, V., R. Russell, J. Lehmkuhl, W. Block and others. Nest site selection in relation to fire on multiple spatial scales.
Workshop on using the monitoring and evaluation protocols developed for birds and their habitat	Completed: Workshops were conducted annually in February 2002-2006, in cooperation with fuels specialists and fire management officers, to modify and improve methods for measuring changes in fuels and bird populations in relation to prescribed fire.

Evaluation of the ecological trade-offs among different fire management practices in the context of NEPA and NFMA	In progress: See Birds and Burns Leaflet listed above.
CD-ROM Interpretive Exhibit - Interactive, guided virtual tour of our study locations using new types of multimedia (e.g., real - time panoramas).	Not completed or planned: This was proposed by a co-investigator that withdrew from the project.

Lessons Learned

We originally intended to use data from locations in eight western states to evaluate the effects of prescribed fire on fuels, vegetation, and bird populations. Prescribed fires were planned at all locations but only implemented in four states (Washington, Idaho, Arizona, and New Mexico) because of weather and logistical constraints. Our conclusions could have been stronger and results applied over a broader area had the other fire treatments been completed.

One of our original objectives was to use remote sensing before and after fire to model woodpecker nest locations, habitat, and burn severity, followed by validation with field-collected data. We quickly learned that investigators and collaborators did not have the remote sensing expertise to complete this objective. However, we are pursuing this objective with new collaborators.

The Before-After-Control-Impact design was vital for determining the effects of a treatment. Without "before" data, any differences between treatment and control plots would have been attributed to the treatment, even though these differences may have existed prior to any treatments. Without "control" data, any differences due to changes in year would also be attributed to treatments. For example, if treatments were conducted in a very dry year and songbird densities were low everywhere, the drop in densities would be attributable to the treatments if no data had been collected on control plots. With control data, the temporal change can be documented and incorporated into the analyses.

One of our biggest challenges was coordination of the research across eight states. Replication of field methods, standardized protocols, and data entry were very challenging to implement at all locations. Data management was and continues to be very time- and labor-intensive.

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INTRODUCTION

Purpose and Need

Fire has been an important ecological process in shaping vegetation structure, landscape patterns, and animal distributions of the Intermountain West. In systems adapted to high-frequency/low-severity fire regimes [e.g., ponderosa pine (*Pinus ponderosa*)/ Douglas-fir (*Pseudotsuga menziesii*)], the past 60-70 years of fire suppression has contributed to high fuel loads, increased stand density, insect outbreaks, and disease, thereby increasing the risk of severe wildfires (e.g., Arno et al. 1995). The USDA Forest Service estimates that over 40 million acres of ponderosa pine are susceptible to uncharacteristic fires (i.e., listed as fire regimes 1, 2 and condition classes 2, 3 in Cohesive Strategies; Laverty and Williams 2000), including communities in the wildland urban interface. Disruptions of natural fire regimes have not only led to increased expenditures by governmental agencies for land rehabilitation costs (USDA-FS and USDI-BLM 1997), but have affected animal populations and their habitats (e.g., Huff and Smith 2000, Saab et al. 2005). Land management agencies are using primarily low-severity prescribed fire and thinning to reduce the risk of severe fires and restore low elevation, dry forest ecosystems throughout the Intermountain West. Many of these fuel reduction plans focus on reducing hazards of wildfire with little consideration given to effects on wildlife populations and their habitats (McMahon and deCalesta 1990, Tiedemann et al. 2000). Additionally, a paucity of scientific information prevents managers from adequately predicting the environmental effects of different fire management activities on bird communities and their habitats. This presents significant legal, scientific, and social ramifications for land management agencies attempting to implement national fire programs. Specifically, effects on bird species such as Mexican spotted owl, northern goshawk, and black-backed woodpecker have been included in appeals and litigation claiming violations of requirements under the Endangered Species Act and National Forest Management Act. In addition, effects on migratory bird species have been incorporated into litigation declaring violations of the Migratory Bird Treaty Act. Essential information has been lacking about the effects of fire management on the long-term persistence of Sensitive Species of cavity-nesting birds that inhabit ponderosa pine ecosystems. Thus, planning and implementation of fire management programs require an improved understanding of fire effects on sensitive wildlife species.

Project Description

In 2002, we began a regional study to evaluate the effectiveness of prescribed fire in reducing fuels, and to assess the effects of fuel reduction on habitats and populations of birds in ponderosa pine forests throughout the Interior West. Known as the Birds and Burns Network, we have study areas located in seven states encompassing much of the range of ponderosa pine in the United States (Arizona, Colorado, Idaho, Montana, New Mexico, Oregon, and Washington). As of 2005, study areas in Arizona and New Mexico (Southwest region; SW), and Idaho and Washington (Northwest region; NW) have received prescribed fire treatments. At these locations, we analyzed changes in downed wood, forest structure (trees and snags), and bird populations measured within one year after fire treatments.

Goals and Objectives

The overall goal of our project is to understand the ecological consequences of fire management activities for avifauna and their habitats in ponderosa pine forests across the Intermountain West.

Our primary objectives are: (1) Quantify population responses of birds to changes in fuels and other vegetation after prescribed fire; (2) Examine and quantify the effectiveness of prescribed fire in reducing fuels and changing forest structure; (3) Evaluate which fire conditions (exclusion or prescribed) are favored habitats for local populations of sensitive bird species; and (4) Determine the ecological trade-offs by calculating nest survival and other demographic characteristics for selected wildlife species of managing for different fire conditions (wildland fire vs. prescribed fire vs. fire exclusion) by using additional data from our ongoing studies of wildland fire effects on habitats and populations of cavity-nesting birds.

STUDY AREAS AND DESIGN

Selection of Study Areas and General Study Design for Prescribed Fire Sites

We began our prescribed fire studies in 2002 (Birds and Burns Network, see http://www.rmrs.nau.edu/lab/4251/birdsnburns/) by selecting paired sampling units (one treatment, one control) at 10 locations in 7 western states (Fig. 1). Study areas were located in forests dominated by ponderosa pine, where prescribed fire treatments were implemented by the USDA National Forests. One to three sets of paired sampling units, each 250-400 ha, were selected at every forest location, for a total of 16 treatment and control pairs. Each unit in a pair was selected on the basis of similar vegetation, topography, and elevation to control for differences attributable to those variables.

Within each unit we characterized fuels and other vegetation, located and monitored nests of cavity-nesting birds (woodpeckers, bluebirds, and nuthatches), and estimated the density and species composition of songbirds using distance sampling techniques. Data were collected for at least one year prior to prescribe burning and for one-to-two years after burning treatments.

Within each 250-400 ha unit we established 20 to 40 permanently marked 0.04 ha random plots to measure fuels, vegetative characteristics, and to conduct songbird point count surveys. All plots centers were at least 250 m apart (Dudley and Saab 2003). To determine the effects of prescribed fire, we estimated fuels, vegetation, and songbird densities at each plot before (pre) and after (post) prescribed fire. We considered the difference in pre and post values by plot to be a measure of the treatment effect size.

We planned our study to reflect the Before, After, Control, Impact (BACI) design with replication (Osenberg et al. 1994). BACI requires data collection on control and treatment units both before and after treatment application. As of 2005, prescribed fire treatments were completed at seven study units in four states and data from these units were used for the analyses in this report. General objectives of these "low-intensity" fire treatments included fuels reduction, fire threat mitigation, and forest restoration.

Pre-treatment data were collected during the summers of 2002 and 2003. Four units were treated with fire in the SW on USDA National Forests (NF); two units during fall 2003 in Arizona (Apache-Sitgreaves and Coconino NFs), and two units that were initiated in fall 2003 and completed during spring 2004 in New Mexico and Arizona (Gila and Kaibab NFs, respectively). Three units were treated in the NW during spring 2004, one unit in Idaho (Payette NF) and two units in Washington (Okanogan and Wenatchee NFs). In 2005, one unit was treated in Washington.

Selection of Study Areas and General Study Design for Wildfire Sites

Two wildfire sites were used as comparisons for prescribed fire locations. One site was located on the Fremont-Winema National Forest of south-central Oregon and two wildfire sites were located in southwestern Idaho. In 2002, the Toolbox and Silver Fires in Oregon burned approximately 34,398 hectares at elevation ranges from 1,500 to 1,800 meters. Both fires were mixed-severity, stand-replacement burns that consumed the forest in a non-uniform pattern across the landscape. Resulting forest areas were characterized by patches of completely charred trees next to relatively green, unburned woodland. Post-fire salvage logging took place on approximately one-third of the sites in 2004, and data were collected on treated and untreated sites in 2005. These sites were logged with a retention of 25 snags/hectare of various diameters. Logged control replicates were paired based upon size, pre-fire canopy closure, vegetation mortality, and cover type, respectively.

In Idaho, a mixed-severity, stand replacing fire created the Foothills Burn (89, 159 ha) in August 1992, where most standing trees were dead (i.e., snags). In August 1994, the Star Gulch Burn (12, 467 ha) was created by a patchy moderate-severity fire that resulted in a greater interspersion of burned and unburned forest. Post-fire salvage logging removed approximately half the snags over 23 cm in diameter at breast height (dbh) at the Foothills Burn (Saab et al. 2004).

Study Area Descriptions

Prescribed Fire sites

Overstory vegetation (trees ≥ 9 inches d.b.h.) on all units in both regions was dominated by ponderosa pine. For trees ≥ 20 inch d.b.h. or larger, ponderosa pine was also the dominant tree species for all locations except for the Gila NF, where alligatorbark juniper (*Juniperus deppeana*) had higher densities.

In Arizona, common understory vegetation included green rabbitbrush (*Chrysothamnus viscidiflorus*) and Fendler rose (*Rosa woodsii*), whereas gambel oak dominated the understory in New Mexico. Arizona fescue (*Festuca arizonica*) and blue gramma (*Bouteloua gracilis*) were the most common grass species throughout the SW. Elevations in the SW region ranged from 6800 feet on the Coconino NF to nearly 8200 feet on the Gila NF.

The understory vegetation in the NW was comprised of various species, including snowberry (*Symphoricarpos albus)*, spirea (*Spirea* spp.), serviceberry (*Amelanchier alnifolia*), and chokecherry (*Prunus spp*.). Bluebunch wheatgrass (*Pseudoroegenaria spicatus*) and Idaho Fescue (*Festuca idahoensis*) were the common grass species. Elevations ranged from 2,200 feet in Washington to 6,500 feet in Idaho.

Wildfire sites

Dominant tree species in the study area consist of ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), and white fire (*Abies concolor*). Ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) dominated the pre-fire canopy at both sites. Other tree species interspersed among the dominant vegetation included quaking aspen, (*Populus tremuloides*), subalpine fir (*Abies lasiocarpa*), and willow (*Salix* spp.). Large open areas of shrubs (e.g. *Artemesia* spp., ninebark [*Physocarupus malvaceus*], and ceanothus [*Ceanothus velutinus*]) were often distributed among the patches of trees and snags (Johnson et al. 2000, Saab et al. 2004).

EFFECT OF PRESCRIBED FIRE ON FUELS, FOREST STRUCTURE, BURN SEVERITY

(also see deliverables – "Changes in downed wood and forest structure after prescribed fire in ponderosa pine forests")

General Vegetation Methods:

We used the same plot design at all nest tree locations and centered the sampling plot on the nest tree. All measurements were nested within the 0.4 hectare plot configured as two 20 x 100 m rectangles that crossed in the center (Figure 2). Plot sizes varied depending on the relative abundance of the habitat component. For example, snags which were relatively rare on most of our landscapes had the largest plot size (0.4 hectares). By contrast, small trees which were relatively abundant had the smallest plot size (0.02 hectares).

Burn Severity

Methods

To measure burn severity for each of seven units treated with prescribed fire, we calculated a Composite Burn Index (CBI) (Key and Benson 2006). The CBI score generated for the Birds and Burns Network indicates the magnitude of fire effects across each unit. The overall score was based on averaged measurements of weight reductions of downed wood, changes in density or percent cover of vegetation, and scorching of tree boles and canopies in the 20-40, 0.4 ha plots within each treated unit. In addition, we recorded char classes of several substrate components at every plot. Our methods were modified from the field sampling portion of the Key and Benson (2006) protocol, which calculates a burn severity index for multiple variables measured in the field. All post-treatment measurements were completed within one year after prescribed fire and we used 18 variables to derive an overall CBI score (Table 2).

Our CBI values for most variables were scored on a scale from 0.0 to 3.0, representing a range of no burn severity to high burn severity (Table 2). These CBI values were based on the scale defined by Key and Benson (2006), with some modifications. Some variables, such as litter char, had only two possible scores (Table 2). Variables with a positive change were assigned to the "no effect", or "0" category. For example, occasionally we observed an increase in shrub cover although we expected shrubs to decrease after fire treatments. Generally shrubs decreased, but some plots did not receive fire or fire effects were minimal. In these cases the plot was assigned to the "no effect" category.

We assigned burn severity scoring based on the percent change of various vegetation measurements (Key and Benson 2006). For example, Key and Benson (2006) suggested that a 10 percent loss in large down wood indicates a low burn severity with a severity value of 1.0. For a 25 percent loss, their severity scoring is 2.0. In our scoring, we used the same divisions for burn severity values when they were defined (Table 2). For variables where divisions were not defined by Key and Benson (2006), we chose the midpoint value for the score. Using large down wood as an example, we assigned the division of a 17.5 percent loss to represent a burn severity value of 1.5 because it was not previously defined.

We calculated CBI scores in three categories: 1) understory; 2) overstory, and 3) overall for each unit. Understory scores were based on changes in ground char and substrates, including downed wood, herbs, shrubs, and small trees. Overstory scores were based on changes in medium and large tree densities, tree crown scorch, and tree char height. The overall CBI score was based on the mean values of all 18 variables at each plot within each unit.

Results and Discussion

Burn severity as a result of prescribed fire was generally low on all study units. Most units had overall CBI scores < 1, indicating low severity fires (Table 3). Only the Gila had an overall score above 1 (CBI = 1.19). A CBI score of 1.3 is considered the midpoint between low and moderate burn severity, whereas a CBI score of 2.3 is considered the midpoint between moderate and high severity. Scores ≤ 0.4 are representative of unburned areas or fires with no effect. This score reflected large reductions in smaller trees and downed wood (Table 4). By contrast, the Coconino had the lowest overall CBI score (CBI = 0.5). This was consistent with the few changes observed in the vegetation data (Table 4). Other units had CBI scores at the high end (≥ 0.78) of the low burn severity scale. On a regional level, we observed less variability in the NW (range = 0.85 - 0.97) compared to the SW (range = 0.5 - 1.19).

Understory CBI scores were consistently higher compared to overstory CBI scores on all units (Table 3). This suggests that these prescribed fire applications were successful in maintaining relatively cool, ground fires while minimizing large tree mortality due to crown fire. Understory CBI scores ranged from a high of 1.18 on the Gila to a low of 0.46 on the Coconino. The Gila had moderate (1.5 or 2.0) scoring for more than half of its variables, whereas the Coconino only had one moderate score (Table 4). In the NW, reductions in the weight of large (≥ 23 cm large end diameter) downed wood contributed most to the understory CBI scores (Table 4). Reductions of > 40% in weight of large downed wood were considered severe and assigned a high burn severity value (Table 1). Likewise, reductions of medium-sized downed wood and small trees were assigned moderate burn severity scores.

Overstory CBI scores ranged from a high of 0.98 on the Gila to a low of 0.38 on the Coconino (Table 3). The Payette also had a low CBI score for overstory (0.47), although the understory index was relatively high at 0.9. Taller tree heights could have affected the overstory CBI score on the Payette, where the height of old-growth ponderosa pine trees averaged more than 26 meters. This compares to an average height of 16.5 meters on other units combined. Many of the Payette tree crowns may have been beyond the reach of the flames produced by prescribed fire.

EFFECT OF FIRE ON AVIAN POPULATIONS

(also see deliverables – “A field protocol to monitor cavity-nesting birds”; “Fire and Avian Ecology in North America”; and “Birds and Burns of the Interior West: descriptions, habitats, and management in western forests”)

Methods
Nest searching and monitoring

We systematically searched 200-m wide belt transects throughout study units for evidence of nesting activity by cavity- nesting birds, by documenting the location of territorial behavior, and returning to the location until a nest was verified (Dudley and Saab 2003). Belt transects were parallel to each other and averaged 1 km in length with some variation depending on the size of study units. Nests were monitored every 3 to 4 days to record the stage of the nest (laying, incubating, nestling, fledgling), evidence of predation, age and number of young, ultimate success or failure of nest, and number of young fledged per successful nest. Information regarding the length of each nesting stage was used to estimate an initiation date for the nest. We used bird behavioral cues to determine nest status and when possible, a treetop-peeper (video camera) to aid in nest monitoring (Dudley and Saab 2003).

Songbird densities and species composition

Density and species composition of the songbird community were estimated using the variable circular plot (VCP) method (Buckland et al. 2001, Buckland et al. 2004). VCP was conducted by estimating the distance between the observer and the location of a bird. Birds were identified occasionally by sight and primarily by sounds (calls and songs). For this reason, VCPs are ineffectual sampling techniques for species such as woodpeckers that do not vocalize frequently (Martin and Eadie 1999, Saab et al. 2005). VCPs are most effective at estimating densities of songbirds that consistently sing throughout the breeding season; therefore, estimating these species' densities was the focus of our point count sampling.

Within each sampling unit, we selected 20 stratified random stations from which to conduct 100-m radius point counts to estimate songbird densities (Buckland et al. 2001, USDA Forest Service 2004). Locations of point count stations were stratified by crown closure into two categories: open canopy (≥ 35% crown closure) and closed canopy (≥ 35% crown closure). The number of closed and open point count stations was proportional to the amount of closed and open habitat available in the sampling unit. Additionally, VCPs were located at least 250 m from each other and 200 m from the edge of the unit. Point counts were conducted between 22 May and 3 July, starting just after the dawn chorus and ending no more than 5 hours later. At each point, the observer stood in the center of the location and recorded the species and distance from observer of all birds seen or heard within a five minute time period.

Birds were grouped into distance categories of 0-10 m, >10-25 m, >25-50 m, >50-75 m, and 75-100 m. Observers were trained to estimate distances, identify species accurately, and avoid double counting birds by initially conducting point counts in pairs and comparing results between observers. When possible, laser range finders were used to assist with accurate distance measurements. Each station was visited two to four times over the sampling period and data from all visits to a station were averaged within Program Distance (Thomas et al. 2004).

Calculation of Effect Size

Effect size was calculated by subtracting the difference between the control and treatment unit prior to treatment from the difference between the control and treatment unit after treatment, which is equivalent to asking "What is the effect size of the treatment once you subtract the differences between the control and treatment unit that existed prior to treatment?". An alternative calculation for effect size can be arrived at by subtracting the difference in the control unit the year before the treatment and the year after the treatment, to the difference in the treatment unit before and after treatment. This is asking "What is the effect size of the treatment once you subtract the difference attributable to the change in year (i.e. the difference on the control site)?" These two methods produce equivalent results.

Analyses
See Table 5
Prescribed Fire Results
Nest Densities
Few statistically significant changes were detected in nest densities on treated units when compared to pre-treatment units, although biologically significant changes were observed. No western bluebirds nests were located either pre or post treatment in Idaho, however statistically significant increases in nest densities were detected for this species in Washington (Table 6a). Although not statistically significant, Black-backed and Three-toed Woodpeckers were found nesting on units that were previously not occupied by these species prior to prescribed fire treatments (Table 6a) (See Appendix A for list of species names). One year after prescribed fire in 2005, three Black-backed and three Three-toed Woodpecker nests were found on the treated unit in Idaho (Parks Creek), and two Black-backed Woodpecker nests were on the treated units in Washington (one each on the Finley and Mills Flat units). Densities of red-naped sapsucker decreased after treatments in the NW. These decreases, however, were not statistically significant. Other species (Hairy Woodpecker, Northern Flicker, Pileated Woodpecker, and Williamson's Sapsucker) showed mixed responses.

In the SW region during the year of burning, non-statistically significant increases in nest densities were observed in Brown Creeper, Hairy Woodpecker, and Northern Flicker (Table 6b). A negative response to prescribed fire was observed for Pygmy Nuthatch, Violet-green Swallow, and Western Bluebird during the year of burning, whereas Mountain Chickadee and White-breasted Nuthatch showed mixed responses.

We observed consistent positive responses in nest densities between the year of burning and one year after burning for Brown Creeper and Northern Flicker, and consistent negative responses for Pygmy Nuthatch and Violet Green Swallow. Species whose responses changed between the year of burning and one year of after burning were Hairy Woodpecker (mixed), Mountain Chickadee (negative), and Western Bluebird (positive). However, none of these changes were statistically significant.

Songbird Densities
NW Songbird Densities
Migratory Status: Nearly half of all species (9 of 19) responded to prescribed fire during the year of burning, versus about a third (7 of 19) in the year following treatments (Table 7a and Table 8a). The three resident species included in this analysis responded either positively or neutrally in both years postfire. About equal percentages of Neotropical migrants responded positively (32%) and negatively (31%) over the two breeding seasons. Western Bluebird populations experienced the largest positive change in densities attributable to burning during the year of treatment (Fig. 2,Appendix B). Other migrants responding positively included the

Northern Flicker (non-songbird), Dusky Flycatcher (positive responses in both seasons), Gray Flycatcher, American Robin, and Brown-Headed Cowbird. Migrants responding negatively included Hammond’s Flycatcher, Red-breasted Nuthatch, Townsend’s Solitaire, Yellow-rumped Warbler (negative responses in both seasons), and Pine Siskin (Table 7a, Fig. 3 and 4, Appendix B). Yellow-rumped Warblers had the largest negative change in density attributable to the burn of any species (Appendix B, Fig 3.).

Several species had responses to the treatments that changed from the year of burning to one year after burning; most notable were the migrants Red-breasted Nuthatch and Townsend’s Solitaire. These species responded negatively in the year after the fire but not in the year of the fire. These results may be due to the difference in the data set between the year of (4 units included) and the year after the burn (3 units included).

Guild responses: Foliage insectivores were the only foraging guild that did not contain species responding positively to the burns. All bark insectivores responded positively or neutrally to fire in the year of the burn. Aerial insectivores had mixed responses to burning but overall more positively than negatively. Open-cup, canopy nesters were the only nest type/nest layer guild to contain species (Hammond’s Flycatcher, Yellow-rumped Warbler, Pine Siskin) that responded negatively to fire in the year of the burn (Table 7a., and Table 8a). Only one cavity-nesting species (Red-breasted Nuthatch) and one ground-nesting species (Townsend’s Solitaire) responded negatively to prescribed fire in either year.

Observations of the two squirrel species (*Tamiasciurus hudsonicus* and *T. douglasii*) were combined for our analyses. We detected a statistically significant negative response by these squirrel species in Washington and Idaho in the year after the burn.

SW Songbird Densities

Migratory status: We detected statistically significant changes in songbird densities for nearly half of the 18 species (8 of 18) during the year of the prescribed fire treatments versus less than a third (5 of 18) in the year following treatments (Table 7b. and Table 8b.). All resident species (5 of 6) except Pygmy Nuthatches responded positively or neutrally to prescribed fire in both years (Table 7b and 8b). Pygmy Nuthatches responded negatively in the year of the prescribed fire but not the year after. A greater percentage of Neotropical migrants responded negatively (31%; Gray Flycatcher, Grace’s Warbler, Yellow-rumped Warbler, and Brown-headed Cowbird) than positively (15%; Northern Flicker and Western Bluebird) over the two breeding seasons after burning in the SW. Grace’s and Yellow Warblers both had negative responses during the year of the treatments but a neutral response in the year after burning.

Guild responses: Most cavity-nesting species (Hairy Woodpecker, Northern Flicker, Western Bluebird) responded positively (Table 7b, Table 8b). Species nesting in the canopy layer were the only nest layer guild to contain species responding positively to prescribed fire (Hairy Woodpecker, Western Bluebird, Northern Flicker, and Steller’s Jay) (Table 7b, Table 8b). We detected no statistically significant changes for shrub- and ground-nesting species. As in the NW, foliage insectivores responded either negatively or neutrally to the prescribed fire, whereas aerial insectivores in the SW responded positively or neutrally.

NW and SW Species

Species with consistent positive responses in both regions were Western Bluebird, Northern Flicker, and Hairy Woodpecker, all of whom are cavity-nesting birds (Table 7, Table 8, Fig. 3). Yellow-rumped Warbler was the only species occurring in both regions whose densities consistently declined after prescribed fire treatments. Two species (Gray Flycatcher and Brown-headed Cowbird) that occurred in both regions had densities that changed in an inconsistent manner. Both of these species had a positive response in the NW and a negative response in the SW. We did not detect any statistically significant changes in Western Tanagers, Chipping Sparrows, Dark-eyed Juncos, or Mountain Chickadees in response to prescribed fire in either region.

Nest Survival

An analysis of nest survival was conducted for the three most common species Hairy Woodpeckers, Northern Flickers, and Western Bluebirds. For units where prescribed fire treatments were completed, daily survival rates (DSR) with 95% confidence limits were calculated for control and treatment locations before and after burning. We estimated overall nest survival (NS) with the following equation $NS= DSR^{days}$, where days equal= the average number of days in a species nesting cycle.

Estimates of nest survival for all three species on control and treatments before and after burning overlapped considerably (Figures 6 and 7). In the Northwest, patterns of nest survival between pre and post fire periods were the same for treatments and controls. Northern Flicker nest survival declined, Hairy Woodpecker survival increased, and Western Bluebird nest survival was constant on both treatments and controls between the pre and post fire periods. These results indicate little or no effect of prescribed fire on nest survival for these species in Washington and Idaho.

In the Southwest, nest survival for both Northern Flickers and Hairy Woodpeckers declined on the controls while nest survival increased on the treatments after prescribed fire, suggesting a positive effect of prescribed fire. However, confidence limits for all estimates overlapped except in cases where nest survival was 100%. Nest survival of Western Bluebirds declined on both treatments and controls between the pre and postfire periods. The decline was greater on treatment units but confidence limits overlapped for all estimates, indicating no statistically significant differences (Figures 6 and 7).

Nest tree characteristics did not change significantly before and after prescribed fire. In the Northwest Hairy Woodpeckers and Northern Flickers tended to nest higher up and in larger trees than Western Bluebirds. In the Southwest, Hairy Woodpeckers nested in the smallest trees, and tended to nest lower after prescribed fire.

Wildfire Results from the Northwest (Nesting Numbers)

At our Northwest study areas, we report on area surveyed for nests and nesting numbers of four species (Black-backed, White-headed, Hairy, and Lewis's woodpeckers) that have been designated as Management Indicator Species and Sensitive Species in three different forest conditions (wildfire burned, unburned, prescribed burned) (Tables 11,12). Area surveyed is reported by year postfire in the wildfire areas and calendar year in the unburned and prescribed burned units. Area surveyed during each year postfire in the wildfire locations averaged 2624 ha ± 611 S.E.. Years postfire in each wildfire represent different calendar years. At the prescribed fire locations an average of 2901 ha ± 887 S.E. of unburned forest were surveyed 2002-2005, while 1056 ± 201 S.E. of burned forest were surveyed in 2004 and 2005 (Table 11).

During the early postfire years (1-4 years after fire) at the wildfire locations, observers averaged 45 hours to nest search 1 km^2 in unlogged units, while it took 14 hours to search the equivalent area in logged units. The difference in the number of hours spent searching is attributable to the differences in snag densities and subsequent number of nests found in unlogged vs. logged units. Survey effort on the unburned and prescribed burned units approximated 10-30 hours of nest searching for 1 km^2.

Nesting numbers of White-headed Woodpecker were relatively low under all forest conditions but their highest numbers were in the unlogged wildfire locations of Idaho and Oregon (Table 12). Black-backed Woodpecker nesting numbers were clearly highest at the unlogged wildfire locations. This species was not found nesting on unburned units in Idaho, Washington, or Montana and only two were found nesting in unburned forests of Oregon, but they were found nesting on units treated with prescribed fire (Table 12). Hairy Woodpeckers, unlike Black-backed Woodpeckers, were found nesting on unburned controls in Idaho, Washington, Oregon, and Montana but their highest numbers were also found in the unlogged wildfire units. Lewis's woodpeckers were relatively rare at all locations except the partially-salvaged logged wildfire units in Idaho.

Discussion

Nest and population densities of most species of resident cavity-nesting birds responded positively to prescribed fire and/or wildfire, with the exception of Pygmy Nuthatches. Two species of cavity-nesting birds (Black-backed Woodpeckers and American Three-toed Woodpeckers) were found nesting in areas that had been recently subjected to fire, either prescribed or wildfire, confirming the close relationship of these species with fire. Prescribed fire effects on migratory birds in both regions were stronger the year of the burn than the year after treatments. These preliminary results suggest that the impact of prescribed fire on migratory birds may be short-term. However, longer-term monitoring will be necessary to determine temporal effects of prescribed fire, particularly for species such as Gray Flycatcher. This species did not have a statistically significant response to fire in the year of the burn in either region, however, in the year after the burn the species responded positively in the NW and negatively in the SW.

Foliage-gleaning insectivores were the only foraging guild that did not contain species with positive responses in population density, while many bark foraging species responded positively postfire. Changes in food availability are the most likely cause of these results. Fire creates standing dead and dying trees that are susceptible to attack by bark (Scolytidae) and wood-boring beetles (Cerambycidae and Buprestidae) (Machmer 2002, Werner 2002), which are the primary food items for many bark foraging species (Machmer and Steeger 1995, Dixon and Saab 2000, Powell et al. 2002). Alternately, elimination of foliage by fire presumably causes declines in insects associated with that foliage, and subsequent losses of food for foliage-gleaning insectivores.

Habitat covariates such as snag and tree densities, amount of downed wood, and percent shrub cover are related to burn severity at the plot-level (Key and Benson 2006). The future inclusion of an actual measure of burn severity as a covariate in models of songbird densities may result in better fitting models and elucidate the relationship between fire and bird presence/absence.

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Table 1. Description of methods used to measure vegetation variables at nest and random plot (see Figure 2) locations in the Birds and Burns Network, 2002-2005.

VARIABLE	MEASUREMENT/CHARACTERISTIC	DESCRIPTION/PLOT SIZES
Overstory Cover	% Upper tree canopy coverage	Mean of four estimates (N, S, E, W) using spherical densiometer averaged across three locations.
Ground Cover	% Herbaceous cover (grass and forbs), % shrub cover (< 1 m (39 inches) height, % bare ground/rock, % litter cover.	Point-intercept method: recorded number of times each component intercepted with a vertically placed dowel at 0.5 m (20 inches) intervals along four transects (each 5-m [16.5 feet]) oriented in the four cardinal directions within three 5-m (4-m radius in NW) radius subplots. A maximum of 40 (SW) or 32 (NW) interceptions were possible within each subplot for each component (James and Shugart 1970).
Shrubs	Total Number of Shrub Stems by Species and Size Class	Complete count of live shrub stems averaged across three 5-m radius subplots (Martin and Geupel 1993) in four size classes: 1) < 2.5 (1 inch); 2) ≤ 2.5-5 (1-2 inch); 3) ≥ 5-8 (2-3.1), and 4) ≥ 8-12 (3.1-5 inches) cm.
Small live trees	Density expressed as stems per hectare (acre). All tree diameters measured with calipers.	Complete count of trees < 23 cm (9 inches) dbh within two 4 m x 100 m (2 m width in NW where stems were more abundant) rectangular plots (Bate et al. 1999) arranged in a cross pattern centered on nest or random tree. Trees tallied in six size classes: 1) 0 to < 2.5 cm (0-1 inch); 2) 2.5 to < 5 cm (1-2 inches; 3) 5 to <8 cm (2-3 inches); 4) 8 to <13 cm (3-5 inches); 5) 13 to <15 cm (5-6 inches); and 6) 15 to < 23 cm (6-9).
Large live trees	Density expressed as stems per hectare (acre). All tree diameters measured with calipers.	Complete count of trees ≥ 23 cm (≥ 9 inches) dbh recorded by species within two 10 m x 100 m rectangular plots (Bate et al. 1999) arranged in a cross pattern centered on nest tree or random point.
	Tree structural class	Structural classes of large (≥ 23 cm [9 inches] dbh) live trees (Bull et al. 1997): **1** = Sound **2** = Some decay evidence (broken top/branch, fungi, fire scars, insect evidence, woodpecker foraging) **3** = Broomed trees **4** = Hollow
	Tree height	Clinometer estimate (0.5 m [20 inches])

Small snags	Density expressed as stems per hectare (acre). All snag diameters measured with calipers.	Complete count of snags < 23 cm (9 inches) dbh within two 4 m x 100 m (13 x 328 feet) rectangular plots (Bate et al. 1999) arranged in a cross pattern centered on nest or random tree (2 m width used in NW where snags more abundant). Snags tallied in six size classes: 1) 0 to < 2.5 cm (0-1 inch); 2) 2.5 to < 5 cm (1-2 inches; 3) 5 to < 8 cm (2-3 inches); 4) 8 to < 13 cm (3-5 inches); 5) 13 to < 15 cm (5-6 inches); and 6) 15-23 cm (6-9 inches).
Large snags	Density expressed as stems per hectare (acre). All snag diameters measured with calipers.	Complete count of snags ≥ 23 cm (9 inches) dbh within two 10 m x 100 m rectangular plots (Bate et al. 1999) arranged in a cross pattern centered on nest or random tree.
	Decay class	Decay classes of large (≥ 23 cm [9 inches] dbh) snags (Bull et al. 1997): **1** = Snags recently dead, typically with little decay, and bark, branches, and top intact. **2** = Snags showing evidence of decay and with some lost bark and branches, and often a portion of the top. **3** = Snags with extensive decay, missing bark and most branches, and with broken top. **4 =** Burned snag; almost entire outer shell case-hardened by fire; looks like charcoal.
	Height	Clinometer estimate (0.5 m [20 inches])
Litter	Litter depth measured in cm (inches)	Brown's planar interest method. Mean litter depth measured down to the bare mineral in three locations along two transects.
Fine downed wood	Weight expressed as metric tons per hectare (tons per acre). Downed wood defined as dead twigs, branches, stems, and boles of trees and brush that have fallen and lie on or above ground (Brown 1974). Fine downed wood is defined as any woody piece with an intersect diameter < 7.6 cm (3 inches).	Brown's (1974) planar intersect method. Downed wood pieces < 2.5 cm (1 inch) diameter (1- and 10-hour fuels) were sampled along 6.25 m (20 feet) of transect in two directions (north and south) from the plot center. Material in ≥ 2.5 cm to 7.6 cm size class (100-hour fuels) measured in the same two directions but along twice the length (12.5 m [41 feet]).
Coarse downed wood	Weight expressed as metric tons per hectare (tons per acre). Coarse downed wood defined as any woody piece with an intersect diameter ≥ 7.6 cm (3 inches).	Brown's (1974) planar intersect method. For coarse wood ≥ 7.6 cm [3 inches] (≥ 1000-hour fuels), recorded intersection diameter of each woody piece along 50 m (164 feet) in each of the four cardinal directions originating from the plot center (total of 200 m (656 feet) sampled). Downed wood pieces ≥ 7.6 (3 inch) were classified as either sound or rotten with specific gravities provided by Brown (1974) to obtain a weight estimate for each condition class.
Large downed wood: density	Density of large logs expressed as logs per hectare (acre). A large log was defined as any log ≥ 23 cm (9 inch) large-end diameter (LED) and ≥ 1 m (39 inches) in length.	Complete counts of large log endpoints within two 4 m x 100 (13 x 328 feet) rectangular plots (Bate et al. 2004) arranged in a cross pattern centered on nest or random tree.

Large downed wood: percent cover	Percent cover of large logs (≥ 23 cm [9 inch] LED). All diameters measured with calipers. Log lengths measured with calipers or logger's tape.	Percent cover of large logs calculated by measuring portion of rectangular plot covered by large logs (≥ 23 cm [9 inch] LED) (Bate et al. 2004).

Table 2. Description of 18 variables used to calculate Composite Burn Index (CBI) and evaluate burn severity for units treated with prescribed fire in the Birds and Burns Network during 2003-2004. Downed wood is categorized by the large end diameter (LED) and trees were measured at diameter breast height (dbh).

	Burn Severity Scale						
	No effect	Low		Moderate		High	
	0.0	0.5	1.0	1.5	2.0	2.5	3.0
Understory variables							
Decrease in percent cover of litter	< 12.5%	12.5 to < 50%	50 to < 75%	75 to < 100%	100	---	---
Litter char classes	Unburned	---	Blackened	---	---	---	---
Increase in percent cover of bare ground and rock	0 to < 2.5	2.5 to < 7.5	7.5 to < 17.5	17.5 to < 40	40 to < 60	60 to < 80	≥ 80
Ground char classes	Unburned		Light char		Moderate char		Deep char
Rock char classes	Unburned	----	Light char	---	Moderate char		
Decrease in weight of fine (<7.6 cm LED) DW[1]	< 16 %	16 to < 32%	32 to < 48%	48 to < 64%	64 to < 80%	80 to < 98%	≥ 98%
Decrease in weight of medium (7.6 to < 23 cm LED) DW	< 5%	5 to < 20%	20 to < 30%	30 to < 40%	40 to < 50%	50 to < 60%	≥ 60%
Decrease in weight of large (≥ 23 cm LED) DW	< 5%	5 to < 10%	10 to < 17.5%	17.5 to < 25%	25 to < 32.5%	32.5 to < 40%	≥ 40%
Large (≥ 23 cm LED) DWM char classes	Unburned		Light char		Moderate char		Deep char
Decrease in percent cover of herbs (forbs and grass)	< 2.5%	2.5 to < 10%	10 to < 30%	30 to < 50%	50 to < 80%	80 to < 100%	100%
Decrease in percent cover of shrubs	< 2.5%	2.5 to < 10%	10 to < 30%	30 to < 50%	50 to < 80%	80 to < 100%	100%
Decrease in small (< 8 cm dbh) tree densities	< 2.5%	2.5 to < 10%	10 to < 30%	30 to < 50%	50 to < 80%	80 to < 100%	100%
Overstory variables							
Decrease in medium (8 to < 23 cm dbh) tree densities	0 %	0.1 to < 10%	10 to < 40%	40 to < 70%	70 to < 85%	85 to < 99%	≥ 99%
Decrease in large (> 23 cm dbh) tree densities	0 %	0.1 to < 10%	10 to < 40%	40 to < 70%	70 to < 85%	85 to < 99%	≥ 99%
Percent of tree canopy green (unaltered)	100%	97.5 to < 100%	95 to < 97.5%	72.5 to < 95%	50 to < 72.5	10 to < 50%	< 10%
Percent of tree canopy black (torch)	0%	1 to < 5%	5 to < 20%	20 to < 40%	40 to < 80%	80 to < 90%	≥ 90%
Percent of tree canopy brown (scorch)	0%	0.1 to < 5%	5 to < 10%	11 to < 30%	30 to < 70%	> 70%	
Mean char height (m) along tree bole	0	0.1 to < 1.8	1.8 to < 2.9	2.9 to < 4	4 to < 5.5	5.5 to < 7	≥ 7

[1] Downed wood.

Table 3. Composite Burn Index for units treated with prescribed fire in the Birds and Burns Network during 2003 - 2004. Scores were based on burn severities from 0 (no fire effect) to 3 (high burn severity) for 18 variables. Indices < 0.4 indicate no fire effect, indices ≥ 0.4 to < 1.3 are considered low burn severity, those ≥ 1.3 to < 2.3 are considered moderate severity, and ≥ 2.3 are high severity[1]. Understory scores are based on measurements of ground cover, ground char, downed wood, herbs, shrubs, and small trees, while overstory scores include those for large tree density, crown scorch, and char height. "Overall" CBI is the average of all 18 variables together.

			Composite Burn Index (CBI)		
Region	National Forest (no. of plots)	Unit	Understory	Overstory	Overall
SW (n = 134)	Apache-Sitgreaves, AZ (29)	LK	1.00	0.74	0.96
	Coconino, AZ (40)	IM	0.46	0.38	0.50
	Gila, NM (25)	CP	1.18	0.98	1.19
	Kaibab, AZ (40)	KE	0.79	0.68	0.78
NW (n = 60)	Okanogan-Wenatchee, WA (20)	FY	0.82	0.67	0.85
	Okanogan-Wenatchee, WA (20)	MT	1.02	0.65	0.97
	Payette, ID (20)	PC	0.90	0.47	0.85

[1] Personal communication; N. Benson

Table 4. Composite Burn Index scores for 18 variables measured at units treated with prescribed fire in the Birds and Burns Network during 2003 - 2004. Burn severities range from 0 (no fire effect) to 3 (high burn severity). Scores were averaged for the 20 to 40 plots within each unit.

Location	Unit	Ground char	Rock char	Litter char	Log char	Δ Ground percent cover	Δ Litter percent cover
Apache-Sitgreaves	LK	0.328	0.301	0.458	0.891	0.741	0.19
Coconino	IM	0.095	0.036	0.363	0.106	0.912	0.05
Gila	CP	0.377	0.29	0.547	1.031	1.8	0.6
Kaibab	KE	0.537	0.565	0.453	0.984	0.712	0.05
Okanogan	FY	0.499	0.034	0.416	0.714	1.675	0.2
Okanogan	MT	0.74	0.067	0.445	0.791	1.95	0.125
Payette	PC	0.63	0.352	0.628	1.224	2.275	0.45

Location	Unit	Δ Herb percent cover	Δ Shrub percent cover	Δ Small (< 8 cm dbh) tree density	Δ Fine (< 8 cm LED) DW weight	Δ Medium (8 to < 23 cm LED) DW weight	Δ Large (≥ 23 cm LED) DW weight
Apache-Sitgreaves	LK	0.97	2.897	2.24	0.828	1.448	1.5
Coconino	IM	0.65	0	1.95	0.475	1.188	0.9
Gila	CP	1.98	2	2.02	1.44	2.1	1.32
Kaibab	KE	0.9	1.05	1.875	0.488	1.362	1.025
Okanogan	FY	0.625	1.675	1.575	0.65	1.225	2.075
Okanogan	MT	0.975	1.65	2.425	0.275	1.3	2.875
Payette	PC	0.375	0.625	1.575	1.525	1.075	1.775

Location	Unit	Δ Medium (8 to < 23 cm dbh) tree density	Δ Large (> 23 cm dbh) tree density	Tree char height	Percent Green canopy	Percent brown canopy	Percent black canopy
Apache-Sitgreaves	LK	1.67	1.2	0.392	0.327	0.649	0.243
Coconino	IM	0.55	0.175	0.370	0.157	0.897	0.125
Gila	CP	1.96	2.12	0.648	0.612	0.55	0.006
Kaibab	KE	1.413	0.825	0.860	0.529	0.465	0
Okanogan	FY	1.95	0.325	0.647	0.56	0.501	0.012
Okanogan	MT	2.3	0.475	0.472	0.331	0.299	0.022
Payette	PC	0.975	0.325	0.682	0.427	0.396	0.003

Table 5. Summarization of analysis methods used to quantify the effects of prescribed fire on avian data sets.

Data	**Response variable**	**Analysis technique**
Songbird densities	"Effect" size: change attributable to the prescribed fire	Program Distance, Bootstrapping, confidence limits
Nest survival	Daily nest survival (1=success, 0=failure)	Proc NLMixed (Dinesmore et al. 2002), confidence limits
Nest Densities	"Effect" size: change attributable to the prescribed fire	T-tests

Table 6a. Changes in nest densities per 40 ha for three sites in the NW in the year after a prescribed fire treatment. Two sites were located on the Okanagon-Wenatchee National Forest in Washington, and one on the Payette National Forest in Idaho. Data for 8 species are reported.

	Effect Size				Individual Site Responses			Number of sites		
Species	Year After	S.E.	T-value	p-value	PAID	OKWA1	OKWA2	increase	decrease	same
Williamson's Sapsucker	0.05	0.06	-0.79	0.51	0.03	0.16	-0.04	2.00	1.00	0.00
Red-naped Sapsucker	-0.06	- 0.06	1.13	0.38	0.00	-0.02	-0.17	0.00	2.00	1.00
Hairy Woodpecker	0.45	0.58	-1.32	0.32	0.26	-0.02	1.10	2.00	1.00	0.00
American Three-toed Woodpecker	ONE SITE ONLY				0.57	0.00	0.00	1.00	0.00	0.00
Black-Backed Woodpecker	0.28	0.15	-1.87	0.20	0.57	0.10	0.16	3.00	0.00	0.00
Northern Flicker	0.23	0.35	-0.65	0.58	-0.14	-0.11	0.94	1.00	2.00	0.00
Pileated Woodpecker	0.07	0.08	-0.90	0.46	0.19	0.10	-0.08	2.00	1.00	0.00
Western Bluebird*	0.19	0.01	-18.61	**0.03**		0.20	0.18	2.00	0.00	0.00

*based on Washington data only

Table 6b. Changes in nest densities per 40 ha for four sites in the SW within a year of a prescribed fire treatment, and one year after the treatment. Coconino (COAZ), Kaibab (KAAZ), and Apache-Sitgreaves (ASAZ) National Forests in Arizona, and Gila National Forest in New Mexico. Data for 8 species are reported.

	Effect Size				Individual Site Responses				Number of sites		
Species	Year of Burn	S.E.	T-value	p-value	COAZ	KAAZ	ASAZ	GINM	increase	decrease	same
Hairy Woodpecker	0.086	0.091	-0.95	0.412	0.099	0.082	-0.14	0.305	3	1	
Northern Flicker	0.307	0.166	-1.852	0.161	0	0.726	0.088	0.413	3	0	1
Violet-green Swallow	-0.086	0.218	-0.394	0.72	0.494	-0.101	-0.561	-0.175	1	3	0
Mountain Chickadee	0.026	0.341	-0.077	0.944	0	-0.726	-0.097	0.927	2	1	1
Brown Creeper	0.253	0.044	-5.773	0.109	0.297	0.209			2		
White-breasted Nuthatch	-0.147	0.223	-0.658	0.558	-0.297	0.367	0.022	-0.678	2	2	0
Pygmy Nuthatch	-1.111	0.56	-1.984	0.141	-0.298	-0.134	-2.526	-1.487	0	4	0
Western Bluebird	0.106	0.37	0.286	0.793	1.185	-0.108	-0.496	-0.158	1	3	0

Species	Year After	S.E.	T-value	p-value	COAZ	KAAZ	ASAZ	GINM	increase	decrease	same
Hairy Woodpecker	0.137	0.163	-0.84	0.463	0.098	-0.063	-0.097	0.611	2	2	0
Northern Flicker	0.316	0.221	1.429	0.248	0.099	0.379	-0.118	0.905	3	1	0
Violet-green Swallow	-0.147	0.063	-2.346	0.101	-0.198	-0.284	-0.118	0.011	1	3	0
Mountain Chickadee	-0.304	0.176	1.725	0.183	0.198	-0.6	-0.487	-0.328	1	3	0
Brown Creeper	0.412	0.078	-4.976	0.126	0.494	0.329			2		
White-breasted Nuthatch	0.113	0.097	1.164	0.329	0.099	-0.139	0.162	0.328	3	1	0
Pygmy Nuthatch	-0.25	0.449	-0.557	0.617	0.693	-0.284	0.044	-1.453	1	3	0
Western Bluebird	0.818	0.343	2.388	0.097	1.58	0.125	0.368	1.199	4	0	0

Table 7a. Species responses to prescribed fire on sites in Idaho and Washington, in the year of the treatment and the year after treatment. Columns indicate migratory status, covariates used in the detection function, foraging guild (AI=aerial insectivore, GI=Ground Insectivore, FI=foliage insectivore, OM=omnivore), nest layer (CA=canopy,SH=shrub, GR=ground), and nest type (C=closed, O=open).

Migrant Species	Year of	Year after*	Covariates	Foraging	Nest Layer	Nest Type
Northern Flicker (short distance migrant)	+	0	no covariates	OM	CA	C
Hammond's Flycatcher	-	-	burned, unburned	AI	CA	O
Dusky Flycatcher	+	+	burned, unburned	AI	SH	O
Cassin's Vireo	0	0	burned, unburned	FI	CA	O
Red-Breasted Nuthatch	0	-	burned, unburned	BI	CA	C
Townsend's Solitaire	0	-	no covariates	AI	GR	O
American Robin	+	0	burned, unburned	GI	CA	O
Yellow-rumped Warbler	-	-	burned, unburned	FI	CA	O
Western Tanager	0	0	burned, unburned	FI	CA	O
Chipping Sparrow	0	0	burned, unburned	OM	SH	O
Dark-eyed Junco	0	0	burned, unburned	OM	GR	O
Cassin's Finch	0	0	burned, unburned	OM	CA	O
Pine Siskin	-	0	burned, unburned	OM	CA	O
Washington only						
Gray Flycatcher	0	+?	no covariates	AI	SH	O
Western Bluebird	+?	0?	no covariates	AI	CA	C
Brown-headed Cowbird (short distance migrant)	+	0?	burned, unburned	OM	-	P
Resident Species						
Hairy Woodpecker	0	+	burned, unburned	BI	CA	C
Mountain Chickadee	0	0	burned, unburned	FI	CA	C
Washington only						
White-breasted Nuthatch	+	0?	no covariates	BI	CA	C
Squirrels						
Red and Douglas Squirrel	0	-	burned, unburned			

* Year after analyses conducted using data from three of four sites only; results highlighted in gray are based on two sites only

Table 7b. Species responses to prescribed fire on sites in Idaho and Washington, in the year of the treatment and the year after treatment. Columns indicate migratory status, covariates used in the detection function, foraging guild (AI=aerial insectivore, GI=Ground Insectivore, FI=foliage insectivore, OM=omnivore), nest layer (CA=canopy,SH=shrub, GR=ground), and nest type (C=closed, O=open).

Migrant Species	Year of	Year after*	Covariates	Foraging	Nest Type	Nest Layer
Northern Flicker (short distance)	+	0	no covariates	OM	CA	C
Western Wood-pewee	0	0	burned,unburned	AI	CA	O
Gray Flycatcher (3 sites only)	0	-	burned,unburned	AI	SH	O
Plumbeous Vireo	0	0	burned,unburned	FI	CA	O
Brown Creeper	0	0	burned,unburned	BI	CA	C
Western Bluebird	+	+	burned,unburned	AI	CA	C
Grace's Warbler	-	0	burned,unburned	FI	CA	O
Yellow-rumped Warbler	-	0	burned,unburned	FI	CA	O
Western Tanager	0	0	burned,unburned	FI	CA	O
Chipping Sparrow	0	0	no covariates	OM	SH	O
Dark-eyed Junco	0	0	no covariates	OM	GR	O
Black-headed Grosbeak	0	0	no covariates	OM	SH	O
Brown-headed Cowbird (short distance)	-	-	burned,unburned	OM	various	P
Resident Species						
Hairy Woodpecker	+	+	burned,unburned	BI	CA	C
Steller's Jay	+	+	burned,unburned	OM	CA	O
Mountain Chickadee	0	0	burned,unburned	FI	CA	C
White-breasted Nuthatch	0	0	burned,unburned	BI	CA	C
Pygmy Nuthatch	-	0	burned,unburned	BI	CA	C

Table 8a. Summarization of species' responses to fire by region, migratory status, nest type, nest layer, and foraging guild in a) the Northwest and b) the Southwest. Percentage of species responding is reported.

	Year of			Year After		
NW (birds only)	**Positive**	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**
Overall	31.58	52.63	15.79	15.79	75.00	21.05
Migratory Status						
Migrant (16)	31.25	50.00	18.75	12.50	62.50	25.00
Resident (3)	33.33	66.67	0.00	33.33	66.67	0.00
Nest Type						
Closed (6)	50.00	50.00	0.00	16.67	66.67	16.67
Open (12)	16.67	58.33	25.00	16.67	58.33	25.00
Parasitic (1)	100.00	0.00	0.00	0.00	100.00	0.00
Nest Layer						
Parasitic (1)	100.00	0.00	0.00	0.00	100.00	0.00
Canopy (13)	30.77	46.15	23.08	7.69	69.23	23.08
Ground (2)	0.00	100.00	0.00	0.00	50.00	50.00
Shrub (3)	33.33	66.67	0.00	66.67	33.33	0.00
Foraging						
Aerial Insectivore (5)	40.00	40.00	20.00	40.00	20.00	40.00
Bark Insectivore (3)	33.33	66.67	0.00	33.33	33.33	33.33
Foliage Insectivore (4)	0.00	75.00	25.00	0.00	75.00	25.00
Ground Insectivore (1)	100.00	0.00	0.00	0.00	100.00	0.00
Omnivore (6)	33.33	50.00	16.67	0.00	100.00	0.00

Table 8b.

SW	Year of Positive	Year of Neutral	Year of Negative	Year After Positive	Year After Neutral	Year After Negative
Overall	22.22	50.00	27.78	16.67	72.22	11.11
Migratory Status						
Migrant (13)	15.38	61.54	23.08	7.69	76.92	15.38
Resident (5)	40.00	40.00	20.00	40.00	60.00	0.00
Nest Type						
Closed (7)	42.86	42.86	14.29	28.57	71.43	0.00
Open (10)	10.00	70.00	20.00	10.00	80.00	10.00
Parasitic (1)	0.00	0.00	100.00	0.00	0.00	100.00
Nest Layer						
Canopy (13)	30.77	46.15	23.08	23.08	76.92	0.00
Ground (1)	0.00	100.00	0.00	0.00	100.00	0.00
Parasitic (1)	0.00	0.00	100.00	0.00	0.00	100.00
Shrub (3)	0.00	100.00	0.00	0.00	66.67	33.33
Foraging						
Aerial Insectivore (3)	33.33	66.67	0.00	33.33	33.33	33.33
Bark Insectivore (4)	25.00	50.00	25.00	25.00	75.00	0.00
Foliage Insectivore (5)	0.00	60.00	40.00	0.00	100.00	0.00
Omnivore (6)	33.33	66.66	33.33	16.67	66.67	16.67

Table 9. Sample size of nests used for analysis by region and time period relative to treatment with prescribed fire (burned/unburned).

	Northwest		Southwest	
	Burned	Unburned	Burned	Unburned
HAWO	13	21	16	32
NOFL	10	47	39	45
WEBL	14	23	113	148
Total	37	91	168	225

Table 10. Mean nest tree DBH and mean nest height for three species of cavity-nesting bird on units treated with prescribed fire and untreated units in two geographic regions, Northwest (NW) and Southwest (SW).

		DBH (cm)		Nest height (m)	
		NW	SW	NW	SW
NOFL	Unburned	58.3 (53.2, 63.3)	55.0 (51.5, 58.4)	14.6 (12.9, 16.3)	7.12 (6.3, 7.9)
NOFL	Burned	60.9 (53.5, 68.3)	55.3 (46.0, 64.6)	18.9 (15.2, 22.5)	6.5 (2.4, 10.7)
HAWO	Unburned	59.0 (54.1, 63.1)	40.9 (35.8, 45.9)	15.2 (13.8, 16.6)	7.5 (6.3, 8.8)
HAWO	Burned	52.0 (40.9, 63.2)	30.4 (26.5, 34.3)	17.1 (12.7, 21.4)	4.3 (2.1, 6.4)
WEBL	Unburned	49.4 (43.0, 56.0)	51.4 (48.5, 54.4)	11.5 (10.4, 12.6)	5.8 (5.2, 6.3)
WEBL	Burned	49.6 (39.5, 59.8)	47.5 (44.0, 50.9)	10.0 (4.7, 15.3)	6.1 (3.5, 8.6)

Table 11. Number of hectares surveyed in logged and unlogged wildfires, and burned and unburned prescribed fire units.

	Year postfire 1		Year postfire 2		Year postfire 3		Year postfire 4	
Wildfires	unlogged	logged	unlogged	logged	unlogged	logged	unlogged	logged
Idaho	948	0	1390	2028	951	1351	951	634
Oregon	783	0	783	0	447	232	NA	NA

	2002	2003	2004		2005	
Before & After Rx Fires	unburned	unburned	unburned	Rx burned	unburned	Rx burned
Idaho	1398	1398	1188	210	1188	210
Washington	2108	2108	1463	645	1061	1046
Montana	0	782	782	0	782	0
Oregon	1200	1200	1200	0	0	0

Table 12. Number of nests found in logged and unlogged wildfires, and burned and unburned prescribed fire locations. YPF = year postfire for wildfire sites. Corresponding area surveyed for these results are reported in Table 11. NA = not available because areas were not surveyed.

White-headed Woodpecker[1]	ypf 1		ypf 2		ypf 3		ypf 4	
Wildfire	unlogged	logged	unlogged	logged	unlogged	logged	unlogged	logged
Idaho	2	0	2	1	2	0	4	0
Oregon	7	NA	13	NA	9	2	NA	NA
	2002	2003	2004		2005			
Before & After Rx Fire	unburned	unburned	unburned	burned	unburned	burned		
Washington	1	0	NA	NA	1	0		
Oregon	0	2	2	NA	NA	NA		
Idaho	0	0	0	0	0	0		

Black-backed Woodpecker	ypf 1		ypf 2		ypf 3		ypf 4	
Wildfire	unlogged	logged	unlogged	logged	unlogged	logged	unlogged	logged
Idaho	3	NA	10	2	9	2	7	0
Oregon	32	NA	69	NA	48	16	NA	NA
	2002	2003	2004		2005			
Before & After Rx Fire	unburned	unburned	unburned	burned	unburned	burned		
Idaho	0	0	0	0	0	3		
Oregon	0	1	1	NA	NA	NA		
Washington	0	0	NA	NA	0	2		
Montana	NA	0	0	NA	0	NA		

Hairy Woodpecker[2]	ypf 1		ypf 2		ypf 3		ypf 4	
Wildfire	unlogged	logged	unlogged	logged	unlogged	logged	unlogged	logged
Idaho	14	NA	43	10	46	16	32	8

Table 12 cont'd	2002	2003	2004		2005			
Before & After Rx Fire	unburned	unburned	unburned	burned	unburned	burned		
Idaho	13	9	5	1	4	2		
Washington	6	5	NA	NA	2	10		
Oregon	9	10	9	NA	NA	NA		
Montana	NA	4	6	NA	5	NA		
Lewis's Woodpecker	ypf1		ypf2		ypf3		ypf4	
Wildfire	unlogged	logged	unlogged	logged	unlogged	logged	unlogged	logged
Idaho	0	NA	6	39	21	113	23	51
Oregon	0	NA	6	NA	3	1	NA	NA
	2002	2003	2004		2005			
Before & After Rx Fire	unburned	unburned	unburned	burned	unburned	burned		
Washington	4	0	NA	NA	0	0		
Idaho	0	0	0	0	0	0		
Oregon	0	0	0	NA	NA	NA		
Montana	NA	0	0	NA	0	NA		

[1] White-headed Woodpecker does not occur in Montana.

[2] Hairy Woodpeckers were not surveyed in the wildfire areas of Oregon.

Figure 1. Map of study locations for the Birds and Burns Network.

Prescribed Fire Completed

Prescribed Fires Scheduled 2006-2007

Treatments completed on one unit and scheduled for 2006-2007 on two units

Wildfire Sites

A: Okanogon/Wenatchee National Forest
B: The Nature Conservancy & Fremont National Forest
C: Toolbox and Silver Wildfires 2002
D: Payette National Forest (partially treated)
E: Foothills Wildfire 1994, Star Gulch Wildfire 1995
F: Helena National Forest
G: San Juan National Forest
H: Kaibab & Coconino National Forests
I: Gila and Apache/Sitgreaves National Forests

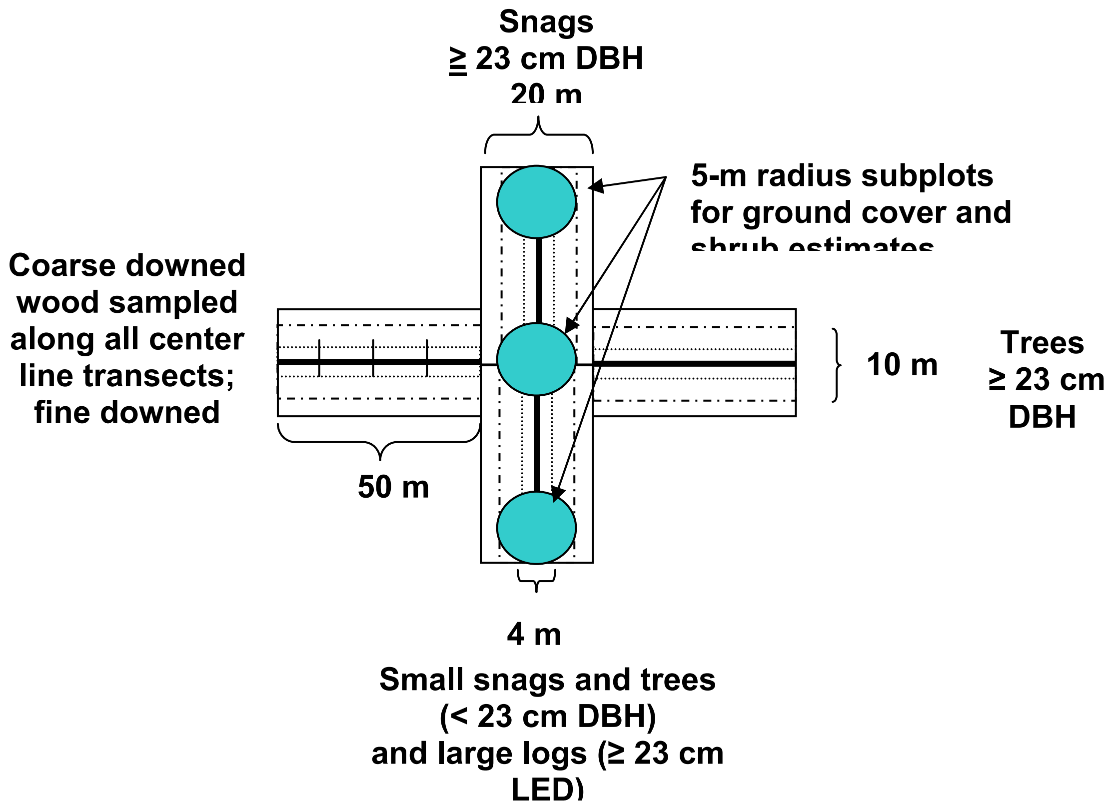

Figure 2. Nested plot design used to sample vegetation and forest structures at all random and nest tree plot locations on Birds and Burns study units.

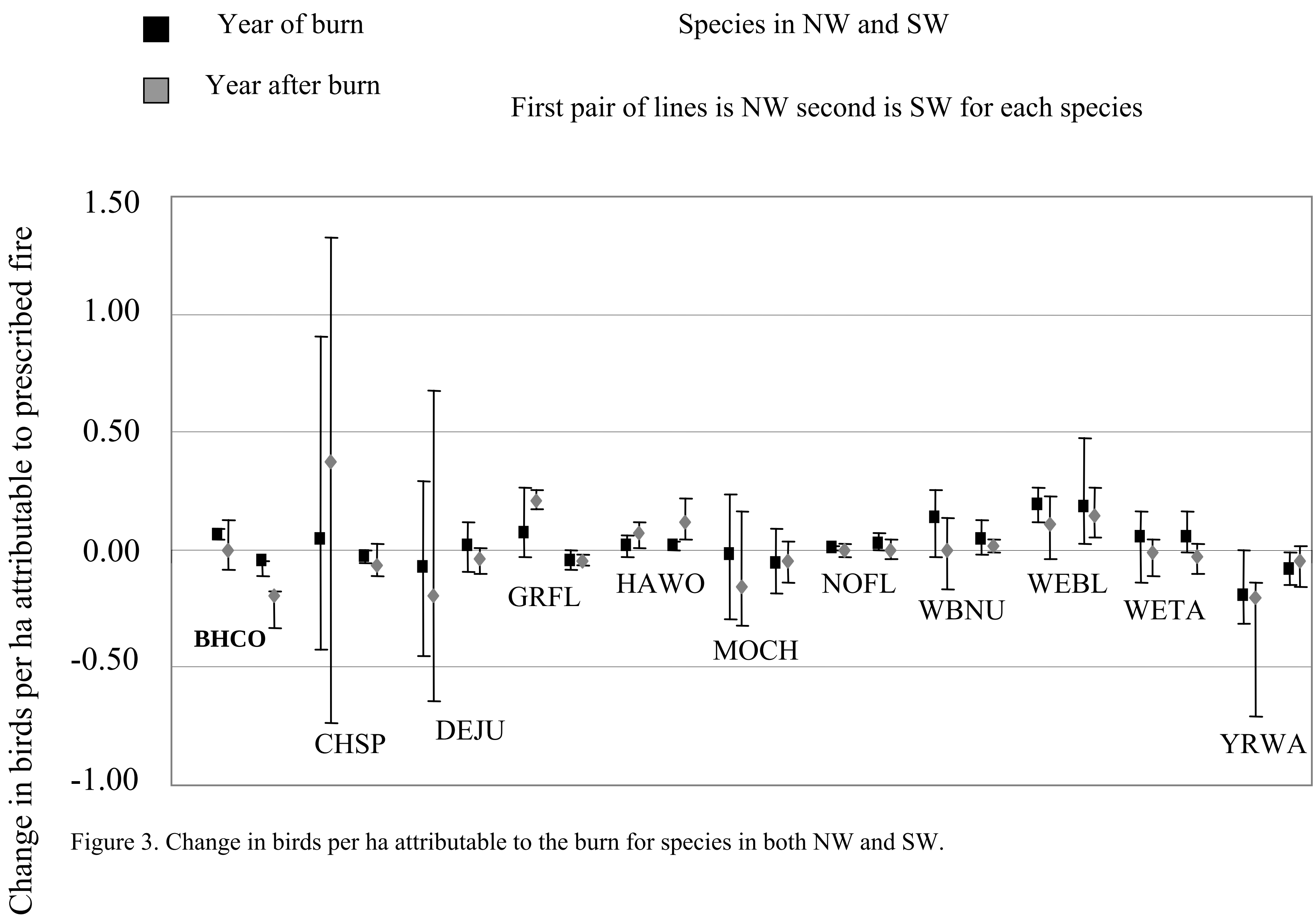

Figure 3. Change in birds per ha attributable to the burn for species in both NW and SW.

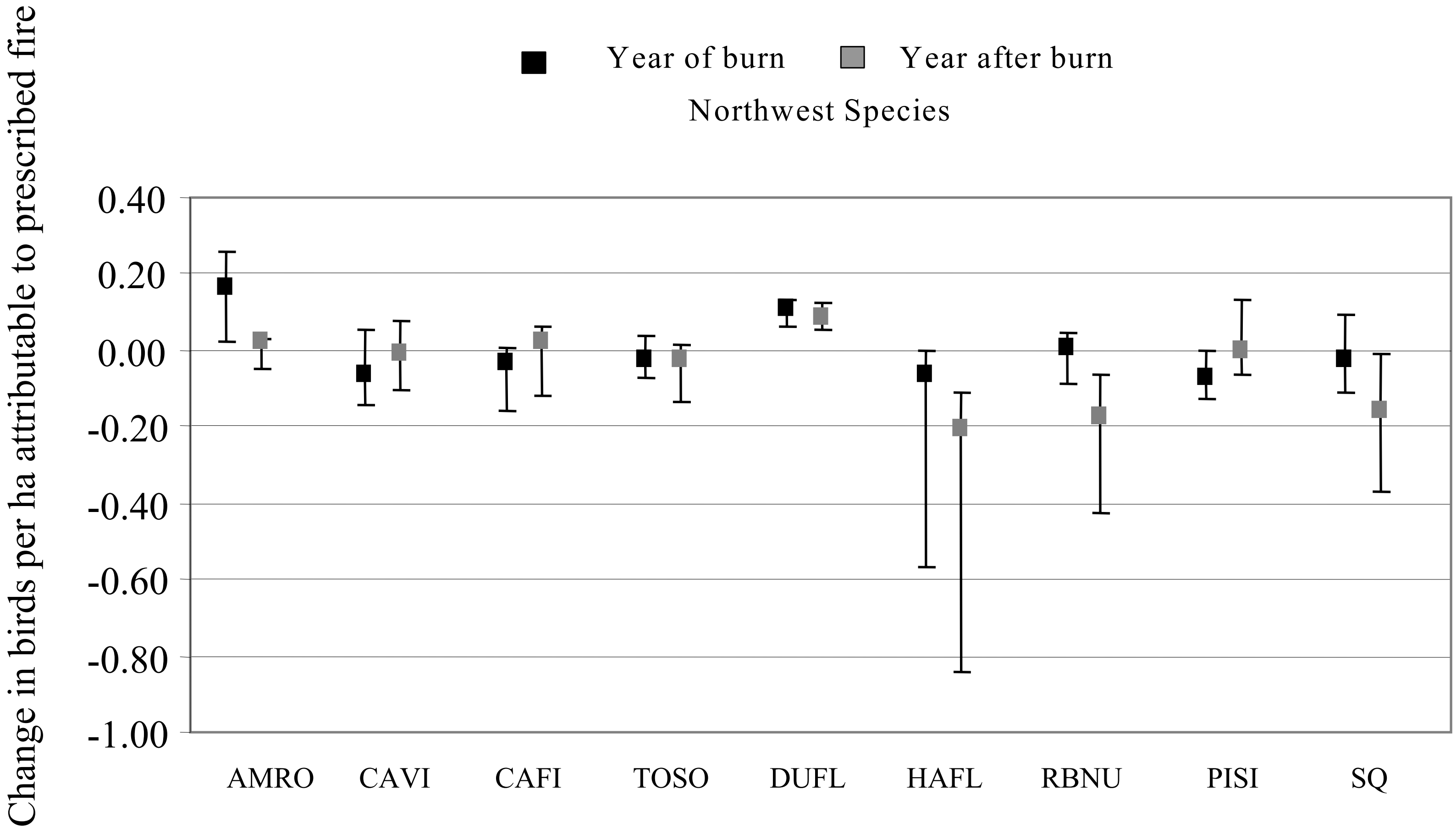

Figure 4. Change in birds per ha attributable to the burn for species in Idaho and Washington.

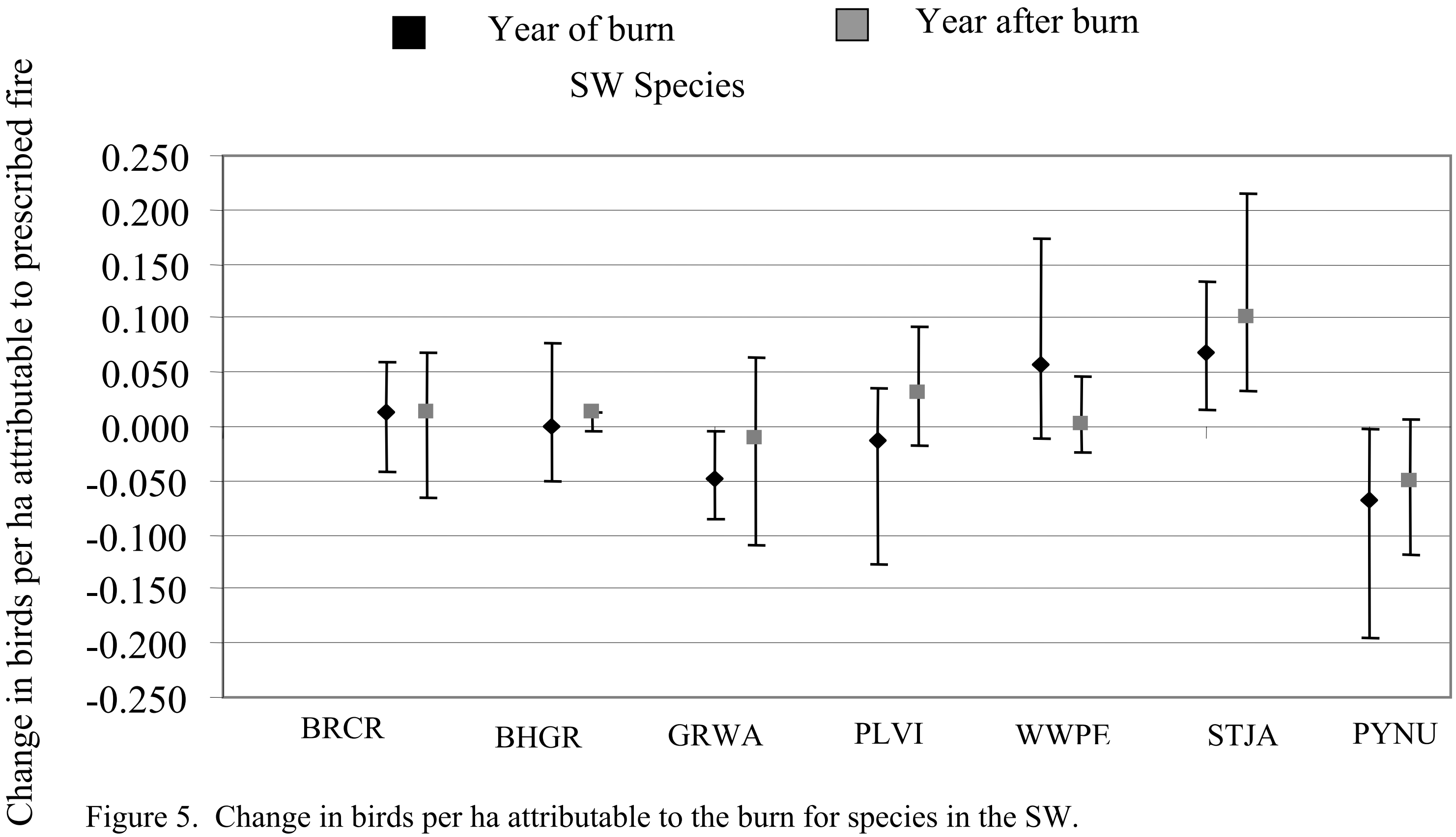

Figure 5. Change in birds per ha attributable to the burn for species in the SW.

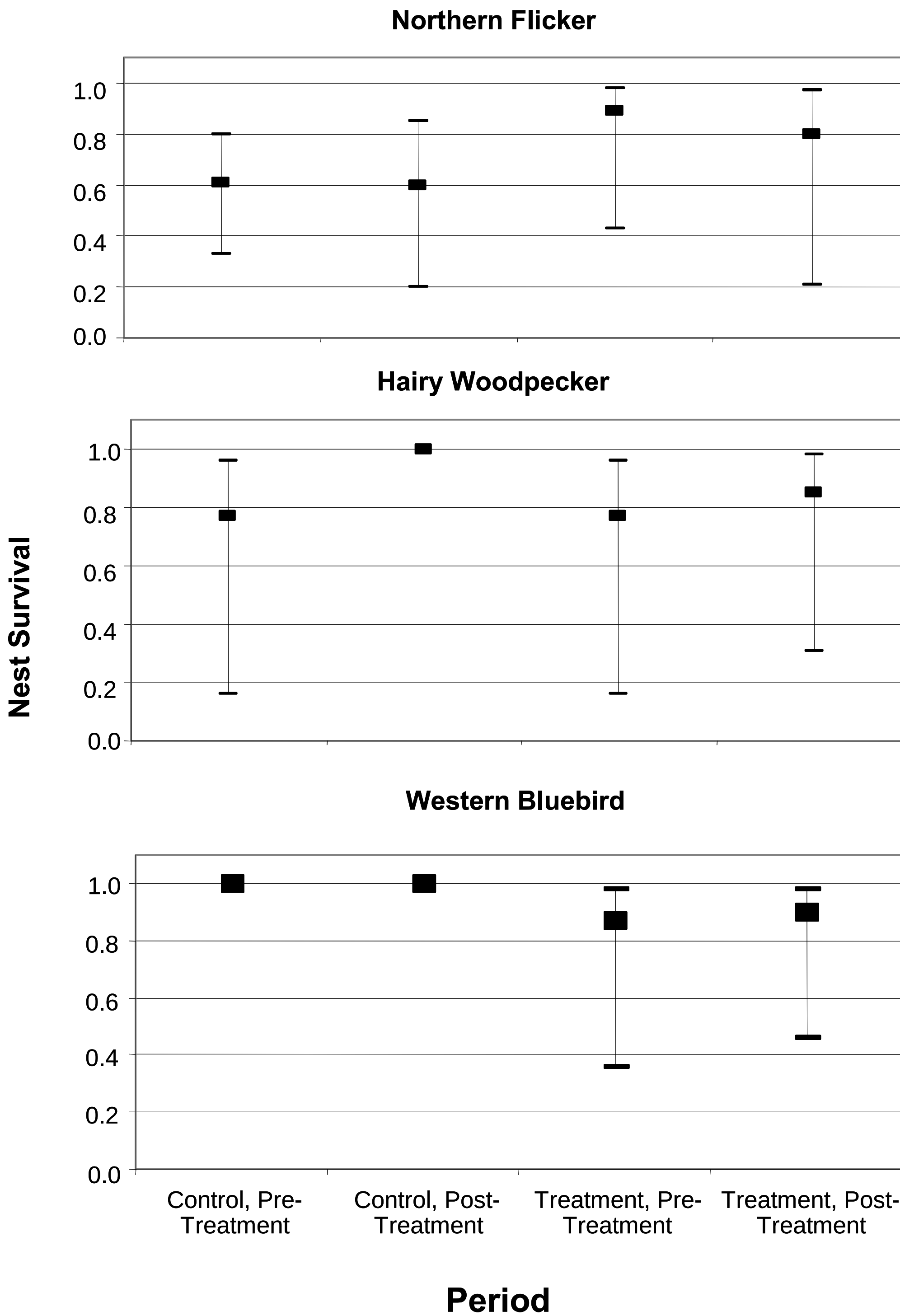

Figure 6. Nest survival (+/- 95% CI) for three species of cavity-nesting bird on units treated with prescribed fire (burned) and units receiving no treatment (unburned) for the Northwest region. Precision for estimates of nest survival for burned units is low due to small sample sizes.

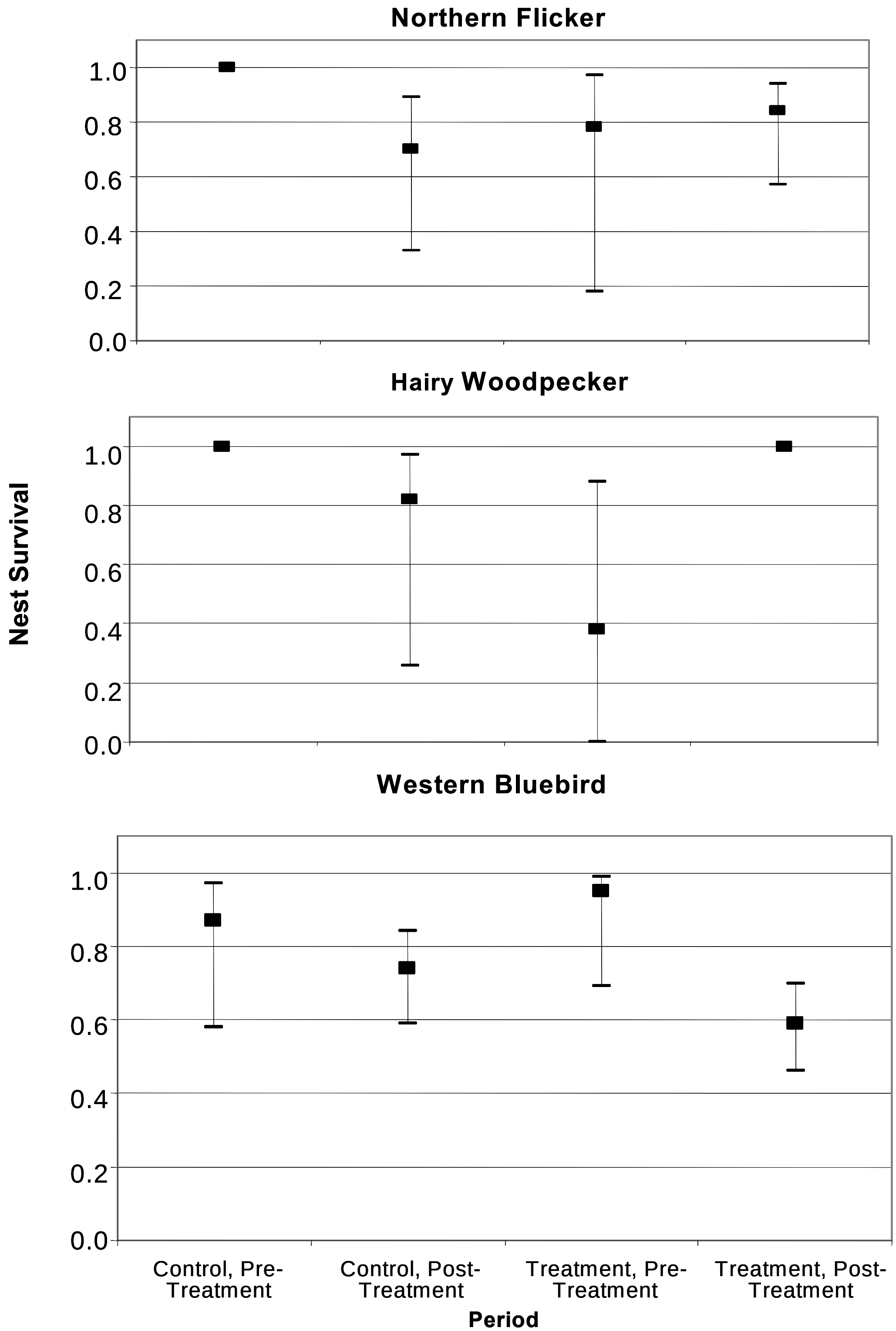

Figure 7. Nest survival (+/- 95% CI) for three species of cavity-nesting bird on units treated with prescribed fire (burned) and units receiving no treatment (unburned) for the Southwest region. *Nest survival for Hairy Woodpecker 100% for burned units

Appendix A. List of Common and Scientific Names of species referred to in text.

Williamson's Sapsucker (*Sphyrapicus thyroideus*)
Red-Naped Sapsucker (*Sphyrapicus nuchalis*)
Hairy Woodpecker (*Picoides villosus*)
White-headed Woodpecker (*Picoides albolarvatus*)
American Three-toed Woodpecker (*Picoides dorsalis*)
Black-backed Woodpecker (*Picoides arcticus*)
Northern Flicker (*Colaptes auratus*)
Pileated Woodpecker (*Drycopus pileatus*)
Western wood-pewee (*Contopus sordidulus*)
Hammond’s Flycatcher (*Empidonax hammondii*)
Gray Flycatcher (*Empidonax wrightii*)
Dusky Flycatcher (*Empidonax oberholseri*)
Plumbeous Vireo (*Vireo plumbeus*)
Cassin’s Vireo (*Vireo cassinii*)
Steller's Jay (*Cyanocitta stelleri*)
Pinyon Jay (*Gymnorhinus cyanocephalus*)
Common Raven (*Corvus corax*)
Violet-Green Swallow (*Tachycineta thalassina*)
Mountain Chickadee (*Poecile gambeli*)
Brown Creeper (*Certhia americana*)
Red-Breasted Nuthatch (*Sitta canadensis*)
White-breasted Nuthatch (*Sitta carolinensis*)
Pygmy Nuthatch (*Sitta pygmaea*)
Western Bluebird (*Sialia mexicana*)
Townsend’s Solitaire (*Myadestes townsendi*)
American Robin (*Turdus migratorius*)
Grace's Warbler (*Dendroica graciae*)
Yellow-rumped Warbler (*Dendroica coronata*)
Western Tanager (*Piranga ludoviciana*)
Chipping Sparrow (*Spizella passerina*)
Dark-eyed Junco (*Junco hyemalis*)
Black-headed Grosbeak (*Pheucticus melanocephalus*)
Brown-headed Cowbird (*Molothrus ater*)
Cassin’s Finch (*Carpodacus cassinii*)
Pine Siskin (*Carduelis pinus*)

Squirrels

Red Squirrel (Tamiasciurus hudsonicus)
Douglas Squirrel (Tamiasciurus douglasii)

Appendix B. Change in number of birds per hectare attributable to the burn on sites in Idaho and Washington. Number of ha for a change in ± 1 bird is calculated as the absolute values of (1/ mean effect change per ha) and indicates that there will be an addition or subtraction of 1 bird per X hectares after prescribed fire based on density estimate changes from our analysis.

Absolute Change in number per ha	Year of				Year After			
	Mean Effect (Change per ha)	Number of ha for a change of ±1 bird	LCL	UCL	Mean Effect (Change per ha)	Number of ha for a change of ±1 bird	LCL	UCL
Migrant Species								
Hammond's Flycatcher (*Empidonax hammondii*)	-0.065	15.440	-0.567	-0.004	-0.208	4.802	-0.115	-0.846
Gray Flycatcher (*Empidonax wrightii*)	0.072	13.867	-0.026	0.264	0.212	4.725	0.174	0.253
Dusky Flycatcher (*Empidonax oberholseri*)	0.112	8.940	0.063	0.132	0.089	11.201	0.054	0.121
Cassin's Vireo (*Vireo cassinii*)	-0.060	16.555	-0.140	0.053	-0.008	130.445	-0.103	0.081
Red-Breasted Nuthatch (*Sitta canadensis*)	0.010	101.893	-0.089	0.047	-0.172	5.809	-0.428	-0.061
Townsend's Solitaire (*Myadestes townsendi*)	-0.025	39.661	-0.073	0.039	-0.023	44.201	-0.137	0.014
American Robin (*Turdus migratorius*)	0.163	6.151	0.022	0.262	0.022	46.506	-0.046	0.032
Yellow-rumped Warbler (*Dendroica coronata*)	-0.19	5.240	-0.316	-0.006	-0.202	4.942	-0.079	-0.142
Western Tanager (*Piranga ludoviciana*)	0.056	17.838	-0.142	0.167	-0.013	74.767	-0.115	0.041
Chipping Sparrow (*Spizella passerina*)	0.044	22.490	-0.425	0.906	0.369	2.707	-0.736	1.326
Dark-eyed Junco (*Junco hyemalis*)	-0.078	12.765	-0.453	0.290	-0.194	5.152	-0.642	0.672
Cassin's Finch (*Carpodacus cassinii*)	-0.036	27.722	-0.160	0.007	0.025	40.003	-0.117	0.058
Pine Siskin (*Carduelis pinus)*	-0.068	14.601	-0.123	-0.002	0.002	440.460	-0.065	0.130
Washington only								
Western Bluebird (*Sialia mexicana*)	0.187	5.335	0.115	0.263	0.106	9.434	-0.035	0.230
Brown-headed Cowbird (*Molothrus ater*) (short distance migrant)	0.061	16.516	0.046	0.093	-0.003	355.586	-0.085	0.123

Resident Species								
Northern Flicker (*Colaptes auratus*) (short distance migrant)	0.005	186.191	0.001	0.013	0.000	2470.908	-0.032	0.022
Hairy Woodpecker (*Picoides villosus*)	0.020	51.016	-0.030	0.066	0.073	13.763	0.012	0.118
Mountain Chickadee (*Poecile gambeli*)	-0.017	59.278	-0.296	0.236	-0.155	6.460	-0.323	0.162
Washington only								
White-breasted Nuthatch (*Sitta carolinensis*)	0.138	7.272	-0.031	0.252	-0.005	197.852	-0.170	0.137
Red and Douglas Squirrel (*Tamiasciurus hudsonicus*, *T. douglasii*)	-0.03	36.214	-0.11	0.09	-0.16	6.339	-0.37	-0.01

Appendix C. Change in number of birds per hectare attributable to the burn on sites in Arizona and New Mexico. Number of ha for a change in ± 1 bird is calculated as the absolute values of (1/ mean effect change per ha) and indicates that there will be an addition or subtraction of 1 bird per X hectares after prescribed fire based on density estimate changes from our analysis.

Absolute Change in number per ha	Year of				Year After			
	Mean Effect	Number of ha for a change of ±1 bird	LCL	UCL	Mean Effect	Number of ha for a change of ±1 bird	LCL	UCL
Migrant Species								
Northern Flicker (*Colaptes auratus*)	0.028	36.083	0.002	0.067	-0.002	407.328	-0.039	0.041
Western wood-pewee (*Contopus sordidulus)*	0.056	17.824	-0.011	0.174	0.002	423.984	-0.025	0.045
Gray Flycatcher (*Empidonax wrightii*)(3 sites only)	-0.020	48.935	-0.138	0.028	-0.043	23.009	-0.066	-0.017
Plumbeous Vireo (*Vireo plumbeus*)	-0.014	70.773	-0.127	0.035	0.032	31.578	-0.018	0.092
Brown Creeper (*Certhia americana*)	0.013	75.485	-0.041	0.060	0.014	72.900	-0.067	0.068
Western Bluebird (*Sialia mexicana*)	0.178	5.631	0.023	0.473	0.146	6.856	0.053	0.259
Grace's Warbler (*Dendroica graciae*)	-0.048	20.786	-0.086	-0.004	-0.010	99.813	-0.109	0.063
Yellow-rumped Warbler (*Dendroica coronata*)	-0.09	11.578	-0.150	-0.014	-0.052	19.360	-0.161	0.015
Western Tanager (*Piranga ludoviciana*)	0.049	20.496	-0.012	0.160	-0.03	39.828	-0.11	0.03
Chipping Sparrow (*Spizella passerina*)	-0.033	30.361	-0.057	0.001	-0.061	16.273	-0.112	0.021
Dark-eyed Junco (*Junco hyemalis*)	0.020	49.621	-0.094	0.118	-0.040	25.216	-0.100	0.006
Black-headed Grosbeak (*Pheucticus melanocephalus*)	0.000	10893.824	-0.051	0.077	0.012	80.125	-0.004	0.012
Brown-headed Cowbird (*Molothrus ater*)	-0.051	19.449	-0.108	-0.047	-0.191	5.228	-0.333	-0.176
Resident Species								
Hairy Woodpecker (*Picoides villosus*)	0.02	65.427	0.001	0.033	0.117	8.583	0.043	0.214
Steller's Jay (*Cyanocitta stelleri)*	0.067	14.950	0.014	0.135	0.101	9.893	0.032	0.215
Mountain Chickadee (*Poecile gambeli*)	-0.059	17.047	-0.188	0.094	-0.044	22.712	-0.141	0.034
White-breasted Nuthatch (*Sitta carolinensis*)	0.045	22.082	-0.019	0.124	0.017	57.270	-0.010	0.041
Pygmy Nuthatch (*Sitta pygmaea)*	-0.069	14.559	-0.195	-0.002	-0.051	19.540	-0.119	0.006