

Experimental Design of Post-fire Salvage Logging:

“Can we manage to benefit economics while maintaining wildlife populations?”

Malheur National Forest, 2019 progress report

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To: Malheur National Forest & Southern Blues Restoration Coalition

Introduction

Forests recently burned by wildfires contain increased snag densities, which provide habitat for disturbance-associated wildlife, but also present economic opportunities for local communities and potential threats to human safety. Removal of burned snags through salvage logging can be of economic value, in addition to reducing snag hazards for public safety. Post-fire salvage logging, however, has negative ecological consequences, including reduction of habitat for disturbance-associated wildlife species. Consequently, forest managers are challenged with implementing post-fire salvage projects while concurrently meeting the requirements of existing laws and planning documents to maintain wildlife habitat (National Forest Management Act 1976 and 2012 Planning Rule Directives).

Salvage logging is often litigated over concerns regarding negative effects on aquatic and terrestrial ecosystems, and on disturbance-associated wildlife (e.g., Karr et al. 2004, Keele et al. 2006, Lindenmayer and Noss 2006, Saab et al. 2005). Several woodpecker species (i.e., black-backed woodpecker [*Picoides arcticus*, BBWO], Lewis’s woodpecker [*Melanerpes lewisii*, LEWO], and white-headed woodpecker [*Dryobates albolarvatus*, WHWO]) are strongly associated with recently burned forests because snags provide critical nesting and foraging resources (Wightman et al. 2010, Saab et al. 2011, Latif et al. 2013). Information is needed to minimize negative consequences of salvage logging and hazard-tree removal on disturbance-associated wildlife, particularly woodpecker species (Hoyt and Hannon 2002, Nappi et al. 2004, Saab et al. 2007, 2009, 2011).

BBWOs, LEWOs, and WHWOs are often focal species considered when proposing salvage logging projects in the Inland Northwest. Nesting habitat of these three species represents a range of conditions in burned forests (e.g., Saab et al. 2007, 2009, Wightman et al. 2010, Latif et al. 2020). BBWOs nest and forage primarily in unlogged burned forests with high snag densities of moderate diameters (Dixon and Saab 2000, Tremblay et al. 2009). In contrast, LEWOs favor large-diameter snags (> 50 cm dbh) for nesting, surrounded by moderate snag densities with openings (Saab et al. 2009, Vierling et al. 2013). WHWOs principally use burned forests for nest placement, while foraging on nearby live trees (Wightman et al. 2010, Hollenbeck et al. 2011). Litigation over these species has impeded implementation of post-fire salvage logging projects on several national forests. The LEWO and WHWO are currently Pacific Northwest Region Sensitive Species.

To meet requirements of the National Forest Management Act 1976 and 2012 Planning Rule Directives for wildlife habitat conservation, while concurrently pursuing economic and social benefits of post-fire salvage logging, forest managers need information on: 1) areas of suitable nesting habitat; 2) critical environmental components of suitable nesting habitat, 3) the influence of salvage logging activities on critical habitat components, overall habitat suitability, and woodpecker populations, and 4) the amount of habitat needed for woodpecker population persistence. The Canyon Creek Complex (CCC) Project will contribute to these information needs by building on the ongoing research program conducted by the Rocky Mountain Research Station (RMRS), aimed at providing guidelines for wildlife habitat management in dry coniferous forests (<http://www.fs.fed.us/rm/wildlife-terrestrial/birds-burns/>).

RMRS researchers have been collaborating with National Forests to develop habitat suitability models for woodpeckers nesting in recently burned forests, to examine population responses to salvage logging treatments, and to identify habitat features affected by those treatments (Russell et al. 2007, Forristal 2009, Wightman et al. 2010, Hollenbeck et al. 2011, Saab et al. 2007, 2009, 2011, Latif et al. 2013, 2015). Habitat models quantifying environmental relationships with species occurrence allow us to map suitable habitat and identify key environmental features associated with population distributions (see above references and Guisan et al. 2013). RMRS habitat models for woodpeckers were developed from wildfire locations in Idaho (Foothills Fire, 1992; Star Gulch Fire, 1994), Oregon (Toolbox Fire, 2002; Canyon Creek Fire, 2015), Washington (Tripod Fire, 2006), and California ([Moonlight Fire, 2007; Cub Fire, 2008; Chips Fire, 2012] Campos et al. 2020; Latif et al. 2018, 2020). Habitat maps generated using GIS software from coarse-resolution models developed with remotely sensed data can estimate potential nesting habitat for multiple woodpecker species in landscapes of interest. Additionally, models quantifying fine-resolution environmental relationships with species occurrence and other parameters (e.g., nest survival) could inform silvicultural prescriptions that maintain or create suitable habitat. In the latter case, habitat maps generated from coarser resolution models could be used to identify areas of lower suitability where silvicultural prescriptions informed by finer resolution relationships could be implemented to advance suitable habitat conditions, e.g., expediting habitat for species favoring relatively open-canopied forests (i.e., LEWO, WHWO).

The CCC Project will provide information on multiple knowledge gaps needed to inform post-fire forest management. We monitored woodpecker populations and habitat over a range of harvest prescriptions for 4 years after wildfire. The data gathered will identify post-fire salvage harvest prescriptions that allow benefits to economics, while minimizing negative consequences to wildlife (i.e., population persistence of three focal woodpecker species). This effort will primarily generate fine-resolution data needed to inform future silvicultural prescriptions that incorporate woodpecker habitat requirements in recently burned forests. Additionally, the CCC Project will inform analysis of trade-offs between timber harvest that captures economic and safety benefits, with the conservation of wildlife species of concern. Data from the CCC Project will facilitate further evaluation and refinement of existing habitat suitability models to broaden their applicability (Latif et al. 2018, 2020). Finally, knowledge generated from the CCC Project will complement landscape-scale analysis of habitat dynamics. Understanding habitat relationships at individual-fire and landscape scales will inform treatment design that minimizes negative effects to woodpecker species, while accounting for overall habitat in a surrounding National Forest. Project objectives, design, field methods, and data analysis are detailed in our

study plan (Saab et al. 2016). Previous progress reports (Saab et al. 2017a, 2017b, 2019) are available via the Forest Service T-drive (T:\FS\RD\RMRS\Science\WTE\Research\CanCrkFire\ProgressReports). Here we report our findings from the final 2019 field season – the fourth year following the fire and the third year following completion of salvage treatments.

Methods

Methods for performing call-broadcast surveys, nest searches, nest monitoring, and vegetation sampling followed those previously outlined in Saab et al. (2017b). We conducted occupancy and nesting surveys for black-backed, Lewis's, and white-headed woodpeckers during 2 visits to each study unit in 2019 (1st visit: 8 May – 1 July; 2nd visit: 1 – 19 July). We monitored the survival of all nests through their completion except for those in Wall Creek unit. We measured vegetation characteristics at all nests and a portion of non-nest locations following the breeding season.

Results

With a crew of 8 people, we detected adult BBWOs, LEWOs, and WHWOs 261, 451, and 96 times, respectively, in 9 study units (Tables 1-3, Appendix 1). This corresponded to detections of adults in 207, 207, and 73 200m x 200m cells for BBWOs, LEWOs, and WHWOs. In addition, we detected BBWOs, LEWOs, and WHWOs at their nests 39, 156, and 24 times, respectively. All 3 species were detected at all 9 study units. BBWO detections were made aurally 182 times and visually 79 times. Female and male BBWOs were detected 114 and 80 times, respectively. Gender was not identified for 67 detections. Adult LEWO detections were made aurally 132 times and visually 319 times. Due to plumage monomorphism, LEWO gender was not identified for all 451 detections. WHWO detections were made aurally 63 times and visually 33 times. Gender was identified as female or male for 29 and 42 detections, respectively, and identified as unknown for 25 detections. Non-target woodpeckers (Williamson's sapsucker [*Sphyrapicus thyroideus*], downy woodpecker [*Dryobates pubescens*], hairy woodpecker [*D. villosus*], northern flicker [*Colaptes auratus*], and pileated woodpecker [*Dryocopus pileatus*]) were commonly detected during call-broadcast surveys, nest searching, and nest monitoring.

We located 32 BBWO, 85 LEWO, and 22 WHWO nests (Table 4, Appendix 2). Twenty-one BBWO nests were associated (i.e., within 300m of unit boundaries) with treated units and 11 were associated with control units. Fifty-five LEWO nests were associated with treated units and 30 were associated with control units. Sixteen WHWO nests were associated with treated units and 6 were associated with control units (Table 4).

Twenty-three of 32 BBWO nests survived to fledge 1.91 nestlings on average, based on the last accurate count of nest contents (Appendix 2). Sixty-nine LEWO nests (n = 85 LEWO nests monitored) survived to fledge 2.75 nestlings on average, and 18 WHWO nests (n = 22 WHWO nests monitored) survived to fledge 2.61 nestlings on average (Appendix 2). Survival results were not determined for 12 of 13 nests in Wall Creek unit due to limited access (Appendix 2). Causes of nest failure included adult abandonment, nest predation, weather, , and unknown

causes. BBWOs initiated egg laying by 12 May on average, followed by WHWOs (28 May), then LEWOs (5 June; Appendix 2). Nest initiation date ranged from 3 May to 15 June 2019 for all species combined ($n = 139$ nests), and successful nests ($n = 110$, all species combined) initiated egg-laying 1 to 11 days earlier on average than unsuccessful nests ($n = 3$, 3, and 2 nests for BBWO, LEWO, and WHWO, respectively; Appendix 2).

Vegetation measurements were completed at all BBWO, LEWO, and WHWO nests ($n = 139$ nests, all species combined) in 2019. We measured vegetation characteristics at 88 non-nest locations distributed proportionally among study units according to each unit's survey area (Table 5, Appendices 3-6).

On average, BBWOs nested in the smallest diameter trees and LEWOs nested in the largest diameter trees (Table 5, Appendices 3-6). Live tree densities in all size classes were higher at random locations compared to nest locations for all 3 species (Table 5), though this was not consistent for all treatment levels (Appendices 3-6). Alternatively, snag densities were higher in most size classes for BBWOs, LEWOs, and WHWOs compared to random locations, especially for snag size classes ≥ 12 " diameter-at-breast-height (Table 5, Appendices 3-6).

Discussion & Future

Adult BBWOs, LEWOs, and WHWOs were detected in 23%, 24%, and 8% of cells, respectively, for all study units combined in 2019. These results suggest a slow declining trend for BBWO populations, an increasing trend for LEWOs, and generally stable trend for WHWOs in our study area since 2016. Overall detections of individual adults and nesting densities from 2019 also reflect these patterns in woodpecker occupancy. These responses are largely consistent with previous work (e.g., rapid response followed by declining BBWO, increasing LEWO, and stable WHWO nesting within 4 years of wildfire). We did not expect BBWO occupancy and nesting densities to begin declining so quickly following the first year after fire, particularly in control units (cf. Saab et al. 2007, 2009). Logging in the surrounding landscape might have influenced BBWO nesting in the controls. Additional data analysis is needed to evaluate how salvage operations influenced trends in occupancy and nesting of BBWO's in the Canyon Creek Complex.

Nesting densities of LEWOs continued to increase as expected in 2019, with highest nest numbers in treatment units and in burned forest patches containing relatively high densities of large-diameter snags (≥ 20 " dbh) compared to non-nest locations. BBWOs nested in partially logged units similar to another location in Oregon (Forristal 2009), in contrast to other recently burned forests in Idaho and Montana (Saab et al. 2009, Latif et al. 2013). Experimental design for this study included treatments that retained relatively high snag densities for typical salvage logging operations (see Saab et al. 2016), and BBWOs placed nests in forest patches containing high snag densities whether in treatment or control units. WHWO nest densities remained the lowest among our focal woodpecker species but were generally stable across all 4 years of study. WHWO nests were commonly placed in forest patches containing relatively high densities of moderate- and large-diameter snags (≥ 15 " dbh) adjacent to unburned or low-burn-severity forests and supports previous work (Wightman et al. 2010, Latif et al. 2020).

Apparent nest success for BBWOs, LEWOs, and WHWOs was generally high throughout the study period and common for woodpeckers in the early years following postfire salvage logging (Saab et al. 2011). Apparent nest success for BBWOs declined 20% in 2019 from previous years and nest productivity was the lowest reported among woodpeckers. When coupled with decreasing BBWO nest densities, these results further suggest a declining BBWO population in the Canyon Creek Complex burn. Additional work that evaluates nest survival and productivity data with environmental factors will help us determine the effects of salvage logging treatments on BBWOs, LEWOs, and WHWOs.

Average nest tree diameters among the 3 species were as expected, where LEWOs nested in the largest diameter snags, followed by WHWOs, then BBWOs. Results of nest tree diameters and snag densities surrounding nests are consistent with past studies (e.g., Wightman 2010, Saab et al. 2009, 2011; Latif et al. 2013). Snag densities were highest at BBWO nests compared with other woodpecker nests and with non-nest locations. This is another indication that unlogged or sparsely logged post-fire forests are necessary to maintain BBWO nesting habitat, and that retaining a range of snag densities and diameters can likely support the entire suite of cavity-nesting species.

Field work was completed during 2019. Four years (2016 - 2019) of funding were secured (via USFS Washington Office [WO]) for this field study with the help of the Southern Blues Restoration Coalition. The USFS Region 6, Malheur National Forest, and Rocky Mountain Research Station have significant investments of funding and effort in this study.

Data analysis, report writing, and publishing will continue through 2021. We will evaluate how treatments influenced populations and nesting habitats, and which habitat conditions are most favored by each species. Our analyses will help advance guidelines for post-fire salvage logging that incorporate habitat requirements needed for successful nesting of focal woodpecker species.

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Table 1. Summary of black-backed woodpecker (BBWO) detections at study and control units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019.

Unit ID	Unit name	Trt Level ^a	# Cells ^b	# Cells with Detections ^c	# BBWO Individual Detections ^d		
Treatment					Visit 1 ^e	Visit 2 ^e	Total
T1	Upper Fawn Creek (UF)	2	102	18	13	9	22
T2	Alder Gulch (AG)	3	109	25	15	17	32
T3	Sloan Gulch (SG)	3	74	15	14	3	17
T4	Crazy Creek (CC)	1	107	35	32	7	39
T5	Big Canyon (BC)	1	81	20	12	14	26
T6	Lower Fawn Creek (LF)	2	105	30	25	15	40
Control							
C1	Wall Creek (WC)	0	98	16	14	4	18
C2	Crawford Gulch (CG)	0	107	20	20	10	30
C4	Overholt Creek (OC)	0	139	34	32	11	43
	Total		922	213	177	90	267

^a Level 0 = retention of all snags; Level 1 = retention of all large snags (>20" dbh) with harvest of all >15-20" dbh & harvest of most >12-15" dbh, intended to strongly benefit LEWOs; Level 2 = harvest half of all size classes, intended to benefit LEWOs & WHWOs; Level 3 = harvest most of largest snags (>20" dbh) & retention of medium size classes (>15-20" dbh & >12-15" dbh), intended to strongly benefit WHWOs.

^b Cell size = 200 m x 200 m.

^c Total number of cells with BBWO detections inside unit boundaries.

^d Total number of BBWO detections in units within 300m of unit boundaries.

^e Visit 1: 8 May – 1 July; 2nd visit: 1 – 19 July.

Table 2. Summary of Lewis's woodpecker (LEWO) detections at study and control units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019.

Unit ID	Unit name	Trt Level ^a	# Cells ^b	# Cells with Detections ^c	# LEWO Individual Detections ^d		
Treatment					Visit 1 ^e	Visit 2 ^e	Total
T1	Upper Fawn Creek (UF)	2	102	42	30	69	99
T2	Alder Gulch (AG)	3	109	47	50	53	103
T3	Sloan Gulch (SG)	3	74	11	10	8	18
T4	Crazy Creek (CC)	1	107	13	17	17	34
T5	Big Canyon (BC)	1	81	10	13	10	23
T6	Lower Fawn Creek (LF)	2	105	31	13	44	57
Control							
C1	Wall Creek (WC)	0	98	23	32	30	62
C2	Crawford Gulch (CG)	0	107	19	15	23	38
C4	Overholt Creek (OC)	0	139	21	19	20	39
	Total		922	217	199	274	473

^a Level 0 = retention of all snags; Level 1 = retention of all large snags (>20" dbh) with harvest of all >15-20" dbh & harvest of most >12-15" dbh, intended to strongly benefit LEWOs; Level 2 = harvest half of all size classes, intended to benefit LEWOs & WHWOs; Level 3 = harvest most of large snags (>20" dbh) & retention of medium size classes (>15-20" dbh & >12-15" dbh), intended to strongly benefit WHWOs.

^b Cell size = 200 m x 200 m.

^c Total number of cells with LEWO detections inside unit boundaries.

^d Total number of LEWO detections in units within 300m of unit boundaries.

^e Visit 1: 8 May – 1 July; 2nd visit: 1 – 19 July

Table 3. Summary of white-headed woodpecker (WHWO) detections at study and control units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019.

Unit ID	Unit name	Trt Level ^a	# Cells ^b	# Cells with Detections ^c	# WHWO Individual Detections ^d		
Treatment					Visit 1 ^e	Visit 2 ^e	Total
T1	Upper Fawn Creek (UF)	2	102	9	7	7	14
T2	Alder Gulch (AG)	3	109	4	4	1	5
T3	Sloan Gulch (SG)	3	74	14	8	11	19
T4	Crazy Creek (CC)	1	107	5	4	1	5
T5	Big Canyon (BC)	1	81	13	5	8	13
T6	Lower Fawn Creek (LF)	2	105	8	8	3	11
Control							
C1	Wall Creek (WC)	0	98	1	0	1	1
C2	Crawford Gulch (CG)	0	107	15	8	10	18
C4	Overholt Creek (OC)	0	139	9	11	2	13
	Total		922	78	55	44	99

^a Level 0 = retention of all snags; Level 1 = retention of all large snags (>20" dbh) with harvest of all >15-20" dbh & harvest of most >12-15" dbh, intended to strongly benefit LEWOs; Level 2 = harvest half of all size classes, intended to benefit LEWOs & WHWOs; Level 3 = harvest most of large snags (>20" dbh) & retention of medium size classes (>15-20" dbh & >12-15" dbh), intended to strongly benefit WHWOs.

^b Cell size = 200 m x 200 m.

^c Total number of cells with WHWO detections inside unit boundaries.

^d Total number of WHWO detections in units within 300m of unit boundaries.

^e Visit 1: 8 May – 1 July; 2nd visit: 1 – 19 July.

Table 4. Number of black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests in treatment and control units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2016-2019.

Unit ID	Unit name	Acres Surveyed	BBWO Nests				LEWO Nests				WHWO Nests				Total
			2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019	
Treatment															
T1	Upper Fawn Creek (UF)	806	3	3	3	2	0	0	5	11	1	2	1	2	33
T2	Alder Gulch (AG)	795	2	4	5	3	0	2	11	17	3	1	3	0	51
T3	Sloan Gulch (SG)	518	4	4	5	3	0	0	0	4	3	3	5	6	37
T4	Crazy Creek (CC)	818	8	8	3	6	0	0	8	5	2	3	2	1	46
T5	Big Canyon (BC)	566	8	8	4	3	0	0	2	4	5	2	3	4	43
T6	Lower Fawn Creek (LF)	831	3	3	5	4	0	6	5	14	5	5	1	3	54
	Subtotal	4,334	28	30	25	21	0	8	31	55	19	16	15	16	264
Control															
C1	Wall Creek (WC)	754	7	9	5	3	0	0	5	10	2	2	2	0	45
C2	Crawford Gulch (CG)	835	9	6	3	2	0	0	2	9	3	2	4	4	44
C3	East Fork Canyon Creek (EF) ^a	161	2	NS	NS	NS	0	NS	NS	NS	1	NS	NS	NS	3
C4	Overholt Creek (OC) ^a	995	NS	2	5	6	NS	0	3	11	NS	2	3	2	34
	Subtotal	2,745	18	17	13	11	0	0	10	30	6	6	9	6	126
	Total	7,079	46	47	38	32	0	8	41	85	25	22	24	22	390

^a East Fork Canyon Creek unit was only surveyed in 2016, then replaced by Overholt Creek unit in 2017; NS = not surveyed.

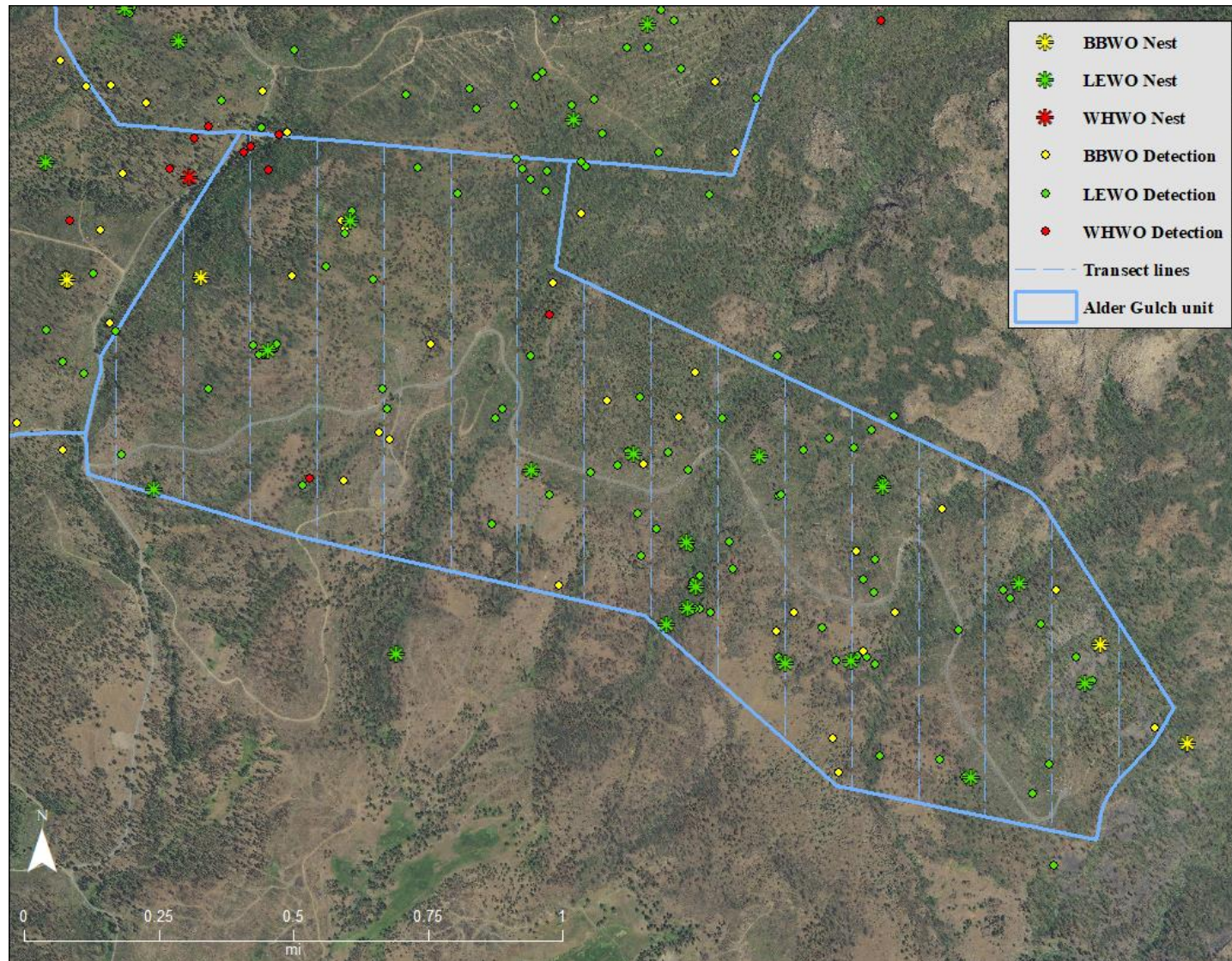
Table 5. Summary statistics (mean \pm SE) of vegetation measurements at black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests at treatment and control units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2016-2019.

	Nest Locations ^a									
	Treatment Units (n=6)					Control Units (n=4)				
	BBWO (n=92)					BBWO (n=53)				
Dbh ^b (in)	15.4 (± 0.5)					14.5 (± 1.4)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.2, 0.2	0.4, 0.1	0.4, 0.1	0.6, 0.2	0.5, 0.1	0.4, 0.3	0.5, 0.2	0.8, 0.3	0.8, 0.3	0.6, 0.2
Snags (#/ac)	65.9, 5.9	19.3, 1.4	16.7, 1.1	12.0, 0.9	7.2, 0.4	61.9, 7.6	17.9, 1.5	17.8, 1.3	11.7, 1.3	6.5, 0.7
	LEWO (n=94)					LEWO (n=40)				
Dbh ^b (in)	28.3 (± 0.7)					27.4 (± 0.5)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.9, 0.4	0.4, 0.2	0.6, 0.2	0.5, 0.2	0.2, 0.1	0.0, 0.0	0.0, 0.0	0.2, 0.1	0.1, 0.1	0.0, 0.0
Snags (#/ac)	47.5, 5.0	15.0, 1.2	11.1, 0.8	9.7, 0.8	6.8, 0.4	47.0, 8.2	15.4, 1.7	16.6, 2.0	13.4, 1.2	8.7, 0.7
	WHWO (n=66)					WHWO (n=27)				
Dbh ^b (in)	20.5 (± 1.4)					18.5 (± 2.2)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.9, 0.5	0.8, 0.3	0.8, 0.3	0.9, 0.3	0.7, 0.2	1.5, 1.5	0.3, 0.2	0.9, 0.3	1.3, 0.5	0.7, 0.2
Snags (#/ac)	45.9, 5.4	15.1, 1.7	13.0, 1.1	11.1, 1.1	6.3, 0.5	41.2, 7.5	17.9, 2.7	13.9, 1.7	12.5, 1.7	5.5, 0.8
	Non-nest Locations ^a									
	Random Guide Points (n=198)					Random Guide Points (n=118)				
Dbh ^b (in)	16.0 (± 0.6)					17.5 (± 0.8)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	3.6, 0.9	1.5, 0.3	1.8, 0.3	1.6, 0.3	1.5, 0.2	3.3, 0.9	1.8, 0.4	2.8, 0.5	2.6, 0.4	1.9, 0.3
Snags (#/ac)	52.1, 3.6	13.6, 0.8	11.5, 0.7	8.5, 0.6	4.7, 0.3	59.4, 4.8	14.8, 1.2	12.4, 0.9	9.2, 0.7	6.0, 0.5

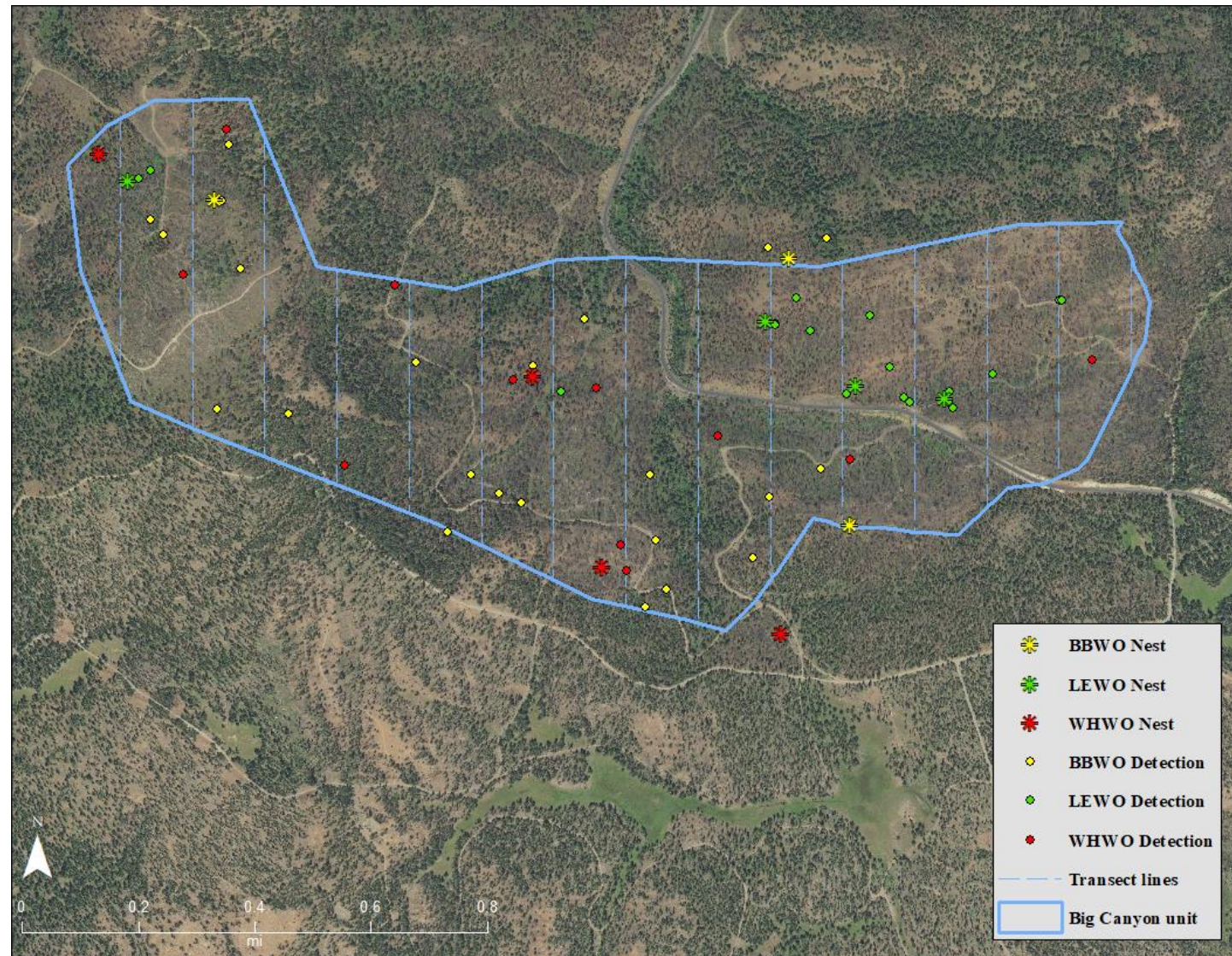
^a Tree species at nest and non-nest locations include *Abies* spp. (*A. grandis*, *A. concolor*), *Cercocarpus ledifolius*, *Juniperus occidentalis*, *Larix occidentalis*, *Picea engelmannii*, *Pinus contorta*, *P. ponderosa*, and *Pseudotsuga menziesii*.

^b Dbh for BBWOs, LEWOs, and WHWOs represents the nest tree; dbh for non-nest locations (i.e., random guide points) is determined from the center tree in the vegetation plot.

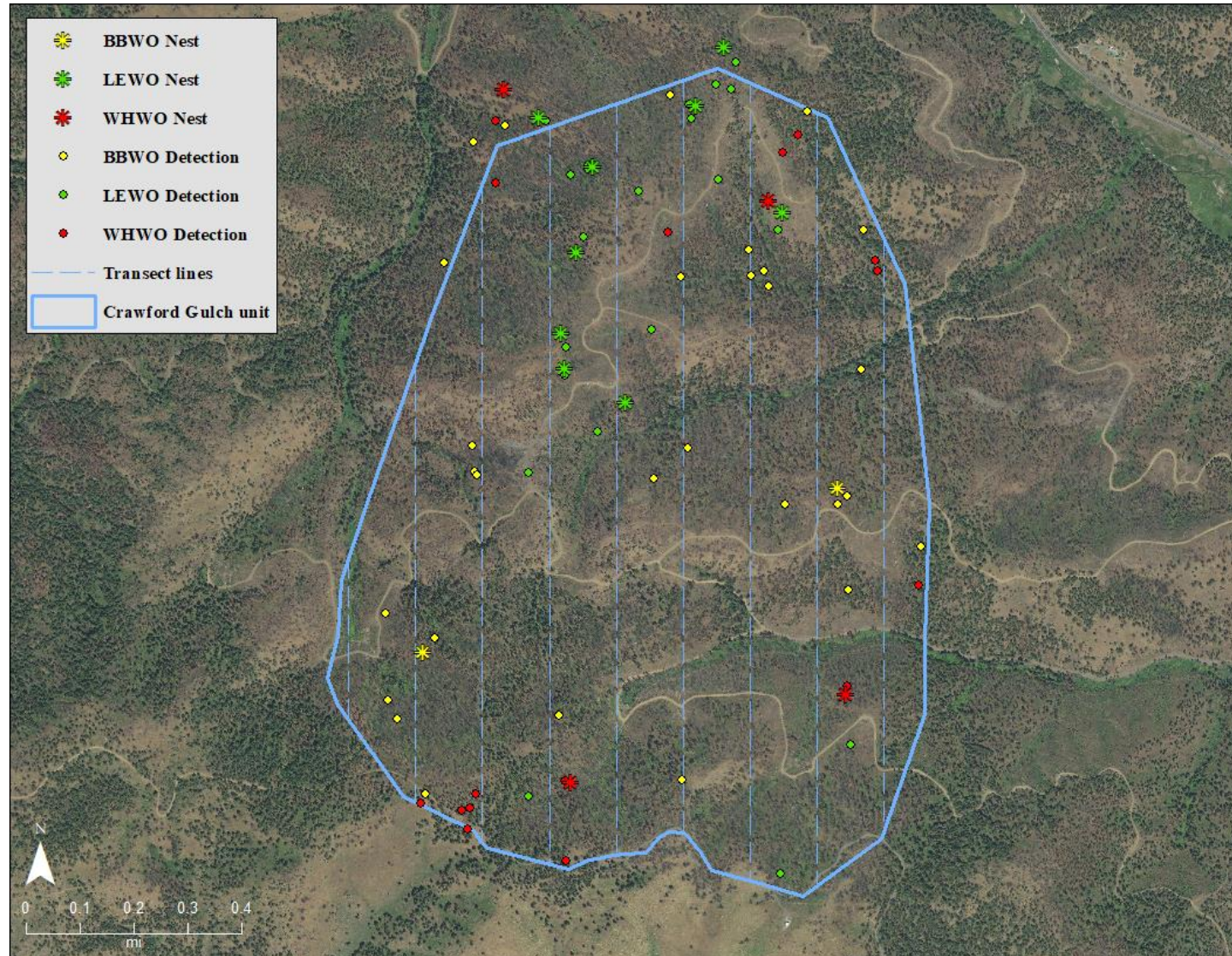
Appendix 1. Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



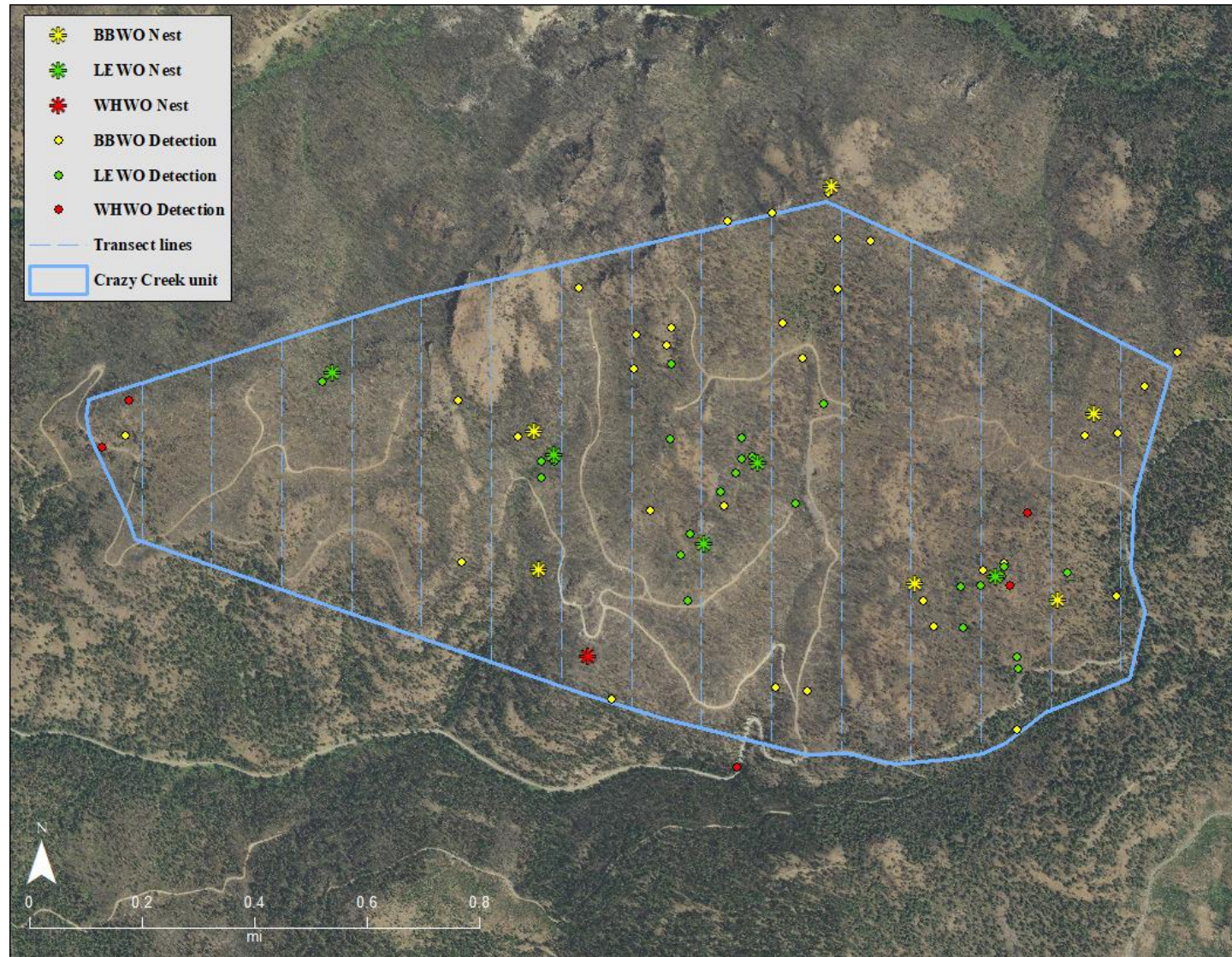
Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



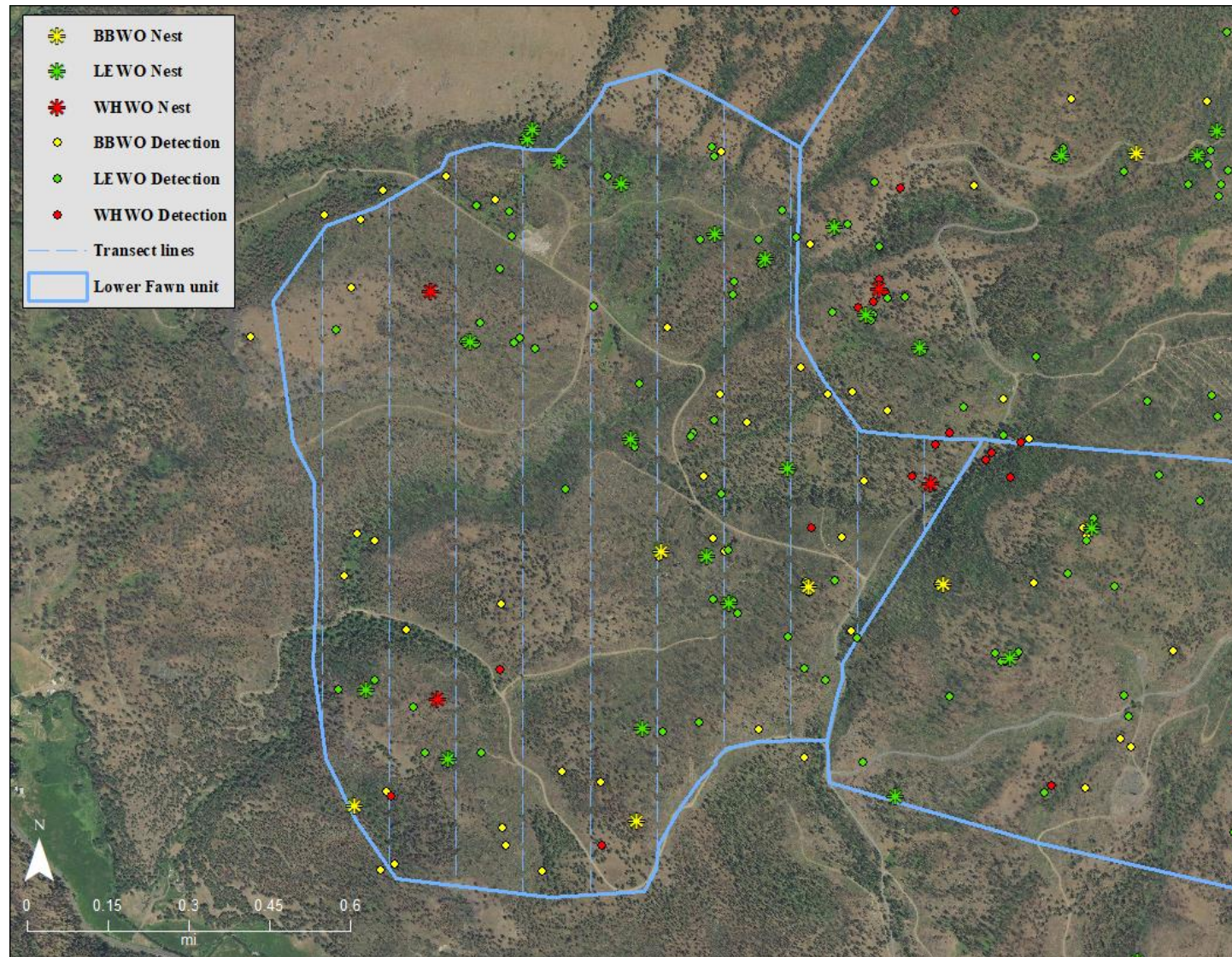
Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



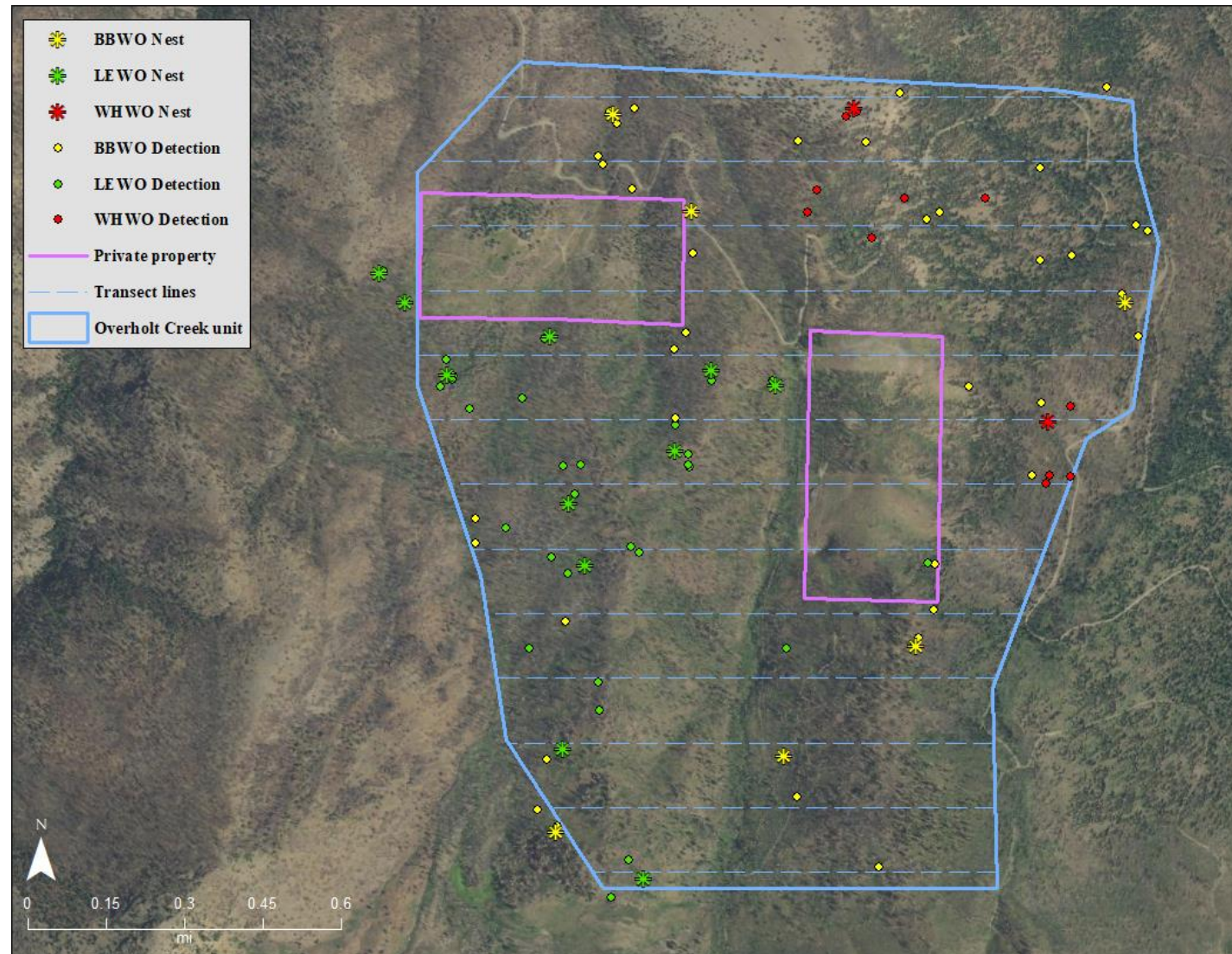
Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



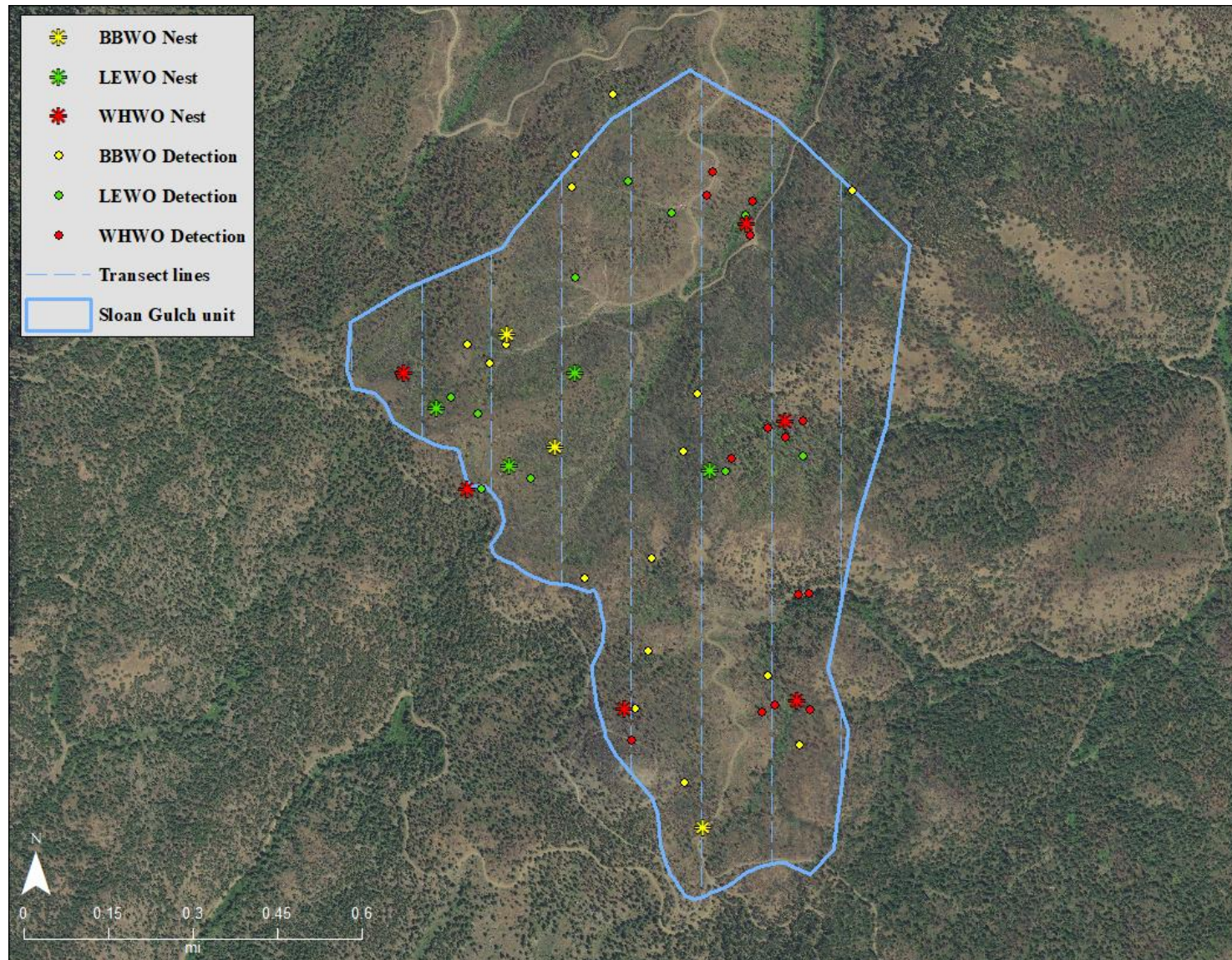
Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



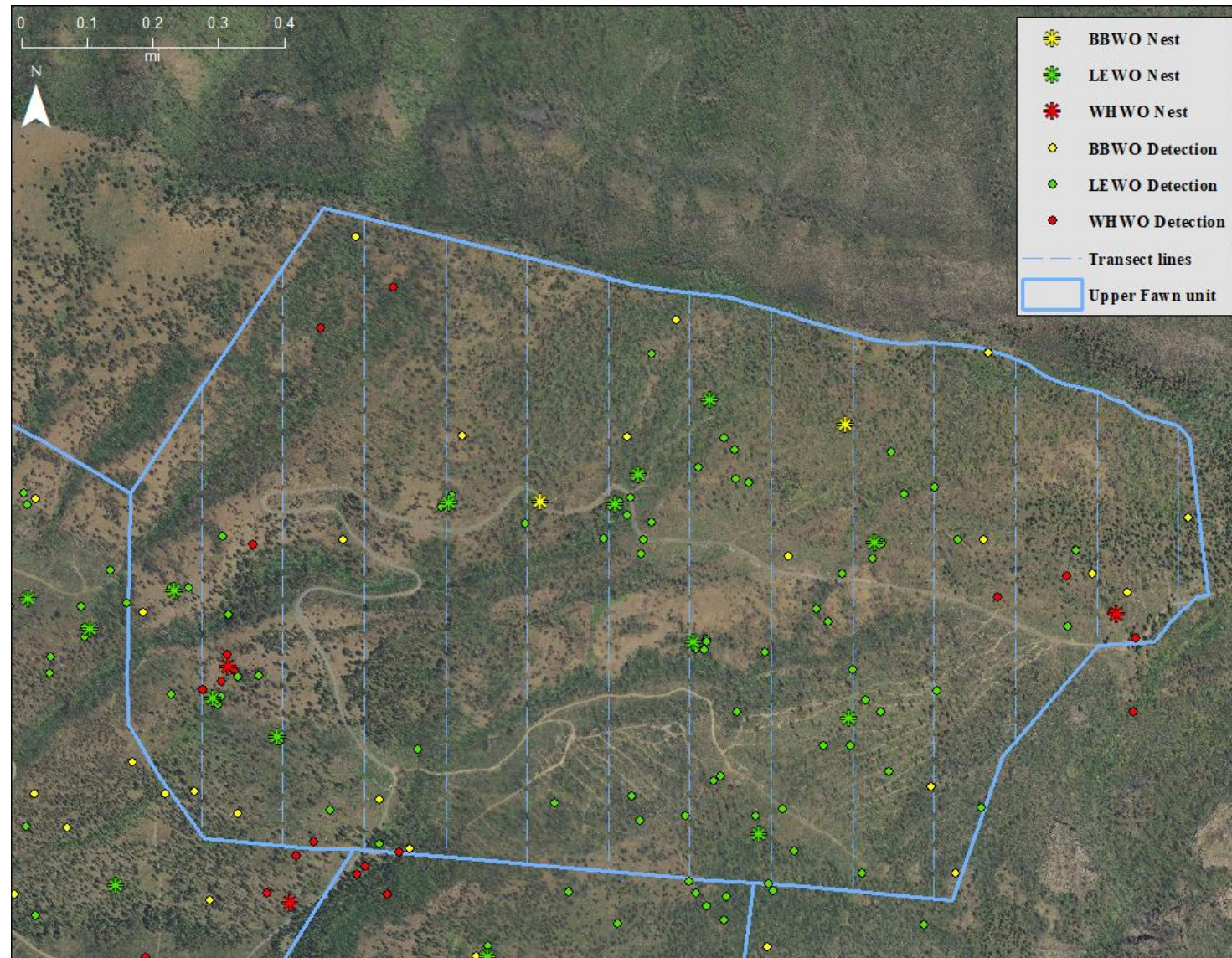
Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



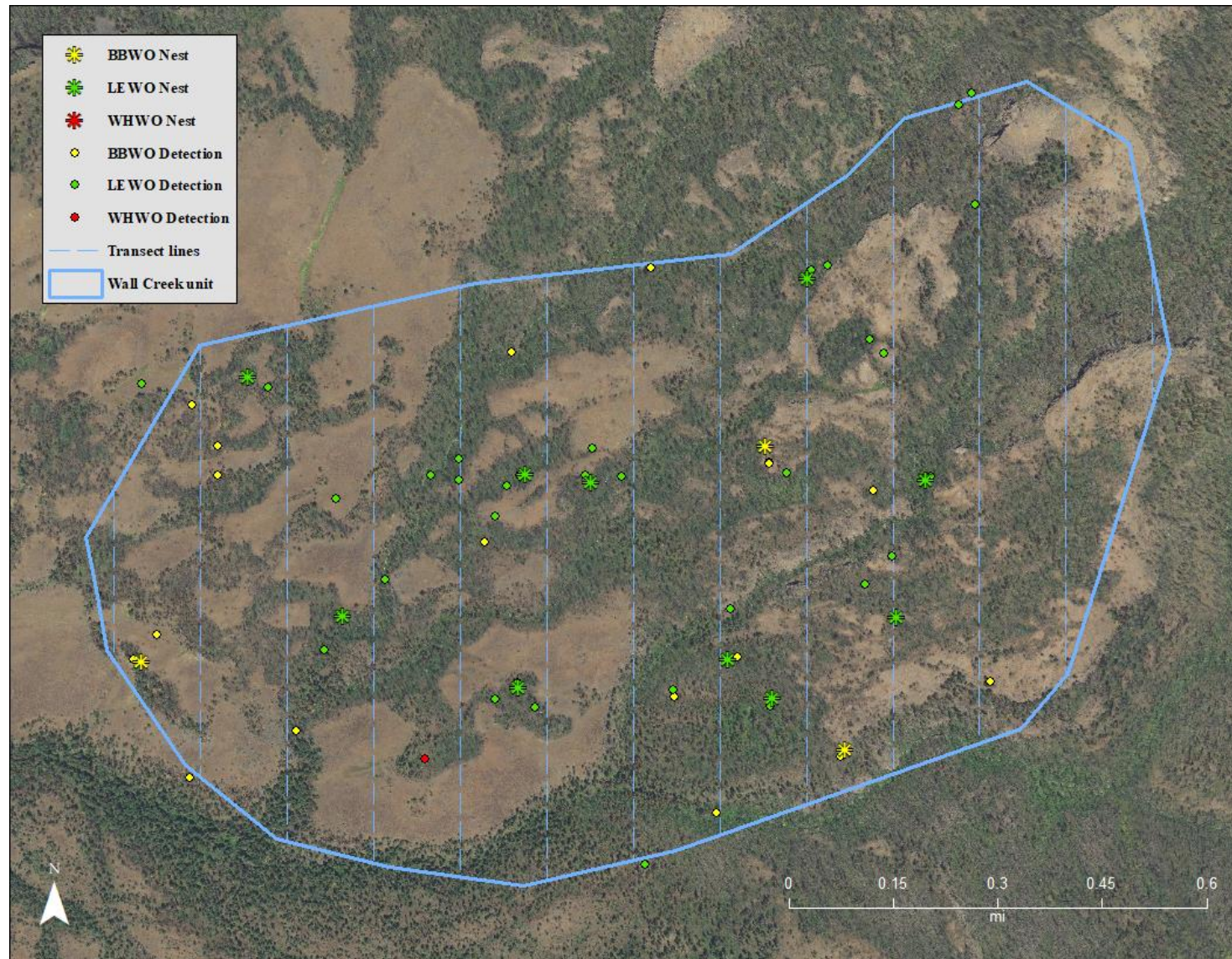
Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



Appendix 1 (cont.). Study units, and woodpecker nest and detection locations for black-backed, Lewis's, and white-headed woodpeckers on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019. Image source NAIP 2018.



Appendix 2. Summary data for black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019.

Unit ID	Unit Name	Nest_ID	Species	Nest Coordinates ^a		Initiation Date ^b	Fate	# Fledged ^c
				Northing	Easting			
T1	Upper Fawn Creek (UF)	CCORUF_NB01	LEWO	4905691	346511	30 May	Success	3
		CCORUF_NB02	WHWO	4905504	346644	-	Failed	0
		CCORUF_NC01	LEWO	4905331	346766	3 Jun	Success	4
		CCORUF_NC02	LEWO	4905427	346606	3 Jun	Success	4
		CCORUF_NE01	LEWO	4905905	347187	10 Jun	Success	3
		CCORUF_NF01	BBWO	4905910	347411	3 May	Success	3
		CCORUF_NG01	LEWO	4905904	347594	2 Jun	Success	4
		CCORUF_NG02	LEWO	4905976	347654	11 Jun	Success	3
		CCORUF_NH01	LEWO	4906159	347829	10 Jun	Success	3
		CCORUF_NH02	LEWO	4905563	347789	7 Jun	Success	3
		CCORUF_NI01	LEWO	4905093	347947	4 Jun	Success	2
		CCORUF_NJ01	BBWO	4906099	348160	10 May	Success	3
		CCORUF_NJ02	LEWO	4905809	348234	29 May	Success	5
		CCORUF_NJ03	LEWO	4905379	348169	6 Jun	Success	3
		CCORUF_NM01	WHWO	4905634	348828	3 Jun	Success	2
T2	Alder Gulch (AG)	CCORAG_NB01	LEWO	4903991	346692	-	Failed	0
		CCORAG_NC01	BBWO	4904622	346834	11 May	Success	2
		CCORAG_ND01	LEWO	4904404	347034	6 Jun	Success	1
		CCORAG_ND02	LEWO	4904791	347281	7 Jun	Success	4
		CCORAG_NE01	LEWO	4903497	347416	30 May	Success	3
		CCORAG_NG01	LEWO	4904047	347822	13 Jun	Success	3
		CCORAG_NI01	LEWO	4904096	348128	6 Jun	Success	5
		CCORAG_NI02	LEWO	4903633	348288	3 Jun	Success	4
		CCORAG_NI03	LEWO	4903585	348227	8 Jun	Success	3
		CCORAG_NJ01	LEWO	4903698	348314	6 Jun	Success	1
		CCORAG_NJ02	LEWO	4903832	348286	5 Jun	Success	2
		CCORAG_NK01	LEWO	4904087	348503	13 Jun	Success	2
		CCORAG_NK02	LEWO	4903470	348580	-	Failed	0
		CCORAG_NL01	LEWO	4903476	348779	7 Jun	Success	5
		CCORAG_NL02	LEWO	4903997	348875	5 Jun	Success	5
		CCORAG_NN01	LEWO	4903128	349137	15 Jun	Failed	0
		CCORAG_NN02	LEWO	4903707	349281	1 Jun	Success	2
		CCORAG_NO01	LEWO	4903409	349479	8 Jun	Success	5
		CCORAG_NP01	BBWO	4903526	349525	19 May	Success	2
		CCORAG_NQ01	BBWO	4903230	349786	11 May	Failed	0
T3	Sloan Gulch (SG)	CCORSG_NB01	LEWO	4898588	345424	10 Jun	Success	3
		CCORSG_NB02	WHWO	4898687	345330	15 Jun	Success	1
		CCORSG_NC01	LEWO	4898423	345629	6 Jun	Success	1
		CCORSG_NC02	WHWO	4898356	345511	17 May	Success	4

^a Nest coordinates are projected as North American Datum 1983, UTM zone 11N.

^b Initiation date is the estimated date the first egg was laid.

^c Number of nestlings fledged is based on the last accurate count of nest contents during nest monitoring.

Appendix 2. Summary data for black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019.

Unit ID	Unit Name	Nest_ID	Species	Nest Coordinates ^a		Initiation Date ^b	Fate	# Fledged ^c
				Northing	Easting			
T3	Sloan Gulch (SG)	CCORSG_ND01	BBWO	4898797	345625	10 May	Success	2
		CCORSG_ND02	BBWO	4898475	345761	15 May	Success	3
		CCORSG_ND03	LEWO	4898687	345817	11 Jun	Success	2
		CCORSG_NE01	WHWO	4897726	345960	28 May	Failed	0
		CCORSG_NF01	BBWO	4897388	346184	20 May	Success	2
		CCORSG_NF02	LEWO	4898410	346206	-	Failed	0
		CCORSG_NG01	WHWO	4897752	346453	26 May	Success	3
		CCORSG_NG02	WHWO	4898551	346420	2 Jun	Success	2
		CCORSG_NG03	WHWO	4899115	346308	9 Jun	Success	3
T4	Crazy Creek (CC)	CCORCC_NE01	LEWO	4898649	357324	7 Jun	Success	5
		CCORCC_NH01	LEWO	4898412	357959	12 Jun	Success	3
		CCORCC_NH02	BBWO	4898084	357916	13 May	Success	3
		CCORCC_NH03	WHWO	4897838	358054	30 May	Failed	0
		CCORCC_NH04	BBWO	4898481	357902	-	-	-
		CCORCC_NJ01	LEWO	4898160	358387	8 Jun	Success	3
		CCORCC_NK01	LEWO	4898390	358541	6 Jun	Success	4
		CCORCC_NL01	BBWO	4899182	358753	17 May	Success	2
		CCORCC_NM01	BBWO	4898046	358989	9 May	Success	1
		CCORCC_NN01	LEWO	4898065	359222	2 Jun	Success	3
		CCORCC_NO01	BBWO	4897998	359400	9 May	Success	1
		CCORCC_NP01	BBWO	4898532	359501	14 May	Success	1
		CCORBC_NB01	LEWO	4895944	352002	3 Jun	Success	2
T5	Big Canyon (BC)	CCORBC_NB02	WHWO	4896020	351920	25 May	Success	1
		CCORBC_ND01	BBWO	4895891	352240	10 May	Success	1
		CCORBC_NH02	WHWO	4895404	353120	26 May	Success	1
		CCORBC_NI01	WHWO	4894876	353314	5 Jun	Success	2
		CCORBC_NK01	LEWO	4895555	353767	6 Jun	Success	1
		CCORBC_NK02	BBWO	4895729	353832	9 May	Success	1
		CCORBC_NK03	WHWO	4894689	353807	27 May	Success	3
		CCORBC_NL01	LEWO	4895377	354017	15 Jun	Success	2
		CCORBC_NL02	BBWO	4894993	354000	4 May	Success	1
		CCORBC_NN01	LEWO	4895342	354263	31 May	Success	1
		CCORLF_NC01	BBWO	4903962	345075	8 May	Success	2
T6	Lower Fawn Creek (LF)	CCORLF_NC02	WHWO	4905499	345302	30 May	Success	1
		CCORLF_NC03	LEWO	4904307	345110	4 Jun	Success	3
		CCORLF_ND01	WHWO	4904281	345323	25 May	Success	4
		CCORLF_ND02	LEWO	4904103	345355	6 Jun	Success	4
		CCORLF_ND03	LEWO	4905348	345422	1 Jun	Success	4
		CCORLF_NE01	LEWO	4905951	345594	1 Jun	Success	1

^a Nest coordinates are projected as North American Datum 1983, UTM zone 11N.

^b Initiation date is the estimated date the first egg was laid.

^c Number of nestlings fledged is based on the last accurate count of nest contents during nest monitoring.

Appendix 2. Summary data for black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019.

Unit ID	Unit Name	Nest_ID	Species	Nest Coordinates ^a		Initiation Date ^b	Fate	# Fledged ^c
				Northing	Easting			
T6	Lower Fawn Creek (LF)	CCORLF_NE03	LEWO	4905982	345608	1 Jun	Success	1
		CCORLF_NF01	BBWO	4903916	345919	3 May	Success	3
		CCORLF_NF03	LEWO	4905821	345873	1 Jun	Success	1
		CCORLF_NF04	LEWO	4905885	345688	4 Jun	Success	4
		CCORLF_NG02	BBWO	4904721	345991	16 May	Success	2
		CCORLF_NG03	LEWO	4905057	345900	3 Jun	Success	2
		CCORLF_NG04	LEWO	4904193	345935	6 Jun	Success	1
		CCORLF_NH01	LEWO	4904568	346195	2 Jun	Success	1
		CCORLF_NH02	LEWO	4905595	346305	30 May	Success	3
		CCORLF_NH03	LEWO	4904708	346130	6 Jun	Success	2
		CCORLF_NH04	LEWO	4905670	346154	31 May	Success	2
		CCORLF_NI01	BBWO	4904617	346432	31 May	Failed	0
		CCORLF_NI03	LEWO	4904968	346369	3 Jun	Success	4
		CCORLF_NK01	WHWO	4904923	346798	29 May	Success	4
C1	Wall Creek (WC) ^d	CCORWC_NB01	BBWO	4901557	350441	5 May	-	-
		CCORWC_NC01	LEWO	4902213	350689	3 Jun	-	-
		CCORWC_ND01	LEWO	4901661	350906	-	-	-
		CCORWC_NF01	LEWO	4901990	351329	-	-	-
		CCORWC_NF02	LEWO	4901496	351312	-	-	-
		CCORWC_NF04	LEWO	4901970	351481	-	-	-
		CCORWC_NH01	LEWO	4901560	351798	-	-	-
		CCORWC_NI01	BBWO	4901354	352069	12 May	Success	1
		CCORWC_NI02	LEWO	4901471	351901	-	-	-
		CCORWC_NI03	BBWO	4902054	351883	16 May	-	-
		CCORWC_NI04	LEWO	4902441	351981	-	-	-
		CCORWC_NJ01	LEWO	4901658	352187	-	-	-
		CCORWC_NJ02	LEWO	4901975	352254	-	-	-
		CCORCG_NB01	BBWO	4897258	348800	-	-	-
C2	Crawford Gulch (CG)	CCORCG_ND01	LEWO	4898210	349215	3 Jun	Success	2
		CCORCG_ND02	LEWO	4898107	349225	1 Jun	Failed	0
		CCORCG_ND03	WHWO	4896869	349242	19 May	Success	3
		CCORCG_ND04	WHWO	4898939	349041	24 May	Success	3
		CCORCG_ND05	LEWO	4898453	349261	2 Jun	Success	1
		CCORCG_ND06	LEWO	4898854	349149	14 Jun	Success	2
		CCORCG_NE01	LEWO	4898708	349308	5 Jun	Success	2
		CCORCG_NE02	LEWO	4898005	349407	11 Jun	Success	2
		CCORCG_NF01	LEWO	4898891	349617	1 Jun	Success	2
		CCORCG_NG01	LEWO	4899065	349699	5 Jun	Success	3

^a Nest coordinates are projected as North American Datum 1983, UTM zone 11N.

^b Initiation date is the estimated date the first egg was laid.

^c Number of nestlings fledged is based on the last accurate count of nest contents during nest monitoring.

^d Due to access limitations, Wall Creek unit nests were not monitored to completion.

Appendix 2. Summary data for black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests on the Canyon Creek Complex, Malheur National Forest, Oregon, 2019.

Unit ID	Unit Name	Nest_ID	Species	Nest Coordinates ^a		Initiation Date ^b	Fate	# Fledged ^c
				Northing	Easting			
C2	Crawford Gulch (CG)	CCORCG_NG02	WHWO	4898605	349834	20 May	Success	3
		CCORCG_NG03	LEWO	4898570	349877	7 Jun	Success	1
		CCORCG_NH01	WHWO	4897132	350063	-	-	-
		CCORCG_NI01	BBWO	4897750	350039	9 May	Success	1
C4	Overholt Creek (OC)	CCOROC_NA01	WHWO	4913529	363216	21 May	Success	4
		CCOROC_NA02	BBWO	4913513	362470	-	-	-
		CCOROC_NC01	BBWO	4913210	362714	15 May	Success	2
		CCOROC_ND01	BBWO	4912928	364053	6 May	Success	2
		CCOROC_ND02	LEWO	4912931	361827	8 Jun	Success	3
		CCOROC_ND03	LEWO	4913021	361747	6 Jun	Success	3
		CCOROC_NE01	LEWO	4912718	362776	9 Jun	Success	3
		CCOROC_NE02	LEWO	4912671	362975	14 Jun	Success	3
		CCOROC_NE03	LEWO	4912825	362275	10 Jun	Success	1
		CCOROC_NF01	LEWO	4912704	361956	4 Jun	Success	3
		CCOROC_NF02	WHWO	4912562	363817	6 Jun	Success	3
		CCOROC_NG01	LEWO	4912306	362332	8 Jun	Success	3
		CCOROC_NG02	LEWO	4912470	362662	6 Jun	Success	4
		CCOROC_NH01	LEWO	4912115	362384	14 Jun	Failed	0
		CCOROC_NI01	BBWO	4911866	363408	29 May	Failed	0
		CCOROC_NK01	BBWO	4911526	363000	14 May	Success	3
		CCOROC_NK02	LEWO	4911547	362315	12 Jun	Success	3
		CCOROC_NM01	BBWO	4911291	362294	-	-	-
		CCOROC_NM02	LEWO	4911146	362564	12 Jun	Success	4

^a Nest coordinates are projected as North American Datum 1983, UTM zone 11N.

^b Initiation date is the estimated date the first egg was laid.

^c Number of nestlings fledged is based on the last accurate count of nest contents during nest monitoring.

Appendix 3. Summary statistics (mean ± SE) of vegetation measurements at black-backed (BBWO), Lewis’s (LEWO), and white-headed (WHWO) woodpecker nests at Level 1 treatment units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2016-2019.

Nest Locations ^a										
Pre-treatment (2016)						Post-treatment (2017-2019)				
BBWO (n=14)						BBWO (n=29)				
Dbh ^b (in)	14.1 (± 1.7)					16.2 (± 1.2)				
	Diameter Class (in)					Diameter Class (in)				
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.7, 0.7	0.6, 0.3	0.5, 0.4	0.4, 0.2	0.8, 0.4	0.3, 0.3	0.5, 0.2	0.5, 0.3	0.6, 0.4	0.5, 0.2
Snags (#/ac)	114.1, 17.9	23.6, 4.1	17.5, 2.7	10.4, 2.2	8.7, 1.4	62.4, 9.7	23.6, 3.2	15.9, 1.8	7.3, 1.3	6.2, 0.8
LEWO (n=0)						LEWO (n=19)				
Dbh ^b (in)						26.4 (± 1.6)				
	Diameter Class (in)					Diameter Class (in)				
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	-	-	-	-	-	0.5, 0.5	0.0, 0.0	0.1, 0.1	0.0, 0.0	0.0, 0.0
Snags (#/ac)	-	-	-	-	-	62.3, 13.0	19.5, 2.9	12.6, 2.1	11.4, 2.5	8.4, 0.7
WHWO (n=7)						WHWO (n=15)				
Dbh ^b (in)	17.4 (± 2.7)					20.2 (± 1.7)				
	Diameter Class (in)					Diameter Class (in)				
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.3, 0.3	0.0, 0.0	3.4, 2.1	2.1, 1.2	1.5, 0.9	1.1, 0.6	1.1, 0.5
Snags (#/ac)	78.2, 13.6	27.8, 7.2	20.4, 5.0	15.4, 3.7	5.6, 1.7	39.1, 10.5	12.1, 2.9	9.4, 2.2	7.6, 2.3	5.3, 1.3
Non-nest Locations ^a										
Random Guide Points (n=20)						Random Guide Points (n=43)				
Dbh ^b (in)	16.1 (± 1.3)					15.3 (± 0.9)				
	Diameter Class (in)					Diameter Class (in)				
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	11.1, 3.7	5.5, 1.9	5.6, 1.6	5.3, 1.6	3.9, 1.2	5.6, 3.2	2.0, 0.7	1.6, 0.7	1.1, 0.5	0.8, 0.3
Snags (#/ac)	58.8, 11.0	14.1, 2.9	10.1, 1.7	7.6, 1.7	3.8, 0.8	66.6, 7.9	19.3, 1.6	12.2, 1.6	6.2, 0.8	4.4, 0.6

^a Tree species at nest and non-nest locations include *Abies spp.* (*A.grandis*, *A.concolor*), *Cercocarpus ledifolius*, *Juniperus occidentalis*, *Larix occidentalis*, *Picea engelmannii*, *Pinus contorta*, *P. ponderosa*, and *Pseudotsuga menziesii*.

^b Dbh for BBWOs, LEWOs, and WHWOs represents the nest tree; dbh for non-nest locations (i.e., random guide points) is determined from the center tree in the vegetation plot.

Appendix 4. Summary statistics (mean \pm SE) of vegetation measurements at black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests at Level 2 treatment units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2016-2019.

	Nest Locations ^a									
	Pre-treatment (2016)					Post-treatment (2017-2019)				
	BBWO (n=6)					BBWO (n=17)				
Dbh ^b (in)	17.8 (± 2.9)					14.6 (± 1.2)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.0, 0.0	0.0, 0.0	1.0, 1.0	1.7, 1.7	0.7, 0.7	0.0, 0.0	0.1, 0.1	0.1, 0.1	0.4, 0.2	0.2, 0.2
Snags (#/ac)	60.7, 27.4	18.0, 2.8	20.8, 2.5	20.8, 5.6	7.8, 1.4	48.8, 12.6	17.5, 2.7	14.9, 2.5	12.7, 1.8	8.6, 0.9
	LEWO (n=0)					LEWO (n=41)				
Dbh ^b (in)	27.4 (± 1.1)									
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	-	-	-	-	-	0.5, 0.3	0.1, 0.1	0.4, 0.3	0.7, 0.4	0.2, 0.1
Snags (#/ac)	-	-	-	-	-	50.6, 7.9	16.3, 1.7	11.3, 1.0	8.4, 1.1	6.6, 0.6
	WHWO (n=6)					WHWO (n=14)				
Dbh ^b (in)	20.8 (± 3.6)					19.3 (± 2.1)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.0, 0.0	0.2, 0.2	0.0, 0.0	0.0, 0.0	0.5, 0.5	0.7, 0.7	0.9, 0.5	1.6, 1.1	1.9, 0.9	1.4, 0.6
Snags (#/ac)	33.2, 12.6	11.0, 2.8	15.2, 3.5	10.9, 4.3	4.9, 1.8	45.5, 17.7	15.7, 4.4	10.6, 1.9	6.3, 1.2	3.8, 0.7
	Non-nest Locations ^a									
	Random Guide Points (n=23)					Random Guide Points (n=51)				
	Dbh ^b (in)					16.4 (± 0.9)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	7.0, 3.3	1.0, 0.4	1.8, 0.6	2.2, 0.6	2.2, 0.7	0.6, 0.4	0.9, 0.4	1.3, 0.6	1.1, 0.4	1.3, 0.4
Snags (#/ac)	62.8, 12.7	10.5, 2.0	11.9, 2.4	9.8, 1.9	6.7, 1.3	47.4, 8.1	12.8, 1.5	9.6, 1.1	7.5, 1.3	4.8, 0.5

^a Tree species at nest and non-nest locations include *Abies* spp. (*A. grandis*, *A. concolor*), *Cercocarpus ledifolius*, *Juniperus occidentalis*, *Larix occidentalis*, *Picea engelmannii*, *Pinus contorta*, *P. ponderosa*, and *Pseudotsuga menziesii*.

^b Dbh for BBWOs, LEWOs, and WHWOs represents the nest tree; dbh for non-nest locations (i.e., random guide points) is determined from the center tree in the vegetation plot.

Appendix 5. Summary statistics (mean \pm SE) of vegetation measurements at black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests at Level 3 treatment units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2016-2019.

	Nest Locations ^a									
	Pre-treatment (2016)					Post-treatment (2017-2019)				
	BBWO (n=6)					BBWO (n=20)				
Dbh ^b (in)	18.1 (± 2.8)					14.8 (± 0.8)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.0, 0.0	0.3, 0.2	0.7, 0.5	1.3, 0.6	1.3, 0.6	0.0, 0.0	0.5, 0.4	0.3, 0.2	0.5, 0.3	0.1, 0.1
Snags (#/ac)	52.3, 18.0	10.1, 1.7	19.1, 6.2	19.1, 4.1	7.9, 0.8	56.2, 10.2	14.7, 1.7	17.0, 2.3	14.5, 1.9	5.9, 0.9
	LEWO (n=0)					LEWO (n=34)				
Dbh ^b (in)	29.6 (± 1.2)									
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	-	-	-	-	-	1.5, 1.1	1.0, 0.5	1.2, 0.5	0.6, 0.2	0.2, 0.1
Snags (#/ac)	-	-	-	-	-	40.2, 6.7	10.9, 1.9	10.0, 1.5	10.3, 1.2	6.1, 0.8
	WHWO (n=6)					WHWO (n=18)				
Dbh ^b (in)	18.6 (± 2.9)					21.7 (± 2.2)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.2, 0.2	0.0, 0.0	0.2, 0.2	0.3, 0.1	0.7, 0.4	0.4, 0.2
Snags (#/ac)	55.6, 10.7	15.7, 4.7	15.2, 1.4	10.7, 4.2	7.8, 0.8	43.8, 7.6	13.5, 2.5	13.5, 2.2	16.1, 2.0	9.2, 1.0
	Non-nest Locations ^a									
	Random Guide Points (n=18)					Random Guide Points (n=43)				
	Dbh ^b (in)					16.0 (± 0.7)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.6, 0.6	0.4, 0.4	0.8, 0.4	0.3, 0.2	1.3, 0.6	0.9, 0.7	0.8, 0.3	1.3, 0.6	1.1, 0.6	0.7, 0.3
Snags (#/ac)	42.7, 9.1	10.9, 1.9	10.5, 1.8	9.2, 1.7	5.9, 0.7	38.4, 5.1	11.5, 1.7	13.9, 1.7	11.4, 1.4	3.9, 0.6

^a Tree species at nest and non-nest locations include *Abies* spp. (*A. grandis*, *A. concolor*), *Cercocarpus ledifolius*, *Juniperus occidentalis*, *Larix occidentalis*, *Picea engelmannii*, *Pinus contorta*, *P. ponderosa*, and *Pseudotsuga menziesii*.

^b Dbh for BBWOs, LEWOs, and WHWOs represents the nest tree; dbh for non-nest locations (i.e., random guide points) is determined from the center tree in the vegetation plot.

Appendix 6. Summary statistics (mean \pm SE) of vegetation measurements at black-backed (BBWO), Lewis's (LEWO), and white-headed (WHWO) woodpecker nests at control units on the Canyon Creek Complex, Malheur National Forest, Oregon, 2016-2019.

	Nest Locations ^a									
	Pre-treatment (2016)					Post-treatment (2017-2019)				
	BBWO (n=17)					BBWO (n=36)				
Dbh ^b (in)	12.8 (± 1.0)					15.6 (± 1.0)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.6, 0.6	1.0, 0.5	1.2, 0.7	1.3, 0.9	0.9, 0.5	0.3, 0.3	0.3, 0.2	0.6, 0.3	0.6, 0.3	0.5, 0.2
Snags (#/ac)	58.9, 14.5	16.5, 2.9	21.4, 2.3	12.9, 2.3	6.6, 1.3	63.2, 8.9	18.5, 1.8	16.1, 1.5	11.1, 1.6	6.5, 0.8
	LEWO (n=0)					LEWO (n=40)				
Dbh ^b (in)	27.9 (± 1.7)									
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	-	-	-	-	-	0.0, 0.0	0.0, 0.0	0.2, 0.1	0.1, 0.1	0.0, 0.0
Snags (#/ac)	-	-	-	-	-	47.0, 8.2	15.4, 1.7	16.6, 2.0	13.4, 1.2	8.7, 0.7
	WHWO (n=6)					WHWO (n=21)				
Dbh ^b (in)	16.8 (± 2.3)					20.4 (± 2.0)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	0.0, 0.0	0.2, 0.2	1.3, 0.9	0.5, 0.5	0.8, 0.5	1.9, 1.9	0.3, 0.2	0.7, 0.2	1.5, 0.6	0.7, 0.3
Snags (#/ac)	42.2, 12.1	19.7, 7.8	14.1, 4.2	11.8, 4.2	5.6, 1.6	41.0, 9.2	17.3, 2.7	13.8, 1.9	12.7, 1.8	5.5, 1.0
	Non-nest Locations ^a									
	Random Guide Points (n=29)					Random Guide Points (n=89)				
Dbh ^b (in)	15.2 (± 0.8)					17.7 (± 0.8)				
	Diameter Class (in)									
	≥4–9	≥9–12	≥12-15	≥15-20	≥20	≥4–9	≥9–12	≥12-15	≥15-20	≥20
Live trees (#/ac)	2.4, 1.6	2.1, 0.7	4.9, 1.4	3.7, 1.1	1.7, 0.4	3.6, 1.1	1.7, 0.5	2.2, 0.5	2.3, 0.4	2.0, 0.4
Snags (#/ac)	65.2, 10.3	16.9, 3.1	16.0, 2.0	11.4, 1.5	7.2, 1.2	57.5, 5.5	14.1, 1.2	11.2, 0.9	8.5, 0.8	5.7, 0.7

^a Tree species at nest and non-nest locations include *Abies* spp. (*A. grandis*, *A. concolor*), *Cercocarpus ledifolius*, *Juniperus occidentalis*, *Larix occidentalis*, *Picea engelmannii*, *Pinus contorta*, *P. ponderosa*, and *Pseudotsuga menziesii*.

^b Dbh for BBWOs, LEWOs, and WHWOs represents the nest tree; dbh for non-nest locations (i.e., random guide points) is determined from the center tree in the vegetation plot.