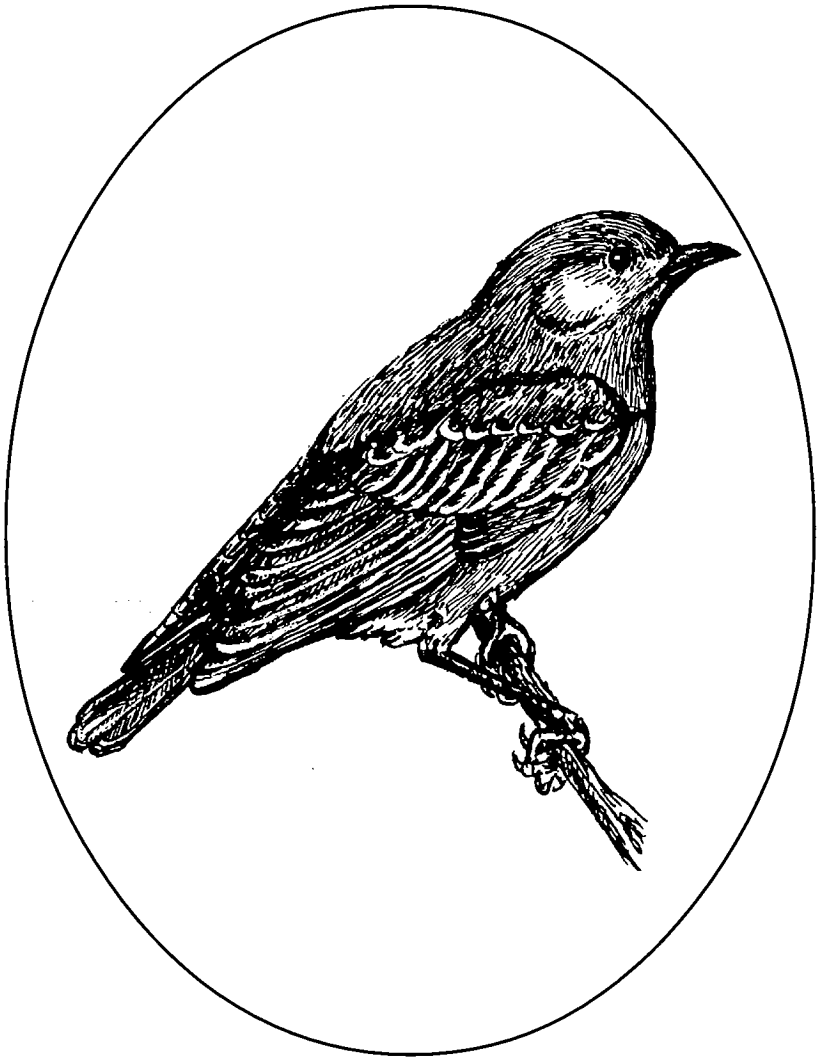
TECHNICAL BULLETIN NO. 97-12 IDAHO BUREAU OF LAND MANAGEMENT July 1997



Breeding Bird Survey of Old Growth/Seral, Prescribed Burn, and Clearcut Stands of Western Juniper

by
Golden Eagle Audubon Society

BREEDING BIRD SURVEY OF OLD-GROWTH/SERAL, PRESCRIBED BURN, AND CLEARCUT STANDS OF WESTERN JUNIPER

Golden Eagle Audubon Society
6 January 1997

Cooperative Challenge Cost Share Project

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Abstract: A survey of avian use of western juniper stands subjected to three management strategies was conducted during May and June 1993 in the Owyhee and Bruneau Resource Areas, Owyhee County, Idaho. The three managment strategies included: untreated (old-growth/seral), prescribed burns, and clearcuts. Two-hundred and ten eight-minute samples were conducted at 70 points. Fourty-one species and 1755 birds were observed. Old-growth/seral plots averaged 4.15 species and 6.44 birds per plot, prescribed burn plots averaged 1.89 species and 2.87 birds per plot, and clearcut plots averaged 1.74 species and 2.49 birds per plot. Gray flycatcher, mountain bluebird, American robin, chipping sparrow, dark-eyed junco, and Cassin's finch were most abundant in old-growth/seral stands. Vesper sparrow were most abundant in prescribed burn stands. Tree swallow, violet green swallow, house wren, green-tailed towhee, Brewer's sparrow, and Brewer's blackbird were most abundant in clearcut areas.

INTRODUCTION

Western juniper (Juniperus occidentalis) stands were historically found in rock outcrops, along streams, and on scablands (Eddleman 1984). Distribution was limited by seed dispersal and periodic fires. During the past 150 years, western juniper has expanded its range into adjacent grass and shrublands as a result of fire suppression, overgrazing, and climatic changes (Burkhardt and Tisdale 1976, Meeuwig and Murray 1978). Understory grass and forb productivity declines as juniper stands mature, thereby reducing forage available to grazing ungulates. For this reason juniper has been considered an invader in some areas and is targeted for removal. A variety of removal strategies have been proposed including clearcutting and prescribed burning.

Several studies have shown the importance of pinyon-juniper stands to avian species (Balda and Masters 1980, Sedgewick 1987). Few studies have been conducted to determine avian use of western juniper stands. Western juniper provided perching and nesting sites for at least 27 species of birds (Maser and Gashwiler 1978). Juniper berries were an important food source for migratory and winter resident birds such as robins and Townsend solitaires (Eddleman 1984).

Overstory removal in pinyon-juniper stands may result in significant declines in avian use (O'Meara et al. 1981, Sedgewick and Ryder 1987). The objective of this study was to inventory avian use during May and June in prescribed burn, clearcut, and old-growth/seral stands of western juniper in southwest Idaho.

METHODS

Survey points were located within a three-mile buffer along the Mud Flat road between Juniper Mountain and the Mud Flat Guard Station, Owyhee County, Idaho (Fig. 1). Three treatment types were surveyed: old-growth/seral (OG/S) (25 points, 5 transects), prescribed burn (PB) (26 points, 3 transects), and clearcut (CC) (19 points, 3 transects) stands. Survey points were located approximately 250 m apart and 125 m from ecotones.

Habitat Parameters

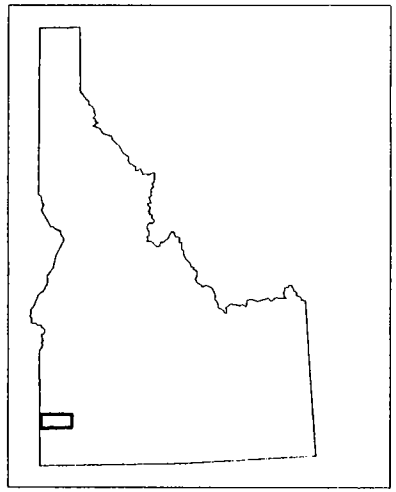
Live tree stems were counted in a fixed radius (11.3 m for moderate and high density stands or 25 m for low density stands) circle centered on the survey point. Stems were recorded by diameter breast height (dbh) classes (seedling, <5 cm, 5-10 cm, 10.1-20 cm, 20.1-40 cm, >40 cm).

Snags and downed logs were counted in a fixed radius (11.3 m or 25 m) circle centered on the survey point. Snags and logs were classified by decay class (undecayed, no bark, moderate decay, very decayed) and size (1-10 cm, 10.1-20 cm, >20 cm).

Avian Population Survey

The point count method was used to determine avian species use. An attempt was made to sample each point three times between 1 May 1992 and 30 June 1993. The same observer

Fig. 1. Location of breeding bird survey points in old-growth/seral, prescribed burn, and clearcut treatments in Owyhee County, Idaho.



N

Old-growth/Seral

Prescribed Burn

Clearcut

North Fork
Owyhee River
Pleasant Valley Creek
Squaw Creek
Pleasant Valley PB
Juniper Mtn PCB
Juniper Mtn OGS
Cottonwood Cr PB
Hanley Cabin CC
Pleasant Valley CC
Pleasant Valley OGS
Rays Res East OGS
Rays Res West OGS
Current Creek
Nickel Creek
Nip and Tuck
Deep Creek
Sam Noble PB
Pole Creek
Camas Creek

conducted all avian surveys. Surveys were conducted only when climatic conditions (high wind, rain) did not affect detectability. Surveys began at sunrise and were terminated at 1100. Each point was surveyed for eight minutes per sample. Observations were recorded for 0-50 m, 51-125 m, and >125 m distances from plot center. Data recorded included: species, activity, number of birds, distance buffer from point (0-50 m, 51-125 m, >125 m), and quadrant (NE, SE, SW, NW). Incidental observations were recorded separately.

Avian Population Data Analyses

Analyses were based on birds observed within 50 m of observation points unless otherwise noted. The mean number of species and birds observed was determined for sample periods and for all periods combined by transect and treatment type. Observations of unidentified birds were included in determining abundance. Observations of identified species were used to calculate diversity. Differences in abundance between treatments and sampling periods were determined using ANOVA (McGarigal and McComb 1992). Similarity in bird species composition between treatments was determined using Sorenson's Index (Mueller-Dombois and Ellenberg 1974):

$$\text{Sorenson's Index} = 2W \times 100/(a+b)$$

where W was the number of species shared between the two treatments being compared
a was the number of species in treatment A
b was the number of species in treatment B

Rarefaction was used to determine expected species diversity in different treatments based on number of birds observed (James and Rathbun 1981).

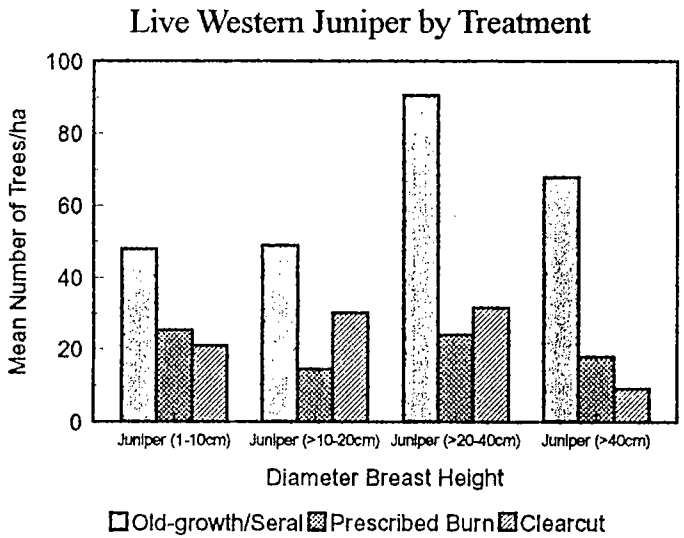
RESULTS

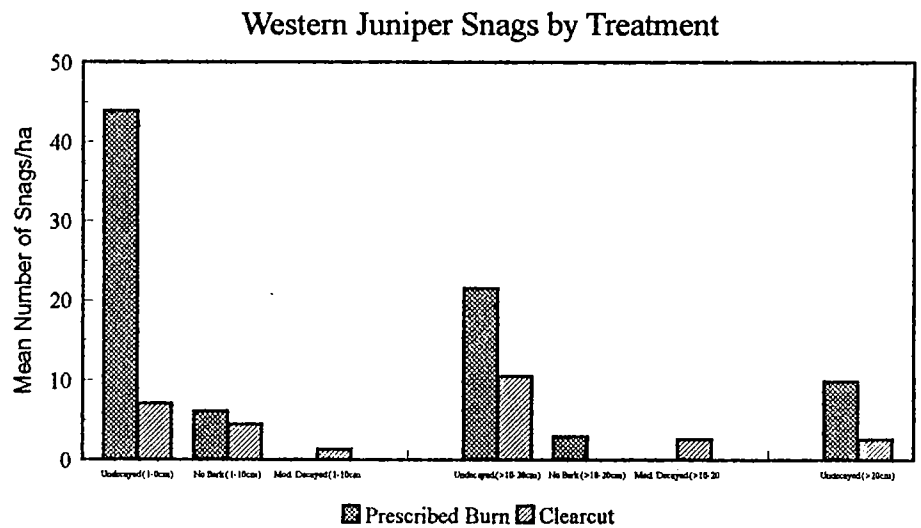
Climate and Habitat Parameters

Precipitation for the period October-July measured at Silver City was 44.5 cm in 1992 and 60.3 cm in 1993. Live juniper densities were 3 times greater in OG/S stands than PB or CC treatments for > 20 cm dbh classes (Fig. 2). Juniper snag and log densities were greatest in PB and CC plots (Fig. 2). Fire removed live mountain mahogany in PB treatments; however, mahogany densities were also reduced in mature juniper stands (Fig. 3).

Avian Populations

Two-hundred and ten separate eight-minute bird surveys were conducted between 2 May and 28 June 1993. Fourty-one species and 1755 birds (including 154 birds of unidentified species) were observed at all distances for all plots combined (Appendix A). Thirty-five species and 859 birds (including 84 birds of unidentified species) were observed within 50 m of all points (Table 1).





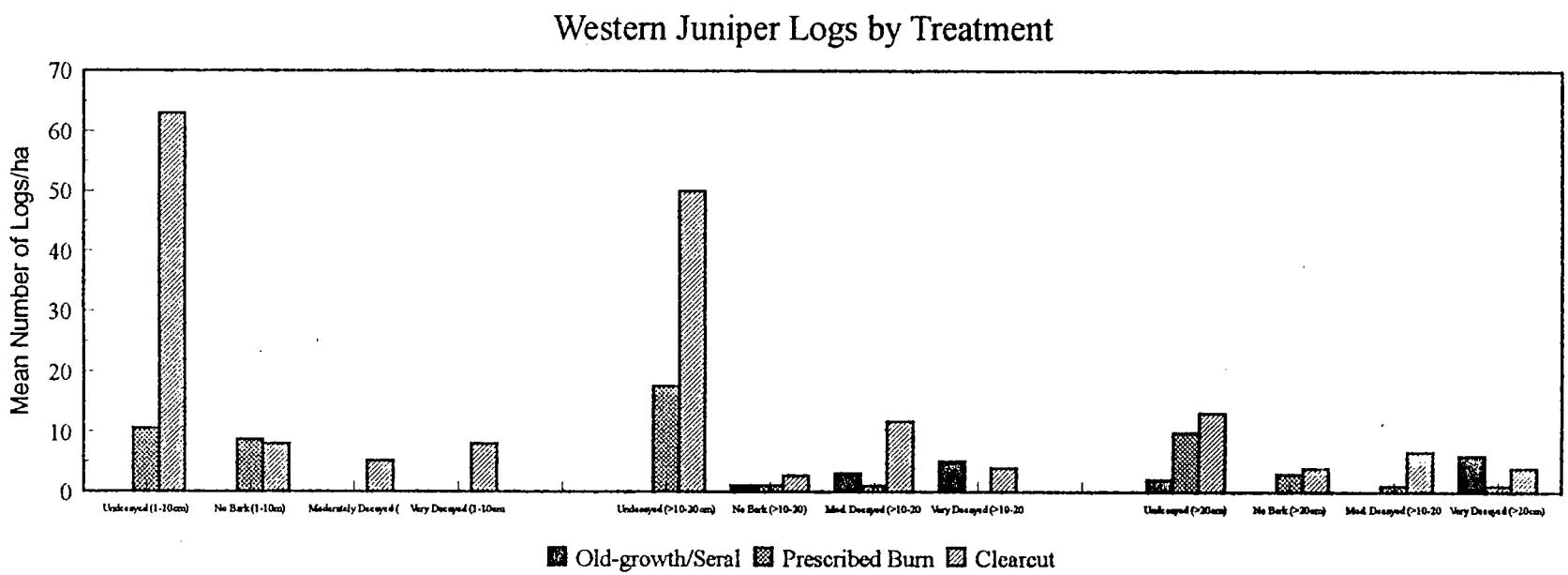
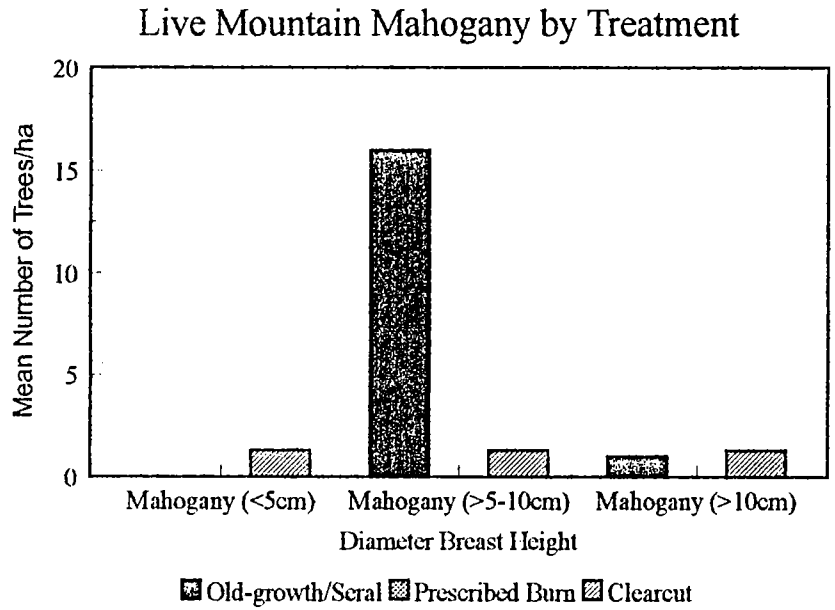
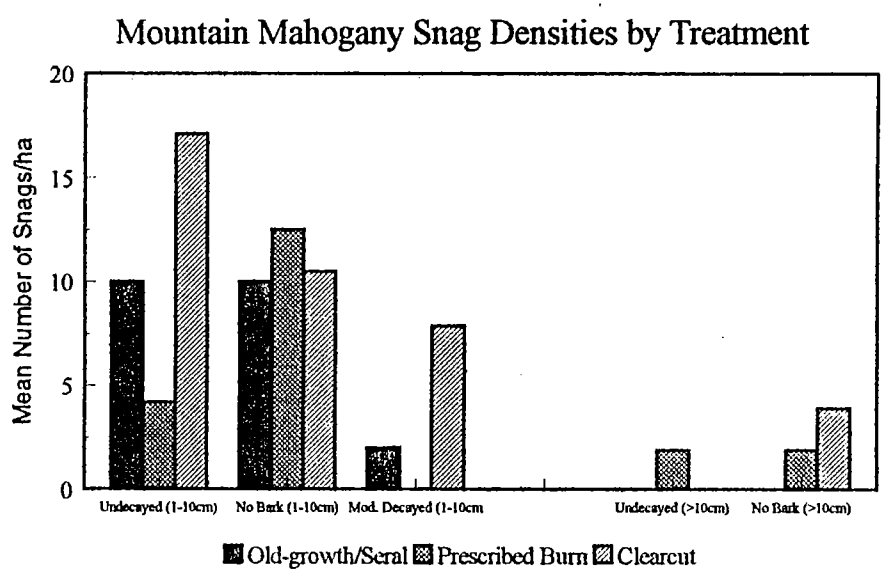


Figure 2. Mean number of western juniper live trees, snags, and logs by treatment (old-growth/seral, prescribed burn, clearcut), Owyhee County, Idaho.





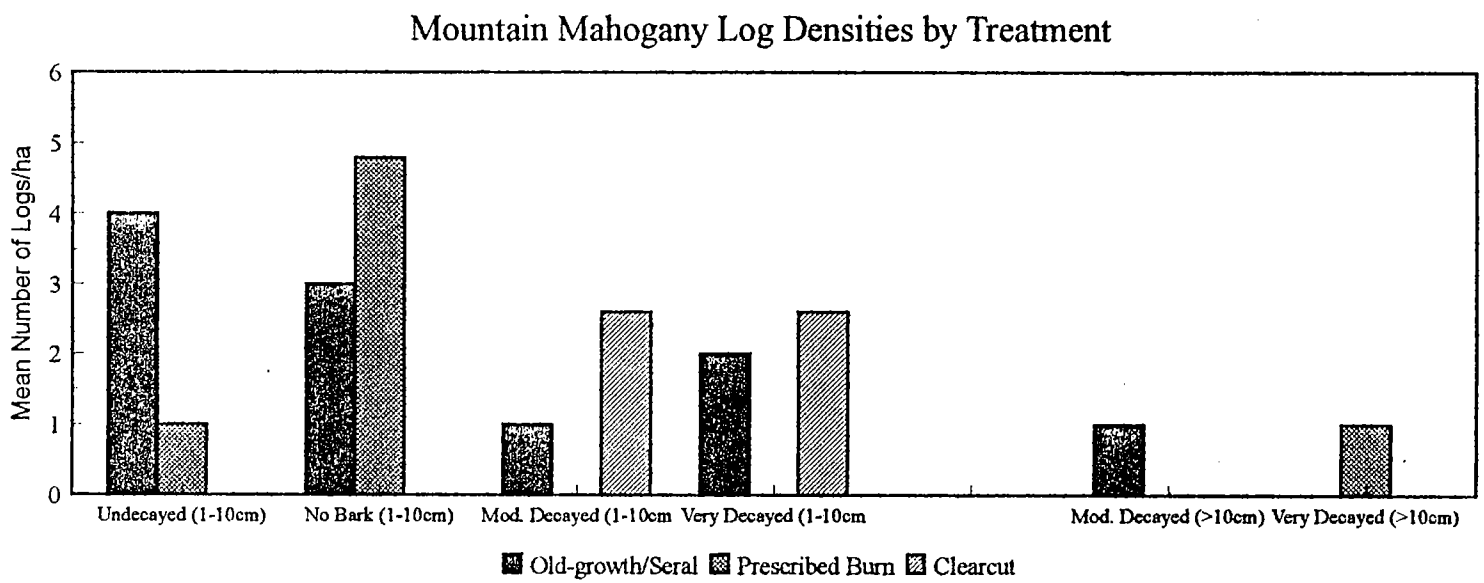


Figure 3. Mean number of mountain mahoghany live shrubs, snags, and logs by treatment (old-growth/seral, prescribed burn, clearcut), Owyhee County, Idaho.

Table 1. Number of birds by species seen within 50 m of sample points in old-growth/seral (OGS), prescribed burn (PB), and clearcut (CC) stands sampled 2 May through 28 June 1993, Owyhee Count, Idaho. Season of use, habitat, and nest location are from Saab and Groves (1992).

Species		w/in 50 m			Season	Habitat	Nest Loc.
		OG/S	PB	CC			
Turkey vulture	TUVU	1					
Red-tailed hawk	RTHA	3	3		R*	R,SS,C,W	D,C
American kestrel	AMKE	3		1	R*	SS,R,A	Sn,Cl
Common snipe	COSN	3	1				
Mourning dove	MODO	3		1			
Calliope hummingbird	CAHU		1	1	B*	R,C,W	D/C,S
Unknown hummingbird	UNHU	2	2	1			
Red-naped sapsucker	RNSA		1				
Northern flicker	NOFL	9	4	1		R	
Downy woodpecker	DOWO	1				R	
Gray flycatcher	GRFL	68	37	15	B*		
Dusky flycatcher	DUFL	2					
Unknown flycatcher	UNFL	1		2			
Tree swallow	TRES			10			
Violet-green swallow	VGSW	2		8	B*	W,C,R	Sn,Cl,T
Common raven	CORA	16	1	2	R		
Mountain chickadee	MOCH	7		4	R		
Red-breasted nuthatch	RBNU	1					
House wren	HOWR	9	10	13	B*	R,W,C	D,Sn
Rock wren	ROWR	3	3	1	B*	SS	G,Cr
Ruby-crowned kinglet	RCKI		2	2			

Species		w/in 50 m			Season	Habitat	Nest Loc.
		OG/S	PB	CC			
Mountain bluebird	MOBL	44	32	12	B*	SS,W,C	Sn,T
Hermit thrush	HETH	10	1		B*	C,W	
American robin	AMRO	30	6	5	R*	C,W,R	D/C,S
Yellow-rumped warbler	AUWA	4	3		B*	C,R	D/C
Black-throated gray warbler	BTYW	3			B*	W	D/C
Unknown warbler	UNWA	1					
Green-tailed towhee	GTTO	7		11	B*	SS,W,R	S,G
Vesper sparrow	VESP	5	26	13		B*	
Chipping sparrow	CHSP	70	32	10		B*	
Brewer's sparrow	BRSP	1	5	12		B*	
Dark-eyed junco	DEJU	35	8			R*	
Red-winged blackbird	RWBL	3		2	R*	We,R,A	R,S
Western meadowlark	WEME		2				
Brewer's blackbird	BRBL	3	2	9			
Brown-headed cowbird	BHCO	21	1	1	B*	C,W,SS	D,S
Cassin's finch	CAFI	53	15	2	R*	C,W	T
Pine siskin	PISI		2	4			
Unknown	UNKN	58	20	6			
Totals		483	234	142			
Identified Species		30	23	22			
Unknown		4	2	3			

Season - R=resident, B=breeding, *=neotropical migrant
Habitat Association - C=coniferous and mixed coniferous/deciduous, W=woodland, aspen, mountain mahogany, juniper, R=riparian, SS=sagebrush, grassland, We=wetland
Nest Location - C=coniferous tree, D=deciduous tree, C/D=coniferous or deciduous tree, Cl=cliff, Cr=crevice, G=ground, S=shrub, Sn=snag, T=tree

Thirty-two (18 obligate, 14 facultative) species of neotropical migrants were observed overall, with 25 (17 obligate, 8 facultative) species occurring within 50 m of points.

Gray flycatcher, mountain bluebird, American robin, chipping sparrow, dark-eyed junco, brown-headed cowbird, and Cassin's finch made up 66% of observations in OG/S plots (Table 1). Gray flycatcher, mountain bluebird, vesper sparrow, and chipping sparrow made up 54% of observations in PB plots. Gray flycatcher, house wren, mountain bluebird, green-tailed towhee, vesper sparrow, chipping sparrow, and Brewer's sparrow made up 73% of observations in CC plots.

Species diversity and abundance were greatest in OG/S plots and lowest in CC plots (Table 2). Abundance increased between the first sample and the last sample in OGS plots, whereas diversity and abundance were greatest in sample 2 for PB and CC plots (Appendix B). Species diversity and abundance were not different between OG/S and PB plots; however, diversity and abundance were lower ($r^2 = 0.239\text{-}0.445$, $P < 0.001$) in CC plots than OG/S and PB plots for each sampling period.

The Sam Noble PB plot had consistently lower species diversity and abundance than all other plots ($r^2 = 0.513 - 0.638$, $P < 0.001$). CC plots generally had lower species diversity than OG/S ($P < 0.001$); however, there was no consistent pattern for diversity and abundance between transects and samples.

Similarity indices for species seen within 50 m of the point were greatest for the OG/S-PB comparison and lowest for the PB-CC comparison (Table 3). Similarity indices between sample periods were greatest between sample periods 1 (2-16 May) and 2 (17-29 May) and lowest between sample periods 1 and 3 (11-28 June) (Table 4). Rarefaction predicted similar species diversity in OG/S, PB, and CC areas (Figure 4). Twenty-two species were predicted in OG/S, 20 species were predicted in PB and 21 species were predicted in CC areas when abundance was held constant between the three areas.

Yearly Variations

Seven species were observed in 1993 that were not observed in 1992 (Canada goose, prairie falcon, dusky flycatcher, red-breasted nuthatch, yellow warbler, black-headed grosbeak, and Brewer's blackbird) (Appendix A). Brewer's blackbird and Canada goose were the only species with more than 2 observations. Eighteen species were observed in 1992 that were not observed in 1993 (mallard, sharp-shinned hawk, Cooper's hawk, goshawk, great-horned owl, cordillerian flycatcher, olive-sided flycatcher, western wood pewee, American crow, bushtit, Townsend's solitaire, sage thrasher, red-eyed vireo, warbling vireo, lazuli bunting, lark sparrow, yellow-headed blackbird, and western tanager). Great-horned owl, downy woodpecker, common bushtit, and Townsend's solitaire were the only species with more than 2 observations.

Changes in relative abundance (percentage of total known observations for a given species) between 1992 and 1993 were variable. Northern flicker numbers decreased in PB plots (5.1%-

Table 2. Average number of bird species and individuals observed within 50 m of points by treatment for sampling 2 May through 28 June 1993, Owyhee Co., Idaho. Average number of species includes unique unknowns (ie. unidentified flycatcher species in a plot with no identified flycatchers).

Treatment	Transect Location	N	# species		# birds	
			mean	SD	mean	SD
Old-growth/ Seral	Stoneman Cr.	18	3.39	0.52	4.00	0.63
	Rays Res. East	24	4.29	1.92	6.58	3.32
	Pleasant Valley	9	4.11	1.05	8.22	2.44
	Juniper Mtn	9	4.78	2.05	6.89	3.89
	Rays Res. West	12	4.50	1.45	6.67	2.67
	Combined	75	4.15	1.57	6.44	2.91
Prescribed Burn	Sam Noble	36	0.89	0.67	1.22	1.20
	Pleasant Valley	24	3.17	1.31	5.08	2.32
	Cottonwood Cr.	18	2.17	1.54	3.22	2.32
	Combined	78	1.89	1.54	2.87	2.50
Clear Cut	Pleasant Valley	21	1.62	1.32	2.10	1.73
	Juniper Mtn	21	1.71	1.06	2.05	1.24
	Hanley Cabin	15	1.93	0.88	3.67	3.85
	Combined	67	1.74	1.11	2.49	2.41

Table 3. Similarity indices (based on Sorenson's index) for avian species observed in old-growth/seral (OGS), prescribed burn (PB), and clearcut (CC) stands during May-June, 1993 in Owyhee County, Idaho.

	OGS	PB	# spp. in common	OGS	CC	# spp. in common	PB	CC	# spp. in common
50 m	30	23	19	30	22	18	23	22	15
% similarity		71.7			69.2			66.7	
125 m	32	30	24	32	26	23	30	26	22
% similarity		77.4			79.3			78.6	
overall	33	31	25	33	31	25	31	31	25
% similarity		78.1			78.1			80.6	

Table 4. Similarity indices (based on Sorenson's index) for avian species observed during three sample periods [A = 2-16 May 1993 (Pleasant Valley PB sample A was conducted on 30 May), B = 17-29 May 1993 (Pleasant Valley PB sample B was conducted on 13 June), C = 11-28 June 1993] in Owyhee County, Idaho.

	A	B	# spp. in common	A	C	# spp. in common	B	C	# spp. in common
50 m	22	23	16	22	26	16	23	26	15
% similarity		67.9			52.4			63.2	

1.9%). Gray flycatcher numbers increased in all treatments (OG/S - 10.7%-16%, PB - 10.6%-17.2, CC - 4.9%-11%). Mountain chickadee numbers decreased in OG/S plots (10.2%-1.6%). House wren numbers decreased in CC plots (13.4%-9.5%). Mountain bluebird numbers increased in OG/S plots (6%-10.4%) and decreased in PB (18.2%-15%) and CC (19.5%-8.8%) plots. Green-tailed towhee numbers increased in CC plots (6.1%-8.1%). Vesper sparrow numbers decreased in CC plots (15.8%-9.6%). Chipping sparrow numbers decreased in OG/S (21.4%-16.5%) and CC (19.5%-7.4%) plots and increased in PB plots (11.4%-15%). Dark-eyed junco numbers increased in OG/S plots (5.2%-8.2%). Brown-headed cowbird numbers decreased in PB plots (6.4%-0.5%). Cassin's finch numbers increased in OG/S (6.6%-12.5) and PB (4.2%-7%) plots.

Number of species ($r^2 = 0.31$, $F = 91.1$, $P < 0.001$) and number of birds seen ($r^2 = 0.25$, $F = 67.1$, $P < 0.001$) were different between treatments for 1992 and 1993 combined. However, they were not different between years (species: $F = 2.6$, $P = 0.107$; total: $F = 2.7$, $P = 0.101$). Number of species ($r2 = 0.44$, $F = 28.8$, $P < 0.001$) and number of birds ($r2 = 0.37$, $F = 20.7$, $P < 0.001$) were different between transects for 1992 and 1993 combined. OG/S and the Pleasant Valley PB transect had greater numbers of species and birds than the other PB and CC transects.

Similarity indices were 3.5% (PB-CC), 7.4% (OG/S-PB), and 16.8% (OG/S-CC) greater in 1993 than in 1992 for the 50 m plots. Indices were even greater when overall numbers were compared.

DISCUSSION

Greater avian abundance and species diversity in OG/S was probably best explained by greater structural diversity. Understory components were similar between treatments, however, cover was greater in OG/S than PB or CC treatments (McCoy 1993). While OG/S stands had no juniper snags and few logs, they had greater diversity and abundance of live junipers. Vegetation composition and structure in the Pleasant Valley PB closely resembled OG/S stands resulting in similar avian abundance and diversity (Appendix C). PB treatments with a > 20% kill rate had relatively open understories that provided less cover for ground foraging species compared to CC sites with slash.

Weather may have influenced changes in species composition and abundance between years. Greater precipitation in 1993 than 1992 may have had variable effects on avian populations. Increased precipitation could result in greater insect and seed production and consequently greater avian productivity, however, extended cool, wet weather may have caused some nest failures. Generalist species may have been favored resulting in lower diversity and greater similarity of avian species between treatments.

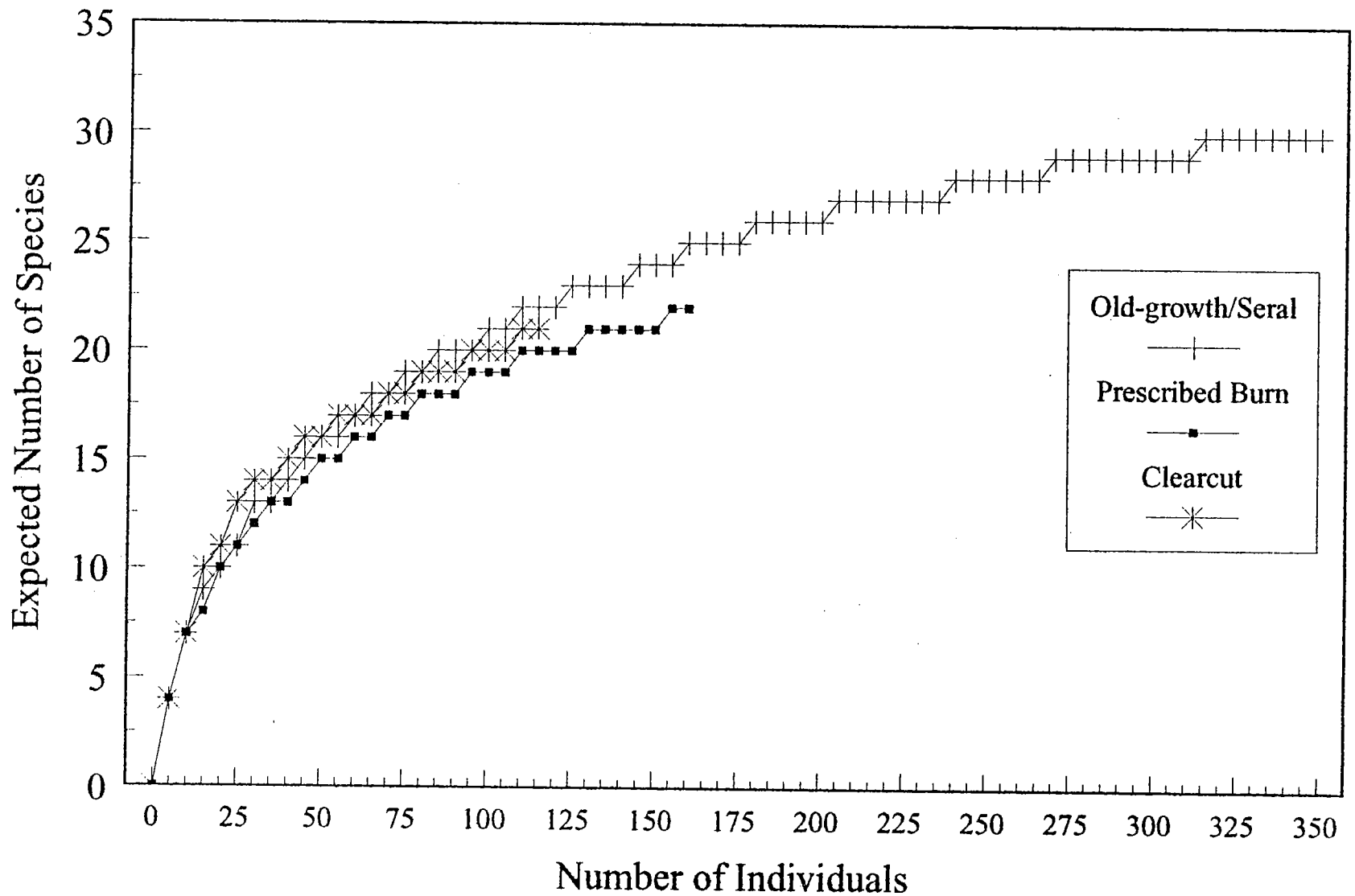


Figure 4. Rarefaction predictions of species numbers based on number of birds observed in old-growth/seral, prescribed burn, and clearcut stands sampled in May-June 1993, Owyhee County, Idaho.

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Appendix A. Numbers of birds observed during 2 May through 28 June 1993 at 70 points in old-growth/seral (OGS), prescribed burn (PB), and clearcut (CC) stands in Owyhee County, Idaho.

Species	Species Code	All distances			w/in 125 m			w/in 50 m		
		OGS	PB	CC	OGS	PB	CC	OGS	PB	CC
Canada goose	CAGO				4					
Common snipe	COSN	1	5	1	1	5	1		3	1
Turkey vulture	TUVU	2		8	2		1	1		
Red-tailed hawk	RTHA	3	5		3	5		3	3	
American kestrel	AMKE	5		3	5		3	3		1
Prairie falcon	PRFA		2			2				
Mourning dove	MODO	9	4	5	9	4	4	3		1
Great-horned owl	GHOW		2							
Common poorwill	COPW	1			1					
Common nighthawk	CONI		1			1				
Calliope hummingbird	CAHU		1	1		1	1		1	1
Unknown hummingbird	UNHU	3	2	1	3	2	1	2	2	1
Northern flicker	NOFL	20	25	16	19	25	10	9	4	1
Red-naped sapsucker	RNSA		2	2		2	1		1	
Downy woodpecker	DOWO	1			1			1		
Gray flycatcher	GRFL	84	64	32	84	64	32	68	37	15
Dusky flycatcher	DUFL	2			2			2		
Unknown flycatcher	UNFL	1		2	1		2	1		2
Tree swallow	TRES			11			11			10
Violet-green swallow	VGSW	2		10	2		10	2		8
Black-billed magpie	BBMA		1			1				
Common raven	CORA	111	14	20	103	4	6	16	1	2
Mountain chickadee	MOCH	10	2	7	10	2	7	7		4
Red-breasted nuthatch	RBNU	1			1			1		
House wren	HOWR	13	15	25	13	14	22	9	10	13

Species	Species Code	All distances			w/in 125 m			w/in 50 m		
		OGS	PB	CC	OGS	PB	CC	OGS	PB	CC
Rock wren	ROWR	7	4	5	7	4	5	3	3	1
Ruby-crowned kinglet	RCKI	2	2	1	2	2	1	2	2	
Mountain bluebird	MOBL	68	65	30	68	64	30	44	32	12
Hermit thrush	HETH	38	1	8	36	1	4	10	1	
American robin	AMRO	59	24	25	59	23	22	30	6	5
Yellow warbler	YEWA			1						
Yellow-rumped warbler	AUWA	5	3	2	5	3		4	3	
Black-throated gray warbler	BTYW	4			4			3		
Unknown warbler	UNWA	1			1			1		
Green-tailed towhee	GTTO	8	2	21	8	2	21	7		11
Vesper sparrow	VESP	7	62	32	7	59	32	5	26	13
Chipping sparrow	CHSP	103	56	16	103	56	16	70	32	10
Brewer's sparrow	BRSP	5	47	49	5	46	49	1	5	12
Dark-eyed junco	DEJU	49	11	1	49	11		35	8	
Western meadowlark	WEME	5	21	1		10			2	
Red-winged blackbird	RWBL	3	3	3	3	3	3	3		2
Brewer's blackird	BRBL	3	4	19	3	4	19	3	2	9
Brown-headed cowbird	BHCO	25	2	3	25	2	2	21	1	1
Pine siskin	PISI	2	4		2	4		2	4	
Cassin's finch	CAFI	85	23	8	85	23	8	53	15	2
Unknown	UNKN	85	46	23	85	46	23	58	20	6
Totals		835	523	397	818	49	344	483	234	14
Identified species		33	31	31	32	30	26	30	23	22
Unknown		4	2	3	4	2	3	4	2	3

Appendix B. Number of species and individuals (mean ± one standard deviation) by sampling period and treatment for avian surveys conducted 2 May through 28 June 1993 in Owyhee County, Idaho. Sample period 1 conducted 3-17 May, sample period 2 conducted 21-31 May, and sample period 3 conducted 18-21 June 1993.

Treatment	Transect Location	# species			# birds		
		Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Old Growth/ Seral	Stoneman Cr.	3.33±0.52	3.33±1.03	3.50±1.05	4.00±0.63	5.17±2.14	6.17±1.94
	Rays Res. East	3.13±1.46	4.38±1.51	5.38±2.20	4.25±2.25	6.50±2.39	9.00±3.55
	Pleasant Valley	4.33±1.53	3.67±0.58	4.33±1.16	6.67±1.16	9.33±0.58	8.67±4.04
	Juniper Mtn	4.00±0.00	5.33±1.53	5.00±5.51	4.67±1.16	8.33±4.16	7.67±5.51
	Rays Res. West	4.25±1.26	5.00±0.82	4.25±2.22	6.25±1.71	7.00±1.63	6.75±2.67
	Combined	3.64±1.15	4.20±1.32	4.60±2.02	4.96±1.84	6.72±2.56	7.64±3.52
Prescribed Burn	Sam Noble	0.58±0.67	1.00±0.85	1.08±0.67	1.00±1.21	1.25±1.22	1.42±1.24
	Pleasant Valley	3.25±0.89	3.63±1.85	2.63±0.92	5.00±1.51	6.13±2.90	4.13±2.17
	Cottonwood Cr.	2.17±1.94	2.67±1.37	1.67±1.37	2.50±2.07	4.00±2.37	3.17±2.64
	Combined	1.77±1.61	2.19±1.74	1.69±1.12	2.58±2.28	3.39±2.97	2.65±2.21
Clear Cut	Pleasant Valley	0.29±0.49	2.86±1.07	1.71±0.76	0.43±0.79	3.86±1.35	2.00±0.82
	Juniper Mtn	1.71±1.38	2.00±1.16	1.43±0.54	2.00±1.41	2.43±1.51	1.71±0.76
	Hanley Cabin	1.40±1.14	2.20±0.84	2.20±0.45	1.40±1.14	5.20±5.12	4.40±3.78
	Combined	1.11±1.20	2.37±1.07	1.74±0.65	1.26±1.26	3.68±2.91	2.53±2.22

Appendix C. Transect descriptions for avian population sampling in old-growth/seral, prescribed burn, and clear cut stands of western juniper in Owyhee County, Idaho.

Old-growth/Seral

Stoneman Creek (6 points) - This transect was located on both sides of the Mud Flat road on a saddle between two drainages. One point on the west side of the road was in a moderately older-aged stand with a few trees removed during prior logging activity. The other point on the west side of the road was located in a younger (estimated <45 years old) seral stand. Points on the east side of the road were located in primarily old-growth stands ranging from fairly shallow soils with rocky outcrops to a somewhat deeper soil with moderate-aged (about 100-125 years) trees. Understory cover was greatest in areas with deeper soils and younger or more open stands of juniper. The nearest water was approximately one-mile away.

Rays Reservoir East (8 points) - This transect was divided by a series of low rocky ridges and dry to semi-wet drainages. Old-growth juniper dominated the ridges and upper slopes with younger (estimated < 75 years old) trees on lower slopes and into meadows. Sample points were generally located in moderate-aged (50-150 years old) stands. There was a spring and reservoir on the transect. A clear cut was initiated on the southeast border of the transect in 1994. One point was clear cut after sampling was completed.

Rays Reservoir West (4 points) - This transect was located on two ridges with old-growth stands of juniper, bisected by a small semi-wet meadow. A spring also existed on the northwest side of the transect.

Pleasant Valley (3 points) - This transect was located adjacent to the Pleasant Valley clear cut transect. The transect was dominated by trees < 100 years old with scattered older (> 150 years old) trees. Pleasant Valley Creek or the spring on the Rays Reservoir West transect were the closest water sources.

Juniper Mountain (3 points) - This transect was dominated by moderate-aged (50-80 years old) trees with old-growth trees on rocky outcrops. This transect had the greatest canopy cover and sparsest understory. It was located adjacent to a perennial stream.

Prescribed Burn

Sam Noble (12 points) - This site was burned in 1985 with approximately 40-50% kill of junipers. The stand was fairly open and consisted of younger (<60 years old) trees prior to burning. Pockets of live junipers were widely scattered throughout the transect. Most of the dead junipers were still standing during the sample period. Most points were located in fairly open areas with < half containing some live junipers within 50 m. Water was available within 1/4 to 1 mile to the west of points in the transect.

Pleasant Valley (8 points) - This site was burned in 1985 with < 20% kill of junipers. The site contained a mixture of old and moderate aged trees. Burned areas were generally < 50 m in

diameter. This transect was very similar in structure to old-growth/seral stands. A reservoir was located within ½ mile of any point.

Cottonwood Creek (6 points) - The site was burned in 1985. The western portion (2 points) experienced a <25% kill and was adjacent to a perennial stream. It had a mixture of old and moderate aged live trees. The eastern portion (4 points) experienced a 45% kill and was located within ½ mile of water. This portion had been dominated by trees < 65 years old prior to treatment. Pockets of live juniper remained within 125 m of each point. This site also included on old-growth/seral point.

Clear Cut

Pleasant Valley (7 points) - This site was cut in 1986-91 The site had fairly shallow soils and was dominated by old-growth trees prior to cutting. Slash up to 1 m deep was common on the site. Old-growth stands ringed the site and extended into the cut area. Pleasant Valley Creek and the spring in Rays Reservoir West were the nearest sources of water.

Hanley Cabin (5 points) - This site was cut in 1990-92. Prior to cutting there was a mixture of young to old trees in moderately deep soils interspersed with semi-wet to wet stringer meadows. There was a small (< 5 acres) stand of aspen around a spring on the perimeter of the cut. Slash up to 1 m deep was common on the site.

Juniper Mountain (7 points) - This site was burned in 1981 and cut in 1982-83. Prior to treatment, there was a mixture of moderate to old (> 50 years old) junipers. There was a complex interspersion of live trees, snags, and open spaces after treatment. Some pockets of partially or un-burned slash were present.

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