Report on woodpecker breeding in the Jasper fire
Submitted to the Game, Fish, and Parks Department
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The Jasper fire burned approximately 83,500 acres in August, 2000, and occurred between Custer, South Dakota and Newcastle, Wyoming. The Black-backed Woodpecker (*Picoides arcticus*) is categorized as a Sensitive Species by the Forest Service, and this species responds positively to large burned areas in dense forest (Dixon and Saab 2000). Recent studies on the role of burned forests suggest that burned forests support a wide variety of woodpecker species (Saab and Dudley 1998), and that burned forests may in fact function as source habitats for some species (Saab and Vierling 2001). Source habitats are habitats in which reproduction exceeds mortality; these sites support population viability and should be preserved (Pulliam 1988). Because Black-backed Woodpeckers require dense forests that are generally unlogged, information pertaining to the occurrence and quality of available breeding habitat will be a valuable tool for resource managers.

Johnson et al. (2000) and Saab et al. (2002) developed a model that suggests that pre-burn forest structure is a good indicator of post-fire use by Black-backed Woodpeckers. This model is based primarily on data gathered by Saab and Dudley (1998) on Black-backed Woodpecker breeding activities in Idaho following stand-replacing burns that occurred in the early 1990's. Saab and Dudley (1998) monitored 35 Black-backed Woodpecker nests between 1994-1998 and quantified a number of different breeding variables (e.g. nest success). Additionally, habitat variables were collected at the nest tree and at random trees in order to develop a model of habitat selection for this species. Based on these habitat data, "suitable" Black-backed Woodpecker breeding sites were in sites with >70% crown closure for trees averaging >23 cm (9") in diameter and "marginal" Black-backed Woodpecker breeding sites occurred in forests with a crown closure between 40-70% for trees averaging >23 cm.

Objective 1: To determine the occurrence of Black-backed Woodpecker nesting activity within areas of differing pre-fire canopy covers following the Jasper Fire between 2001-2004.

Objective 2: To determine the breeding activity of other cavity nesters within the study sites based on breeding activities in 2001-2004.

Objective 3: To determine habitat characteristics associated with cavity nester breeding activity and to compare those habitat characteristics with random sites within the forest based on vegetation analyses in 2001-2004.

Objective 4: To determine the influence of salvage logging within the study sites following the Jasper Fire.

METHODOLOGY

Site selection

Based on Johnson et al. (2000), Saab et al. (2002) and communications with Dr. Saab, Wildlife Biologist Patti Lynch of the Black Hills National Forest Mystic district utilized GIS to generate maps of potential study sites. The sites were between 300-400ha in size (Dudley and Saab 2001) and a subset of the sites identified through GIS were randomly chosen as study sites. Two sites with high pre-fire canopy cover (>70%), two sites with moderate pre-fire canopy cover (40-70%), and two sites with low pre-fire canopy cover (<40% pre-fire canopy cover) sites were chosen for surveys (Figure 1). The sites with low pre-fire canopy cover allowed testing of Saab et al. (2002) because these sites did not meet the model criteria necessary to be suitable nesting sites for Black-backed Woodpeckers. We therefore predicted that Black-backed Woodpeckers would be absent from the pre-fire low canopy cover areas, whereas the highest amount of breeding activity would be in the high pre-fire canopy cover sites.

An additional purpose of this study was to examine the effects of salvage logging on cavity nesting bird communities. This was originally to be incorporated in the study site selection; however, an initial assessment of the area showed a lack of snags in salvage-logged areas. Since woodpeckers typically rely on snags with a larger diameter at breast height (DBH) for nesting purposes, random site selection was focused on model parameter descriptions. However, there are some data relevant to salvage logging within this report since a variety of salvage activities occurred within the study sites after we had chosen them as such (Figure 2).

Methodology to meet objectives #1 and #2

Surveys and monitoring

We followed methodology outlined by Dudley and Saab (2001) for surveying and monitoring cavity nesting species. Using belt transects that were between 1-1.6 km long and 200m apart, we surveyed for cavity nesting activity within the 300-400 ha study sites. We surveyed approximately 10 transects/study site. Each transect was traversed slowly and taped calls/drums were broadcast every 200m; if a bird was sighted or drummed in response, we attempted to find the nest cavity associated with that bird. If a bird exhibited breeding behavior (e.g. was carrying food), we followed that bird until we were successful in finding the cavity or until the bird had flown out of sight. During both years, surveys began in early May and were concluded by early July.

Once nest cavities were located, we visited them every 3-4 days and observed the behaviors of adults to determine the approximate stage of the nest cycle. Parents that had a high attendance rate in the nest cavity were likely incubating whereas parents that were feeding hatchlings made frequent trips to the cavities with food visible in their mouths. We determined nest success (the number of nests successful in fledging at least one young) using the Mayfield method (1975) and we quantified productivity (the number of fledglings produced/successful nest) at the time of fledging.

Our hypothesis that Black-backed Woodpeckers would prefer nesting in suitable sites (i.e. pre-burn canopy cover of > 70%) could not be analyzed statistically. Chi-square tests require a minimum of 5 occurrences in all cells used for the analysis, and Black-backed Woodpeckers did not use the random sites frequently enough for this

requirement to be met. Therefore, data relating to habitat selection at the landscape scale (i.e. pre-burn canopy cover) are presented descriptively.

Methodology to meet objective #3

Vegetation sampling

We followed methodology outlined by BBIRD protocol (Martin et al. 1997) with some modifications suggested by V. Saab (pers. comm.). The center of the nest vegetation plots were the nest trees themselves. For each nest tree, we recorded variables such as diameter at breast height (DBH), the decay class of the tree, tree species, tree height, cavity height, and tree top condition. The decay classes were based on a scale between 1-5 where a 1 is a slightly decayed tree and a 5 represents a severely decayed tree (after BBIRD protocol; Martin et al. 1997). Additionally, we gathered microhabitat characteristics of the area surrounding the nest tree. The percent ground cover (e.g. herbaceous, bare ground, litter, etc.) was recorded within 5m subplots radiating from the nest tree in cardinal directions. We conducted stem counts of saplings and shrubs within 5m of the nest tree and we gathered overstory estimates using a densiometer facing the 4 cardinal directions.

Within an 11.3m circular plot centered on the nest tree, we also quantified stem counts of snags/trees that were ≥ 8cm DBH, including decay classes and tree top conditions (V. Saab, pers. comm.). Additionally, we gathered data on the downed woody debris surrounding nest trees; these data included the number of stumps/logs and sizes of the stumps/logs surrounding the nest tree. After gathering these data at the nest sites (hereafter occupied sites), we used the same methodology at randomly selected sites. We matched occupied sites and random sites within cover types (i.e. if an occupied site was in ponderosa pine, the random site was selected to be in ponderosa pine); our two cover types were ponderosa pine and aspen (*Populus tremuloides*). The same measurements gathered for nest trees were then gathered at these random sites. Sample sizes differ between occupied and random sites due to time constraints during the field season. Additionally, there were more nests found compared to nest sites examined due to renesting attempts in the same tree. We gathered vegetation data on 151 nest sites between 2001-2004 and on 151 random sites for the same time period.

I used binary logistic regression to determine the habitat factors that were most important in predicting overall woodpecker presence. Binary logistic regression will examine the likelihood that a site is occupied or not based on habitat characteristics. The covariate characteristics in this analysis included factors such as nest tree dbh, nest tree height, and snag densities surrounding the nest tree. Additionaly, factors such as understory cover, overstory cover, and the decay class of the occupied vs. random sites were compared. The logistic regression was used to examine habitat selection for all woodpecker species and specifically for Black-backed Woodpecker habitat selection. Lewis's Woodpeckers are a species of interest for many agencies, but sample sizes from this study are too low to conduct statistical comparisons between occupied and random sites, so only descriptive data are provided for that species. Significance values of $p<0.05$ are used throughout and data are represented as averages ± standard errors unless otherwise noted.

RESULTS

Objectives 1 and 2:
Nesting activity of Black-backed Woodpeckers and other cavity nesters

A total of 160 nests have been monitored in the study sites during the four breeding seasons after the fire (Table 1). The composition of the woodpecker community has been relatively diverse; we have noted Red-headed Woodpeckers (*Melanerpes erythrocephalus*), Hairy Woodpeckers (*Picoides villosus*), Northern Flickers (*Colaptes auratus*), Lewis's Woodpeckers (*Melanerpes lewis*), Downy Woodpeckers (*Picoides pubescens*), Black-backed Woodpeckers, and Red-naped Sapsuckers (*Sphyrapicus nuchalis*) nesting within the study sites. No Three-toed woodpeckers (*Picoides tridactylus*) have been noted in the Jasper Fire study sites within our study sites.

Black-backed Woodpeckers were most abundant in 2002, the second year after the fire. We found no nests in 2001, although a small number of adults were noted to forage in the area. In 2002, we found 12 Black-backed Woodpecker nests, and the numbers of Black-backed Woodpecker nests declined annually after 2002. In general, Black-backed woodpeckers nested within the sites with the greatest pre-burn canopy cover. Out of the 21 nest sites found, 52% of them (11/21) were within the sites with >70% pre-fire canopy cover, 43% (9/21) were in the sites with 40-70% canopy cover, and 5% (1/21) occurred within the random sites.

Table 1. Total number of woodpecker nests in the Jasper Fire during the 2001-2004 breeding seasons. AOU abbreviations are in parentheses next to species names.

	>70% pre-fire canopy cover (n=2)	40-70% pre-fire canopy cover (n=2)	0-40% pre-fire canopy cover (n=2)	Total
Black-backed Woodpecker (BBWO)	11	9	1	21
Downy Woodpecker (DOWO)	2	0	0	2
Hairy Woodpecker (HAWO)	38	17	11	66
Red-headed Woodpecker (RHWO)	14	3	6	23
Lewis's Woodpecker (LEWO)	0	0	6	6
Northern Flickers (NOFL)	26	6	9	41
Red-naped Sapsucker (RNSA)	1	0	0	1
TOTAL	92	35	33	160

Overall nest success has varied between years. In 2001, overall nest success was low (37%) and while cause of nest failure in 2001 is unknown due to the lack of cavity viewers, we noted that 25% of the nest failures occurred during the incubation stage and 75% of the failures occurred after parents had initiated feeding activities. In contrast, overall nest success was approximately 80% in 2002. Predation was the major cause of mortality in subsequent years, but a number of nests also failed due to cavity trees being broken due to wind.

Table 2. Nest success (number of nests successful in fledging at least one young) between 2001-2004 based on Mayfield analyses. Species names are the four letter AOU acronyms used in Table 1 and nest numbers are in parentheses. Sample sizes for the nest success values are slightly less than the overall number of nests found. Many of the nests found in 2004 had evidence of nest occupancy (i.e. the presence of eggs/nestlings) but were not visited more than once due to time limitations.

	2001	2002	2003	2004	TOTAL
BBWO*	0 (n=0)	60.0% (n=12)	75% (n=4)	59% (n=5)	62%
HAWO	67% (n=3)	83.0% (n=36)	83% (n=23)	50% *(n=2)	81%
LEWO*	0 (n=0)	100% (n=2)	100% (n=2)	100% (n=2)	100%
NOFL	33% (n=3)	100% (n=16)	79% (n=14)	100% *(n=1)	79%
RHWO	0 (n=2)	58.5% (n=9)	18% (n=11)	100% (n=1)	34.8%
RNSA*	0 (n=0)	0 (n=0)	100% (n=1)	0 (n=0)	100%
DOWO*	0 (n=0)	0 (n=0)	100% (n=2)	0 (n=0)	100%
Total	37.5% (n=8)	80.4% (n=75)	70% (n=57)	72.7% (n=11)	73.5% (n=151)

*The overall average nest success is based only on data from 2002-2004.

Table 3. Average number of fledglings per nest for woodpecker species nesting in the Jasper from 2001-2004. Species names are the four letter AOU acronyms used in Table 1. Averages are followed by standard errors in parentheses.

Species	Average number of fledglings per nest
BBWO	1.72 (1.51)
HAWO	2.76 (1.48)
LEWO	4.17 (2.14)
NOFL	4.33 (2.58)
RHWO	1.15 (2.34)
RNSA	4 (0)
DOWO	2 (1.41)

Results pertaining to objective #3:
Microhabitat characteristics of occupied and random sites

We have monitored 160 nests since the beginning of this study, and collected vegetation data on 151 nest and 151 random sites. The number of plots used for vegetation analyses are slightly less than the number of nests monitored since some nest trees were used multiple times. Additionally, trends were similar between years so data were pooled.

Woodpecker nest sites were significantly different from random sites ($p<0.0001$), and the major factors that predicted nest sites were nest tree DBH, snag density surrounding the nest tree, and shrub density. In general, woodpecker nest sites had significantly larger nest trees than found at random (Table 4), a higher number of snags surrounding their nest trees (Table 5), and higher shrub densities as compared to random sites.

DBH was a significant factor influencing occupancy ($p<0.0001$), and nest trees selected by woodpeckers are generally larger than those randomly selected. DBH values ranged between an average of 21± 0 cm dbh for Downy Woodpeckers up to an average of 39.3 ± 1.2 cm dbh for Lewis's Woodpeckers. Black-backed Woodpeckers select nest trees that are approximately 6 cm larger in diameter than trees sampled randomly (19.8 ± 0.7)

Table 4. Tree characteristics for random and occupied sites between 2001-2004. All values are averages with standard errors in parentheses.

Species	Average DBH (cm)	Average height (m)
BBWO (n=20)	26.4 (1.3)	13.2 (1.0)
HAWO (n=64)	26.1 (0.91)	13.3 (0.65)
LEWO (n=6)	39.3 (1.2)	17.5 (2.3)
NOFL (n=41)	29.4 (1.6)	11.3 (0.85)
RHWO (n=17)	27.5 (1.3)	14.2 (1.1)
RNSA (n=1)	33 (0)	12 (0)
DOWO (n=2)	21 (0)	13 (1.0)
Random sites (n=151)	19.8 (0.7)	11.2 (0.4)

Stem counts for trees/snags were conducted within 11.3m of the center of the plot as well (0.04ha), and the number of snags surrounding a nest tree was a significant predictor of woodpecker presence ($p<0.015$). There were significantly more stems ≥ 8cm within 11.3m of the nest tree (16.5 ± 1.0) as compared to random sites (13.0 ± 0.9); $p<0.0001$). Averages of the number of stems within plots for each species are represented in Table 5. Stems had to be only ≥ 8cm DBH to be consistent with nation-wide methodologies used for snag determination related to bird studies (e.g. Martin et al. 1997), but included in Table 5 are data for snags ≥ 23cm DBH as well.

Table 5. Average number of snags per plot for all species combined and for selected species with sample sizes ≥ 20. Note that sample sizes pertaining to individual species may be less than the number of nest attempts due to renests that occurred in the same nest tree.

Species	Average no. of stems ≥ 8cm per plot (± s.e.)	Average no. of snags ≥ 23 cm DBH per plot
All woodpeckers combined	16.5 (1.0)	4.4 (0.01)
HAWO (n=64)	15.6 (1.2)	4.3 (0.04)
NOFL (n=41)	11.0 (1.3)	3.1 (0.03)
BBWO (n=20)	26.4 (4.1)	5.9 (0.99)
Random sites	13.0 (0.9)	3.2 (.27)

Stem counts for shrubs and saplings were conducted surrounding the nest tree, and virtually no shrubs or saplings with a dbh of greater than 2.5cm occurred in either occupied or random sites. There were significantly more shrubs/saplings with dbh less than 2.5cm within 5 m of nest sites (81.6 ± 9.2) compared to random sites (39.2 ± 5.0; $p<0.0001$). There were no shrubs or saplings that had a dbh greater than 8 cm within 5m of the nest tree.

Black-backed Woodpecker nest sites were significantly different from random sites ($p<0.0001$), and the major factors that predicted nest sites were nest tree DBH and snag density surrounding the nest trees (see Tables 4 and 5). Shrub density surrounding Black-backed Woodpecker nest sites did not differ from random shrub density ($p=0.64$); this was the one major difference between Black-backed Woodpecker habitat selection and woodpecker habitat selection as a whole. Shrubs were an important component in predicting overall woodpecker habitat, and this is likely due to different foraging methods utilized by different species of woodpeckers.

A number of variables were not important predictors of woodpecker occupancy, and those included ground cover within 5m of the nest tree (Table 6). None of the below ground cover characteristics were important predictors of either overall woodpecker occupancy or Black-backed Woodpecker occupancy between 2001-2004.

Table 6. Average % ± standard error of microhabitat characteristics surrounding occupied (n=151) and random (n=151) sites in 2001-2004.

Ground cover	Occupied sites	Random sites
Shrub	9.7 ± 1.1	8.7 ± 1.0
Herbaceous	39.7 ± 2.1	28.3 ± 2.1
Bare ground	28.9 ± 2.2	29.8 ± 2.0
Litter	22.9 ± 1.6	25.3 ± 1.6
Vegetation	49.0 ± 2.6	42.2 ± 2.5

Habitat characteristics of BBWO and LEWO

Black-backed Woodpeckers and Lewis's Woodpeckers are both species of special interest for a variety of federal and state agencies, and habitat requirements for these species are very different. For instance, Black-backed Woodpeckers tend to prefer sites with a greater number of snags surrounding the nest tree while Lewis's Woodpeckers prefer more open forested habitats with large snags in which to nest (Table 7). Lewis's Woodpeckers are aerial flycatchers and thus require generally open areas in which to forage.

Table 7. Nest site characteristics of BBWO nests and LEWO nests compared to characteristics found at random sites between 2001-2004. Data are presented as averages ± standard errors.

	BBWO nest sites (n=20)	LEWO nest sites (n=6)	Random sites (n=151)
Nest tree height (m)	13.2 (1.0)	17.5 (2.3)	11.2 (0.4)
Nest tree DBH (cm)	26.4 (1.3)	39.3 (1.2)	19.8 (0.7)
No. of saplings < 2.5cm DBH within 5m	22.7 (10.6)	17.3 (8.3)	39.7 (5.0)
No. of snags ≥ 8cm within 11.3m (0.04 ha)	26.4 (4.1)	9.5 (2.9)	13.0 (0.9)
No. of snags ≥ 23cm within 11.3m (0.04 ha)	5.9 (0.99)	1.2 (0.40)	3.2 (.27)

Objective 4

To determine the influence of salvage logging within study sites following the Jasper Fire.

Few nests occurred within the salvage logged sites. While Figure 2 indicates that approximately 13 nests occur in or near salvage logged area (some are right on the border between logged and unlogged habitat), all 13 nests occurred within aspen groves that were not logged. There were no woodpeckers nesting in pine trees within logged areas.

Additionally, woodpecker nest sites have a higher snag density as compared to random sites (see Results). This would suggest that woodpeckers as group are choosing clumps of snags as compared to snags that are evenly distributed in the landscape; therefore the distribution of snags within a logged area should be considered.

Discussion

Black-backed Woodpecker habitat selection

Black-backed Woodpecker habitat selection occurred at multiple scales within the Jasper Fire area. At the landscape scale, Black-backed Woodpeckers selected sites with a high amount of pre-burn canopy cover. This lends support to Saab et al. (2002) that pre-burn canopy cover might be an important management tool for evaluating potential Black-backed Woodpecker habitat immediately following a burn. We hypothesized that the birds would select sites with higher pre-burn canopy cover , and sites with >70% pre-fire canopy cover represented 52% of all of the selections made by Black-backed Woodpeckers while sites with 40-70% pre-fire canopy cover marginal sites represented 43% of the sample. Black-backed Woodpeckers only nested within sites with <40% pre-fire canopy cover once.

At smaller scales, the major factors influencing Black-backed Woodpecker habitat selection were primarily snag density surrounding the nest tree and nest tree dbh. Snag density surrounding the nest tree is particularly important to note, since the trends in this study are somewhat reflective of data available from both local and regional sources. The results from this study note that Black-backed Woodpecker nest sites had an average of 5.9 snags/0.04ha. Dixon and Saab (2000) suggest retaining 104-123 snags/ha (which averages 4.16 snags/0.04 ha), and while the data they use is based from studies primarily in Oregon and Idaho, the values suggested for snag retention following a stand-replacing fire are relatively similar to the findings in this study. Mohren (2002) reports that Black-backed Woodpecker foraging sites in burned areas within the Black Hills had an average of 7.2 snags/0.04ha, and that nest sites had an average of 1.7 snags/0.04ha surrounding the nest tree. His nest data are based on 8 nest sites found over a two year study and it was unclear whether the nest sites occurred in burned or unburned habitat since his study occurred in both habitat types.

The temporal use of the habitat is also important. Despite extensive searches, no Black-backed Woodpeckers were found using the burn in 2001. Because the burn was a late summer burn, it is likely that post-fire colonization of insects was not sufficient to support Black-backed Woodpecker breeding populations in that first post-fire breeding season. Dixon and Saab (2000) note that colonization can sometimes occur almost immediately (i.e 3 months after a burn), but that typical patterns show colonization 1-2 years post-fire.

Lewis's Woodpecker habitat selection

Very few Lewis's Woodpeckers were found within the study sites and this may be due to a lack of suitable nest trees as well as the characteristics they prefer surrounding nest trees. Lewis's Woodpeckers prefer nesting in large, dead/decaying trees; Vierling (1998) notes that the average DBH for Lewis's Woodpeckers nesting in cottonwood riparian habitats in Colorado was 112.6 cm and Saab et al. (2000) note that the DBH for Lewis's nesting in pine forests averages 47.5 cm in Idaho forests. Nest trees alone might be the limiting factor for Lewis's Woodpecker nesting activities in the Jasper Fire area because the average tree DBH for randomly selected trees (which would represent average forest conditions within the study sites) averaged 19.6 cm (± 0.7). The largest

DBH measured on random trees was 50 cm and only 4 of the 151 random trees were large enough to potentially function as LEWO nest trees.

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