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HUMAN INFLUENCE ON AVIAN ASSEMBLAGES ALONG THE SNAKE RIVER, WYOMING

ABSTRACT

We conducted bird surveys during the breeding season on eleven 100-m strip transects located within areas used heavily by humans. Bird abundance and composition were then compared to eleven 100-m strip transects of similar vegetation composition and structure to determine what effect human intrusion had upon avian communities. Human-use areas had similar vegetation structure (tree stem density, tree dbh, shrub density, nearest tree, largest log, canopy cover, ground cover, vertical and horizontal cover, and canopy height) and composition (number of snags and plant species) according to statistical analysis ($P \geq 0.05$). Observed differences in avian species composition and abundance could therefore be attributed to the presence of humans. We compared species richness and relative abundance of birds in both treatments. Thirty-six of the 77 avian species observed (47 %) were significantly less abundant where human use was prevalent. The following decreases in avian species richness were observed in the six cover types studied when human use was present: lodgepole pine (Pinus contorta) *(three species), Engelmann spruce* (Picea engelmannii) *(four), willow* (Salix sp.) *(seven), narrowleaf cottonwood* (Populus angustifolia) *(nine), big sagebrush* (Artemisia tridentat) *(nine), and cottonwood/conifer mixture (11). Nine bird species were more abundant in human-use areas: downy woodpecker* (Picoides pubescens), *hairy woodpecker* (Picoides villosus), *dusky flycatcher* (Empidonax oberholseri), *common raven* (Corvus corax), *black-capped chickadee* (Parus atricapillus), *American redstart* (Setophaga ruticilla), *green-tailed towhee* (Pipilo chlorurus), *Brewer's blackbird* (Euphagus cyanocephalus), *and brown-headed cowbird* (Molothrus ater). *Only the common raven ($P = 0.002$) and black-capped chickadee ($P = 0.035$) were significantly more abundant in human-use areas.*

Key words: avian abundance, avian diversity, Grand Teton National Park, human disturbance, riparian corridor, Snake River, Wyoming.

INTRODUCTION

Approximately 3 million people visit Grand Teton National Park during an average year, mainly during the summer months. Park managers were concerned about human impacts on songbirds using riparian areas. Eleven areas within the riparian zone along a 40 km section of the Snake River below Jackson Lake dam were heavily used by humans. Those areas included picnic areas, fishing access, and boat launch ramps, which were minimally altered vegetatively. Areas of similar vegetation composition that had little or no human use were located on islands or across the

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river channel, which denied easy access to the public. Comparison of bird communities within areas of heavy human use to adjacent areas with similar vegetation composition and structure allowed us to determine what effect human presence had on bird assemblages.

Some research suggests little correlation between avian abundance and species richness as a result of human intrusion (Confer and Holmes 1995, Riffell *et al.* 1996). Most research, however, indicates that many bird species decline as a result of human intrusion (Knight and Temple 1986a, 1986b, Rodgers and Smith 1995, Steidl and Anthony 1996).

Both direct and indirect human presence can affect bird assemblages. Certain avian species avoided direct association with humans (Knight and Temple 1986a, Gutzwiller *et al.* 1994, Confer and Holmes 1995, Rodgers and Smith 1995, Riffell *et al.* 1996, Steidl and Anthony 1996). Indirect alteration of avian communities has resulted from predator attraction (Wilcove 1985, Sullivan and Dinsmore 1990, Andrén 1992, Miller and Knight 1993, Rudnicky and Hunter 1993, Suhonen 1993), habitat alteration (Lynch and Whigham 1984, Yahner 1988, Robbins *et al.* 1989, Hoover *et al.* 1995), or nest parasitism (Brittingham and Temple 1983, Scott and Ankney 1983, Johnson and Temple 1990, Hahn and Hatfield 1995). Temporal intervals of disturbance are seemingly an important factor when determining human influence on avian assemblages. Certain avian species seemed to tolerate human presence better if the intrusion interval was spaced farther apart (Steidl and Anthony 1996). The birds returned to the area to resume their activity after the intruder left. Gutzwiller *et al.* (1994) found that song occurrence and singing consistency were more affected by 25 percent human disturbance than by 100 percent disturbance. They attributed the increased singing in 100 percent human-disturbed areas to birds discerning observers as non-predators, while the 25 percent disturbance may have caused a reduction in singing to avoid detection.

In addition, if adequate habitat is available, bird species tolerate human activity better (Confer and Holmes 1995). Unfortunately, human use and vegetation complexity is usually inversely related (Askins *et al.* 1987).

Methods of intrusion also were important. For example, birds were more influenced by an intruder walking into a habitat than by a motor boat approaching a colony of nesting waterbirds (Rodgers and Smith 1995). Researchers have concluded that birds may perceive walking humans as predators more so than mechanical vehicles. Predation of songbird nests in human-dominated landscapes also may have decreased bird species richness and abundance (Angelstam 1986, Martin 1988, Baillie *et al.* 1991, Andrén 1992). Increased predation was attributed to predators using ecotones. Predatory species such as American crow *(Corvus imparatus),* common raven, gray jay *(Perisoreus canadensis),* and black-billed magpie *(Pica pica)* were observed scavenging human food scraps. Attraction and subsequent concentration of those species may negatively impact breeding songbirds. Unusually large numbers of common ravens have been reported in the Jackson Hole region (Dunk *et al.* 1994). We assumed that high common raven numbers were due to numerous elk perishing each winter on the National Elk Refuge. Large quantities of carrion possibly increased over-winter survival of scavengers. Nest parasites (brown-headed cowbird) also were associated with human presence (Brittingham and Temple 1983, Rothstein *et al.* 1984). Cowbirds have become established in the Jackson Hole region and seem to be increasing (Cody 1996).

We determined how human

intrusion affected avian species composition within riparian habitat. We defined human-use areas as those that were used for picnic grounds, fishing access, and boat launch areas. Non-use areas were defined as isolated areas that were infrequently visited by humans. Used versus non-used areas were compared to ascertain (1) how various avian species were affected by human intrusion; and, (2) avian species composition within each cover type in areas of human-use and non-use.

STUDY AREA

We surveyed a 40-km segment of the Snake River riparian corridor within Grand Teton National Park in northwest Wyoming from Jackson Lake downstream to the bridge at Moose, Wyoming. The width of the riparian corridor ranged from 0.25 km to 2.6 km (mean = 1.4 km). Elevation decreased from 2066 m at Jackson Lake to 1968 m at the Moose bridge. Primarily stands of mature, closed-canopy lodgepole pine and Engelmann spruce surrounded the upper 10-km segment of the study site (Mattson and Despain 1985). Adjacent habitat along the lower 30-km segment was dominated by big sagebrush and silver sagebrush *(Artemisia cana).* Temperatures varied from a winter low of -40°C to summer highs that rarely exceeded 32°C (Ruszkowski 1996). Annual precipitation averaged 40 cm, mostly consisting of snowfall between December and May (Boyce 1989).

We defined six cover types in the riparian corridor: lodgepole pine, engelmann spruce, willow, narrowleaf cottonwood, big sagebrush, and a mixture of narrowleaf cottonwood/ engelmann spruce/lodgepole pine (Mattson and Despain 1985). The "willow" cover type included a variety of willow species varying primarily with soil moisture.

METHODS AND MATERIALS

Human-use and non-use areas (11 each) were identified within the study site by personal inspection and through communication with Park personnel. Transects were 100 m in length, originating at the water's edge and extending inland. Each transect was marked at 10 m intervals as well as 50 m to each side for a total area of 10,000 m^2 (1 ha). Transects were at least 200 m apart to ensure independent sampling at each location (Emlen 1971). Preliminary vegetation variables were collected from random locations within each transect according to guidelines set by James and Shugart (1970) and later modified by Noon (1981). We identified adjacent locations with minimal human presence in which we compared vegetation to that in areas of human use through one-way analysis of variance (ANOVA). A preliminary analysis revealed no differences between areas ($P \geq 0.05$). Areas determined to be the most similar to human-use areas (i.e., high P-values) were selected for avian assemblage comparisons to minimize biases caused by variations in habitat composition/ structure. Vegetation analysis was conducted within a 0.4 ha bird-centered circular plots (Noon 1981) based upon activity patterns (singing, foraging, nesting, and perching) of each species (Buhler 1998).

We conducted bird surveys in early morning (0530-1030) and late evening (1900 - 2200) hours during peak singing and displays by breeding males (Crompton 1994, Ruszkowski 1996). Evening surveys were conducted to include thrush species that typically sing during the evening hours (Crompton 1994). Surveys were conducted between 20 May and June 30 during 1996 and 15 May and June 30 in 1997. Each day, we surveyed different areas in random order to assure equal sampling in each of the areas across all hours of the morning and evening. Surveys were not conducted during periods of inclement weather. We conducted eight replicate counts at each transect for a total of 88 surveys in each use category.

Bird surveys were conducted by the same observer who walked each transect at 0.6 km/hour and recorded each individual bird heard or seen within 50 m on either side of the transect. We counted individual birds as independent observations and also counted each flock as a single observation to avoid pseudoreplication. We assumed that bird avoidance decreased as birds became familiar with the observer and transect patterns (Knight and Temple 1986a). Each sighting was recorded separately and included: species, sex, number of individuals, location, and activity. Comparison of diversity and abundance between utilization treatments was done through means as well as presence/absence.

RESULTS

Avian species abundance varied depending on cover type; many exhibited lower (L) abundance in human-use areas and a few were more abundant (H) (Table 1). Those that significantly differed ($P \leq 0.05$) in human-use areas were noted with an asterisk (*). The cottonwood/conifer cover type had a total of 41 avian species; with 19 species (46%) less abundant and three species (7 %) more abundant in human-use areas. Cottonwood totaled 37 avian species, 15 (41 %) less abundant and four (11 %) more abundant. Engelmann spruce totaled 33 avian species, 15 (45 %) less

Table 1. *Avian species for which abundance was lower (L) or higher (H) at sites with high human use for each cover type within the riparian corridor of the Snake River, Grand Teton National Park.*

	COVER TYPE						average # of individual birds	
species	cottonwood & conifer	cottonwood	Engelmann spruce	willow	sagebrush	lodgepole pine	human-use	non-use
black-crowned night-heron				L			0	1
sandhill crane	L				L		0	1.6*
bald eagle							0	1.3*
Cooper's hawk	L*		L*				0	1.3*
red-tailed hawk		L*	L				0	3.1*
American kestrel	L	L					0	1.8
ruffed grouse			L*			L*	0	2.1*
common snipe				L			0	2.7*
great-horned owl	L		L				0	1.4
great-gray owl			L*				0	0.4
common nighthawk							0	2.2*
calliope hummingbird							0	3.5*
broad-tailed hummingbird	L			L			2.5	3.8
Lewis' woodpecker						L*	0	3.2*
red-napped sapsucker						L	0	1.1
Williamson's sapsucker	L						0	1.6*
downy woodpecker							1	1
hairy woodpecker							3	1.4
northern flicker		L			L	H	1.2	2
western wood-pewee	L	L*					0	2.2*
willow flycatcher				L*			1.9	3.8*
Hammond's flycatcher	L*	L*	L*				0	1.6*
dusky flycatcher		H	L	H	H	L	7.5	6.4
tree swallow							1.3	7.5*
northern rough-winged swallow							0	4.2*
gray jay							0	2.6*

Table 1. con't

	COVER TYPE						average # of individual birds	
species	cottonwood & conifer	cottonwood	Engelmann spruce	willow	sagebrush	lodgepole pine	human-use	non-use
black-billed magpie	H			H*			1.2	2.6*
American crow		L	L				0	3.7
common raven			H*			H*	5.3*	1.8
black-capped chickadee		H*					4.7*	2.9
mountain chickadee		L	H			L	3.4	6.2*
red-breasted nuthatch	L	L				L*	2.3	4.6*
white-breasted nuthatch		L*				L	0	2.3*
brown creeper	L		H			L*	1	2.3*
American dipper			L				0	1
golden-crowned kinglet	L					L	0	1.5
ruby-crowned kinglet	L*	L*	L*			L*	6.7	12.3*
mountain bluebird		L					1.7	2.1
hermit thrush	L*		L*			L*	0	1.9*
American robin	H	H			H*		9.8	11.2
warbling vireo		L				L	4	4.1
orange-crowned warbler	L						0	1
yellow warbler			L				12.3	15.4
yellow-rumped warbler			L		H		6.1	7.7
American redstart							1	0
MacGillivray's warbler	L	L		L*			0	5.8*
common yellowthroat	L			L*			4	12.8*
Wilson's warbler				L			0	1.9*
western tanager	L		L*			L*	1.3	2.6*
green-tailed towhee							2.2	1.5
spotted towhee	L*						0	0.4
chipping sparrow	L		H		L	L	3.7	6.7*
Brewer's sparrow					L*		0	3.0*
vesper sparrow					L*		0	2.6*
savannah sparrow					L*		0	17.3*
song sparrow				L	L	L	7.8	8.1
white-crowned sparrow		L		L	L	L	2.5	7.8*
dark-eyed junco		L				L	3.6	5.5
red-winged blackbird				L			0	3.3*
western meadowlark					L		0	1
yellow-headed blackbird				L*			0	2.1*
Brewer's blackbird		H		L	H		5.1	4.6
brown-headed cowbird	H*			H*	H*	L	4.5	3.2
Cassin's finch							2	3.1
red crossbill			L			L*	0	3.8*
pine siskin							5.6	10.4*
American goldfinch							0	1.3

* - Significant at $P \leq 0.05$.

abundant and four (12 %) more abundant. Willow totaled 30 avian species, 12 (40 %) less abundant and three (10 %) more abundant. Sagebrush totaled 25 avian species, nine (36 %) less abundant and five (20 %) more abundant. Lodgepole pine totaled 36 avian species, 19 (53 %) less abundant and two (6 %) more abundant.

Of 77 avian species observed, 68 were less abundant in human-use habitats (36 at $P \leq 0.05$) while nine species were more abundant (two at $P \leq 0.05$) or exhibited similar abundance

(Table 1). Those nine species were downy woodpecker, hairy woodpecker, dusky flycatcher, common raven (P = 0.002), black-capped chickadee (P = 0.035), American redstart, green-tailed towhee, Brewer's blackbird, and brown-headed cowbird. Brown creepers *(Certhia familiaris)* were more abundant (P = 0.042) within Engelmann spruce in human-use areas. Brown creepers were, however, significantly less abundant (P = 0.002) in lodgepole pine or in overall abundance's (P = 0.048).

Human-use effects on avian species abundance varied with cover types (Fig. 1). Sagebrush (sage) had nine bird species that were lower in abundance in human-use areas of which three were significant ($P \leq 0.05$); four species were higher in abundance of which two were significant. Willow (willow) had 12 species lower in abundance of which four were significant; three were higher in abundance of which two significant. Cottonwood (cotton) had 15 species lower in abundance of which five were significant; four species were higher of which one significant. Engelmann spruce (spruce) had 15 species lower in abundance of which seven were significant; four species higher in abundance of which one significant. Cottonwood/conifer mixture (C & C) had 19 species lower in abundance of which five were significant; three species higher in abundance of which one was significant. Lodgepole pine (pine) had 19 species lower in abundance of which eight were significant and two species higher in abundance of which one significant.

Both numbers of species and overall abundance (number of individuals) were lower in all cover types in human-use areas than in non-use areas (Fig. 2). For example, willow contained 16

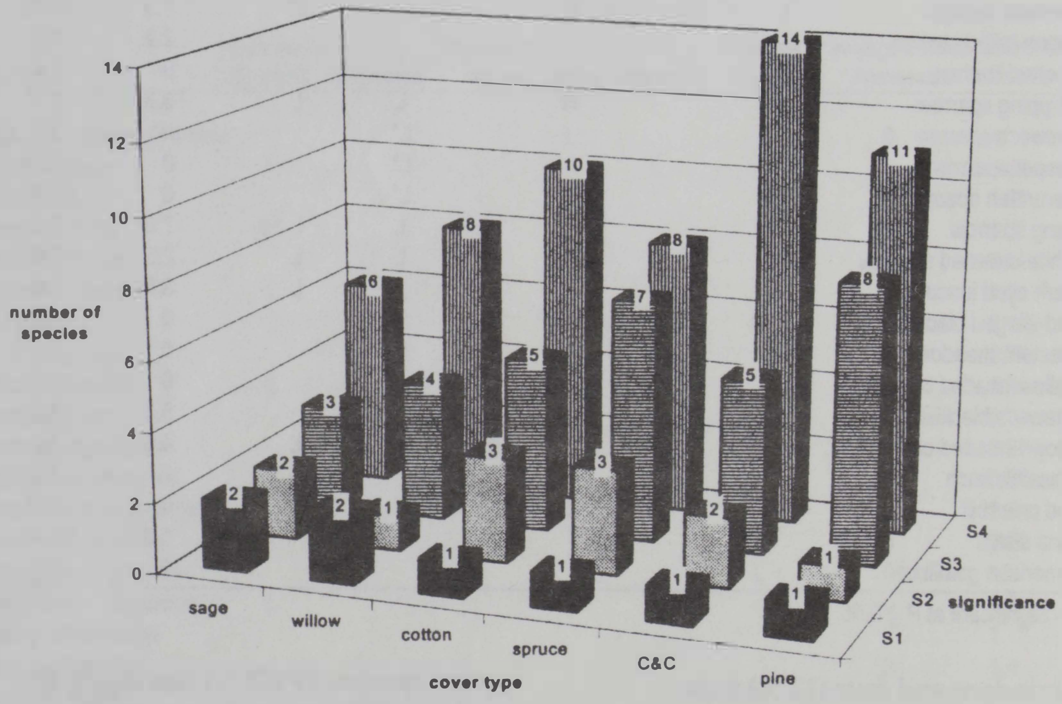

Figure 1. *Human influences on avian species for each cover type. S1 denotes number of species significantly ($P \leq 0.05$) higher in abundance in human-use areas. S2 denotes number of species higher in abundance in human-use areas, but not significantly. S3 denotes number of species significantly ($P \leq 0.05$) lower in abundance in human-use areas. S4 denotes number of species higher in abundance in human-use areas, but not significantly.*

species in human-use and 20 in non-use areas. A total of 12 species were common to both areas. Human–use areas contained dusky flycatcher, yellow-rumped warbler *(Dendroica coronata)*, American redstart, and chipping sparrow *(Spizella passerina)* in addition to the shared 12 species. Non-use areas contained eight additional species that included black-crowned night-heron *(Nycticorax nycticorax)*, common snipe *(Gallinago gallinago)*, calliope hummingbird *(Stellula calliope)*, northern rough-winged swallow *(Stelgidopteryx serripennis)*, violet-green swallow *(Tachycineta thalassina)*, MacGillivray's warbler (Oporornis tolmiei), red-winged blackbird *(Agelaius phoeniceus)*, and yellow-headed blackbird *(Xanthocephalus xanthocephalus)*. This pattern remained constant in other habitats. Sagebrush was the only cover type that did not show any difference between use areas and non-use areas. The other five cover types showed lower avian species diversity at sites with increased human use.

DISCUSSION

Our data suggest that human use negatively influenced the abundance of avian species within the riparian corridor of the Snake River (Table 1). Within each of six cover types, the number of avian species was lower in areas used by humans as compared to non-use areas (Fig. 1). Those differences were most pronounced in conifer cover types (Engelmann spruce and lodgepole pine). Engelmann spruce stands contained four avian species that were more abundant in human-use areas whereas lodgepole pine only had three. Broad-leaf cover types contained more

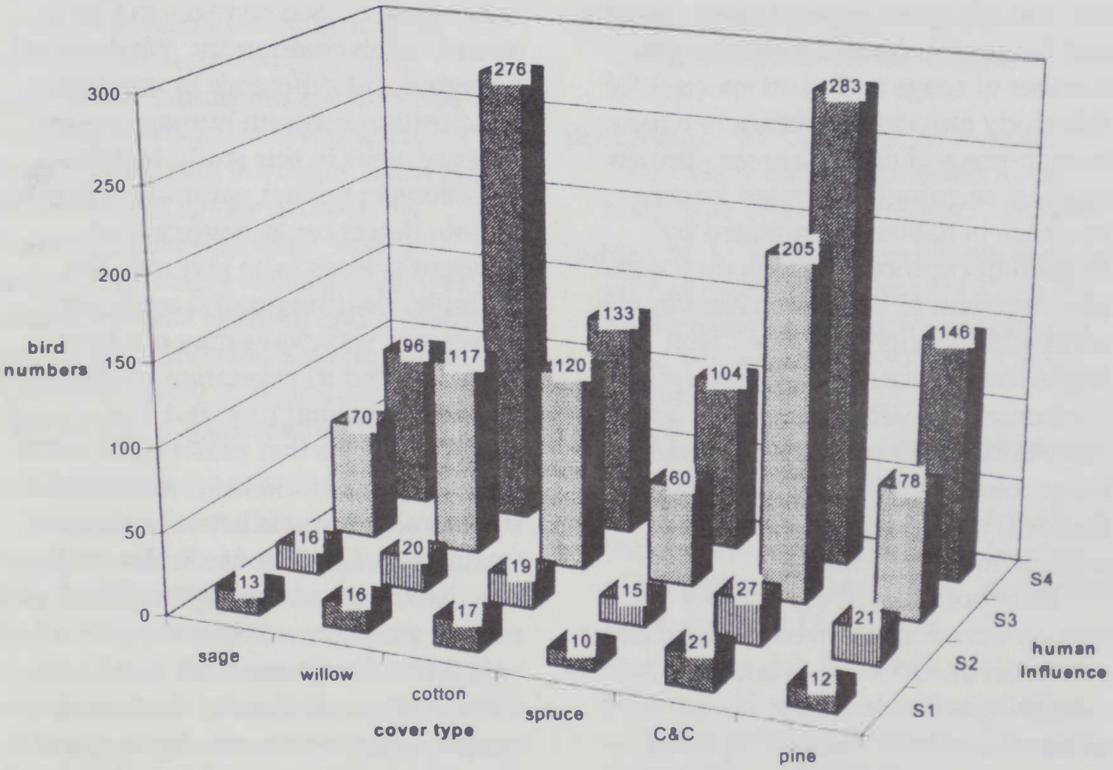

Figure 2. *Average number of bird species and individuals recorded in each cover type for human-use and non-use areas. S1 denotes average number of species observed in human-use areas. S2 denotes average number of species observed in non-use areas. S3 denotes average number of individuals observed in human-use areas. S4 denotes average number of individuals observed in non-use areas.*

avian species that were more abundant in human-use areas. Cottonwood, cottonwood/conifer, willow, and sagebrush cover types had nine, eleven, seven, and nine species, respectively, which increased in abundance within human-use areas. Broad-leafed cover types (excluding sagebrush) had greater horizontal and vertical vegetation structure than coniferous types (Buhler 1998). This additional screening cover may have provided adequate habitat structure, allowing avian species to remain relatively undisturbed closer to human activities (Sherry and Holmes 1985, Holway 1991, Suhonen 1993).

Within Engelmann spruce, brown creepers were more abundant ($P = 0.042$) in human-use areas. Keller (1987) found that brown creepers avoided areas with habitats altered by humans. Habitat variables (e.g. tree stem density, tree dbh, shrub density, nearest tree, largest log, canopy cover, ground cover, vertical and horizontal cover, canopy height, number of snags and plant species) for this study remained constant between human-use and non-use areas. Brown creepers seemingly tolerated human presence in habitats dominated by Engelmann spruce although they were less abundant ($P = 0.002$) in human-use areas within lodgepole pine. That Engleman spruce stands contain more horizontal and vertical structure and more understory plant species than lodgepole pine, as earlier described by Buhler (1998), provided a possible explanation of our results.

Incorporating all cover types and bird observations showed the total effect of human intrusion on avian assemblages (Table 1). For all observations, nine out of 77 species (12%) were more abundant although only two were significant. Those nine species were downy woodpecker, hairy woodpecker, dusky flycatcher, common raven ($P = 0.002$), black-capped chickadee ($P = 0.035$), American redstart, green-tailed towhee, Brewer's blackbird, and brown-headed cowbird. The remaining 68 species were lower in abundance of which 36 were significant (Table 1). The reasons for these patterns are unclear; in this study we did not differentiate between direct and indirect human influences nor did we identify cause-specific differences in abundance. However, habitat alteration would not be a consideration since both areas were of similar vegetation composition.

Both species richness and abundance were greatest in areas not used by humans for all six cover types except sagebrush which had equal species richness (Fig. 2). Past research noted that human intrusion altered the composition of the avian communities (Riffell *et al.* 1996) with the primary explanation being alteration of habitat structure (Confer and Holmes 1995). Alteration of vegetation composition by human use caused changes in the overall avian community. We detected no significant difference in vegetation composition between human-use and non-use areas in this study, but small variations in habitat parameters that we did not detect could have caused different species to be favored. For example, clearing ground cover for drives and walkways may not have been detected in vegetation analysis (0.4 ha circular habitat plot) but was enough to allow species that prefer open cover types to persist. There were some structural variations between the two treatments. Deciduous shrubs, nearest tree distance, and density board 0.0 - 1.0 m high were almost significant ($P > 0.05 \Leftrightarrow \leq 0.10$). For human-use areas, deciduous shrub density decreased, nearest tree distance was farther, and density board measurements decreased. This indicated that the human-use areas were slightly more open than adjacent non-use areas. The openness may have contributed to the number of avian species that were lower in abundance in human-use areas. It may not simply be the presence of humans that lowered avian abundance, but a decrease in vegetation complexity, or combination of factors. Five out of six cover types had lower species richness with human-use. Only sagebrush remained constant with an average of nine species.

Impacts to avian communities can be immense in areas such as the Snake River, which receive extensive human use. Since there is limited road access into this region, human influence can be restricted in a few locations. However, further development and increased access can impact the relative abundance and diversity of birds. The planning of these developments should consider selection of habitat types by birds. Our data suggested that birds in broad-leafed habitats might be more resilient to human intrusion. Habitat requirements for species of concern should be determined and minimal impacts to those areas considered. Sagebrush communities are the most simplistic and contain fewer species affected by human intrusion. However, species such as savannah sparrow *(Passerculus sandwichensis)*, vesper sparrow *(Pooecetes gramineus)*, Brewer's sparrow *(Spizella breweri)*, and western meadowlark *(Sturnella neglecta)* were found exclusively in sagebrush and may be impacted by habitat alteration.

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