AUTUMN LANDBIRD COMMUNITIES IN THE BOISE FOOTHILLS AND OWYHEE MOUNTAINS OF SOUTHWESTERN IDAHO

JAY D. CARLISLE, Idaho Bird Observatory, Department of Biology, Boise State University, 1910 University Dr., Boise, Idaho 83725; jaycarlisle@boisestate.edu

CHARLES H. TROST, Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209 (current address 225 N. Lincoln Ave., Pocatello, Idaho 83204-4126)

SARAH L. STOCK, Idaho Bird Observatory, Department of Biology, Boise State University, 1910 University Dr., Boise, Idaho 83725 (current address P. O. Box 617, Yosemite National Park, California 95389)

GREGORY S. KALTENECKER, Idaho Bird Observatory, Department of Biology, Boise State University, 1910 University Dr., Boise, Idaho 83725

ABSTRACT: Identifying important stopover areas is a critical step in conservation and management of migratory birds, and relatively little effort has been directed toward this task in Idaho or the Intermountain West. We used mist-net captures to describe the relative abundance, species richness, and community similarity of autumn migrant landbirds in the Boise Foothills and Owyhee Mountains of southwestern Idaho, two mountain ranges separated by the Snake River Plain. We captured birds at three mist-net sites from August to October 1998. Two sites were situated in the Boise Foothills, one in deciduous mountain shrubland, the other in an adjacent willow-dominated riparian draw; the third site was at a riparian spring in the Owyhee Mountains. Capture rates for resident species, temperate-zone migrants, and irruptive migrants were highest at the Boise Foothills riparian site, whereas the Boise Foothills mountain shrubland site had the highest abundance of neotropical migrants. Species richness was highest at the two Boise Foothills sites, but at all sites diversity and evenness were similar. Among the three sites, the two Boise Foothills sites (mountain shrubland and willow riparian) had the most similar bird communities. Capture rates were high (> 1 bird per mist-net hour) at all three sites, and these results demonstrate that many species of autumn migrants occur frequently in montane deciduous habitats across southwestern Idaho.

The distribution and abundance of migrating landbirds is generally understudied in the Intermountain West. Most neotropical and temperate-zone migrant passerines common to the western United States pass through Idaho during fall migration (Burleigh 1972, Stephens and Sturts 1998, Carlisle et al. 2004), yet their specific habitat associations, timing, and relative abundance are only beginning to be thoroughly described (Carlisle et al. 2004, 2005). Because migrating landbirds need suitable stopover sites for rest and refueling, identification and protection of suitable stopover habitat is an important link in the conservation of migratory birds (Moore et al. 1995, Hutto 1998, Petit 2000). To increase our understanding of migrants' distribution in the Intermountain West, we examined autumn migrant landbird occurrence in two montane areas of southwestern Idaho.

The Boise Foothills and Owyhee Mountains lie on the north and south sides, respectively, of the Snake River Plain in southwestern Idaho (Figure 1). The degree to which the Snake River Plain, representing the northern edge of the Basin and Range Province, affects landbird migration and distribution

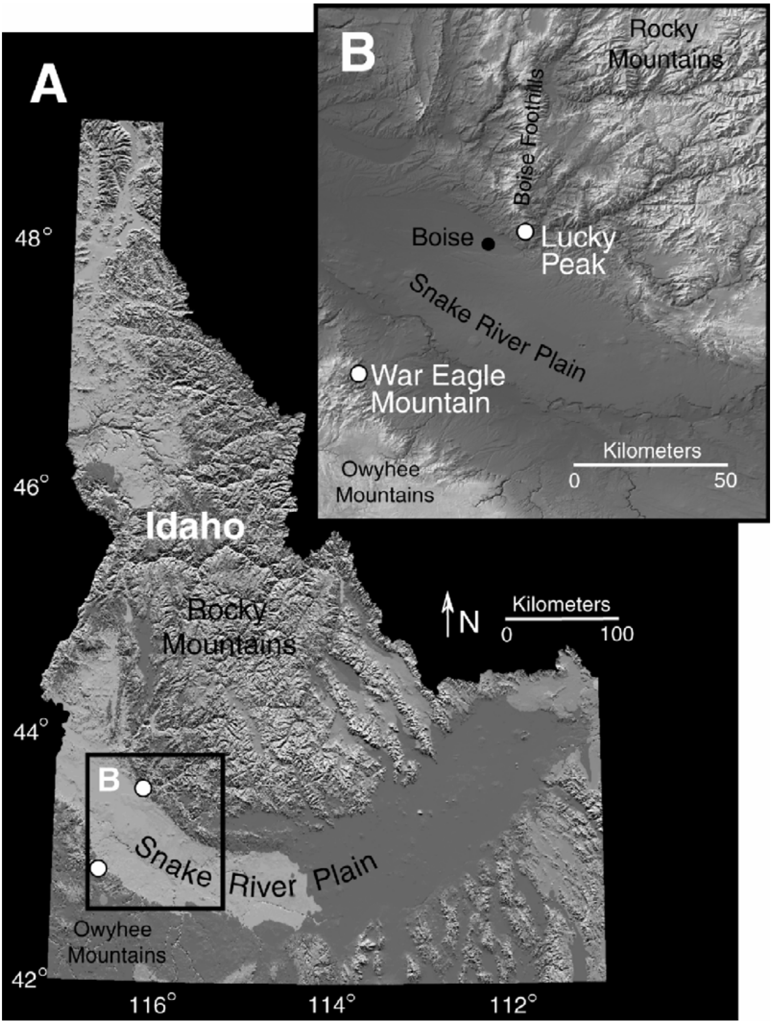

Figure 1. Location of study sites (white circles) relative to the Snake River Plain in Idaho.

is mostly unexplored. Habitats in the Snake River Plain, with the exception of the relatively narrow riverine corridor, are composed mostly of desert and agricultural lands that are likely unsuitable for most woodland migrants. Long-term research and monitoring of autumn migrants' habitat associations and stopover ecology was already underway in the Boise Foothills (Carlisle et al. 2004), so in this study we compared the migrant-bird community in the Owyhee Mountains to that in the Boise Foothills during fall 1998.

We used mist-nets to survey migrant landbirds at two sites in the Boise Foothills and one site in the Owyhee Mountains from August through October 1998. We compared the species composition, relative abundance, community similarity, and migration timing for neotropical and temperate-zone migrants at these sites.

STUDY SITES AND METHODS

Study Sites

Two mist-net sites were located on Lucky Peak in the Boise Foothills, east of Boise, Ada County, and a third was located on War Eagle Mountain in the Owyhee Mountains south of Boise (Figure 1). Lucky Peak (1845 m) lies 12 km east of Boise (43° 36' N, 116° 05' W) and is the southernmost peak along the Boise Foothills. The Boise Foothills, trending north–south in the Boise Mountains, form the northern boundary of the Snake River Plain and the southernmost extension of the central Idaho mountains. The study site is at the boundary between two major habitat zones: the largely forested mountains to the north and the shrubsteppe-dominated Great Basin to the south. Four distinct habitat types occur in a mosaic at Lucky Peak and along the Boise Foothills in general: coniferous forest, deciduous mountain shrubland, shrubsteppe, and riparian shrubland (see Carlisle et al. 2004 for more detailed descriptions of habitats). One netting site was located in mountain shrubland near the top of Lucky Peak. The second site was in a spring-fed, willow-dominated riparian draw on the western slope of Lucky Peak. The centers of these two sites were separated by about 600 m (nearest nets about 400 m apart), and recaptures of banded birds traveling between sites were rare (Carlisle, unpubl. data). Although habitats at these two sites differed, the surrounding landscape, local weather, and migration routes likely affected both sites similarly.

The Owyhee Mountains lie to the south/southwest of the Boise Foothills and are separated from the Boise Foothills by the Snake River Plain. Thus the Owyhees are at the northern edge of the Great Basin province. The study site in the Owyhees was located on the slope of War Eagle Mountain at about 2073 m in elevation (43° 01' N, 116° 42' W), near the northern edge of forest in the Owyhee Mountains. The site is characterized by a riparian spring dominated by willows surrounded mostly by a grassy meadow, shrubsteppe and, on one side, by high-elevation coniferous forest dominated by subalpine fir (*Abies lasiocarpa*). The Owyhee site is approximately 84 km from the two Boise Foothill sites, and may be subject to slightly different local weather patterns and migration pulses than the Boise Foothills sites.

METHODS

We captured birds in standard mist-nets (12 × 2.6m, 32 mm mesh) at each of the three study sites in the fall of 1998. We used ten nets at the Boise Foothills mountain shrubland site, six at the Boise Foothills riparian site, and five at the Owyhee site. Because the riparian habitat at the Boise Foothills and Owyhee sites is constricted, nets were more spread out at the mountain shrubland site, and the area covered by the netting scheme was approximately twice that at the other sites. Therefore, the number of nets was approximately proportional to the extent of the mist-netting area at each site. We located nets nonrandomly and opportunistically throughout the habitats in areas that concentrated bird movement for efficient captures (Ralph et al. 1993) and kept net placement constant during the study. All nets at the Boise Foothills sites were in deciduous shrubs (mountain shrubland or riparian), whereas in the Owyhees four nets were in willows and one net was in the adjacent fir forest. The similar habitat structure and similar behavior of birds (migratory stopover) at all three sites should overcome most of the cautions outlined by Remsen and Good (1996) for among-site comparisons of mist-netting data (see also Carlisle et al. 2004). Nets were opened at sunrise and closed 5 hours after sunrise. Nets were not opened during inclement weather. The mountain shrubland site was operated daily from 5 August 5 to 15 October; the Boise Foothills riparian site was operated daily from 21 August to 14 October; and the Owyhee site was operated on a three-day-on, four-day-off schedule from 12 August to 15 October. Only data from banding days in common at all three sites (a total of 23 banding days from 25 August to 15 October) were used in analyses. We identified captured birds to species with reference to Pyle (1997) and fitted each with individually numbered U.S. Geological Survey aluminum leg bands. Capture effort (in mist-net hours; 1 net open for 1 hour = 1 mist-net hour) was recorded for each station.

Analyses

We assigned species to one of three categories for comparisons: neotropical migrants (more or less long-distance migrants), temperate-zone migrants (more or less short-distance migrants), or residents/irruptive migrants. We categorized neotropical migrants according to DeGraaf and Rappole (1995) but applied more stringent criteria such that at least half of the population's winter distribution must occur south of the United States for the species to be considered a neotropical migrant (see Carlisle et al. 2004).

We used capture data from each site to compare species richness (number of species), diversity (Shannon index, H), evenness (J), and Morisita's index of community similarity (I_M) (Brower et al. 1998). Values of both J and I_M range from 0 to 1; values close to 1 are most even or similar, respectively. To correct for unequal sample sizes and netting effort among sites, we used rarefaction to compare expected numbers of species ($E[S_n]$) at a given sample size (James and Rathbun 1981, Carlisle et al. 2004). Chi-squared goodness-of-fit tests were used to compare capture totals (adjusted for effort; projected captures at 1000 mist-net hours) among sites for all species pooled and each category of migrant (Carlisle et al. 2004). All tests used $P \leq 0.05$ for statistical significance, and we used the sequential Bonferroni procedure to maintain an overall alpha of 0.05 in χ^2 tests that relied on multiple comparisons within the same data set (Rice 1989).

RESULTS

Relative Abundance and Species Composition

At all three sites combined, we captured a total of 3090 birds of 53 species in 2146.3 mist-net hours (mnh), an overall capture rate of 1440 birds/1000 mnh (Table 1). Total captures (corrected for equal effort: birds/1000 mnh) differed significantly ($\chi^2 = 53.51$, d.f. = 2, $P < 0.01$), with Owyhee having the lowest rate and Boise Foothills willow riparian the highest (Table 1). For each category of migrant, capture rates (birds/1000 mnh) also differed significantly from site to site. Neotropical migrants were captured most frequently at the Boise Foothills mountain shrubland site ($\chi^2 = 57.52$, d.f. = 2, $P < 0.01$), whereas temperate-zone migrants ($\chi^2 = 14.94$, d.f. = 2, $P < 0.01$) and residents/irruptive migrants ($\chi^2 = 77.01$, d.f. = 2, $P < 0.01$) were most frequent at the willow riparian site (Table 1).

The proportion of each category of migrant differed slightly from site to site such that captures at the Boise Foothills sites were made up of a higher proportion of neotropical migrants (mountain shrubland 21.0%, willow riparian 17.4%) than at the Owyhee site (12.3%). In contrast, captures at the Owyhee site consisted of a higher proportion of temperate migrants (82.9% vs. 76.6% for mountain shrubland and 74.0% for willow riparian), and willow riparian had the highest proportion of resident/irruptive species (8.6% vs. 4.8% in the Owyhees and 2.3% in mountain shrubland). If captures from both Boise Foothills sites are combined, the foothills captures were composed of 19.7 % neotropical migrants, 75.6 % temperate-zone migrants, and 4.7 % residents. The Green-tailed Towhee (*Pipilo chlorurus*; 11 captures) was the only species unique to the Owyhee site (Table 1). In contrast, 25 species captured at one or both foothills sites were not encountered at Owyhee; however, only two of these (the Nashville, *Vermivora ruficapilla*, and Townsend's, *Dendroica townsendi*, warblers) were represented by ≥10 individuals at any site (Table 1).

Richness, Diversity, and Community Dominance

Species richness (not corrected for sample size) was 47 species at mountain shrubland, 41 species at willow riparian, and 28 species at Owyhee. Because of unequal netting effort and sample sizes, we used rarefaction curves to compare expected numbers of species ($E[S_n]$) at similar sample sizes (see Figure 2.). For example, the $E[S_n]$ at an N of 400 total birds was 34 species for both Boise Foothills sites and 26 species for Owyhee (Figure 2). Thus the Owyhee site appeared to support fewer species than the two Boise Foothills sites. Shannon diversity values (H) were 2.397 for mountain shrubland, 2.432 for willow riparian, and 2.247 for Owyhee. Evenness (J) was 0.626 for mountain shrubland, 0.655 for willow riparian, 0.674 for Owyhee. Thus diversity and evenness values were roughly similar at all sites, although diversity was slightly lower and evenness was slightly higher at Owyhee. Morisita's index of community similarity (I_M) for all captures was 0.848 between mountain shrubland and willow riparian, 0.573 between mountain shrubland and Owyhee, and 0.456 between willow riparian and Owyhee. Thus the two Boise Foothills sites were much more similar to each other than either was to the Owyhee site.

Migration Timing

The migration schedule of neotropical migrants was similar at all sites (Figure 3). Capture rates for neotropical migrants were highest at the begin-

Table 1 Numbers and Rates of Birds Captured in the Boise Foothills and Owyhee Mountains, Southwestern Idaho, August–October 1998[a]

		Totals			Capture rate[c]		
Species	Category[b]	MS	WR	OWY	MS	WR	OWY
Sharp-shinned Hawk *Accipiter striatus*	T	3	0	0	2.84	0.00	0.00
Cooper's Hawk *A. cooperii*	T	1	0	0	0.95	0.00	0.00
Northern Pygmy-Owl *Glaucidium gnoma*	R	1	1	0	0.95	1.74	0.00
Calliope Hummingbird *Stellula calliope*	N	2	0	0	1.89	0.00	0.00
Rufous Hummingbird *Selasphorus rufus*	N	1	0	0	0.95	0.00	0.00
Downy Woodpecker *Picoides pubescens*	R	0	0	1	0.00	0.00	1.94
Red-naped Sapsucker *Sphyrapicus nuchalis*	N	4	2	0	3.78	3.49	0.00
Western Wood-Pewee *Contopus sordidulus*	N	3	5	0	2.84	8.72	0.00
Dusky Flycatcher *Empidonax oberholseri*	N	41	13	12	38.75	22.67	23.29
Hammond's Flycatcher *E. hammondii*	N	21	11	3	19.85	19.18	5.82
Western Flycatcher *E. difficilis/occidentalis*	N	1	0	0	0.95	0.00	0.00
Willow Flycatcher *E. traillii*	N	1	0	0	0.95	0.00	0.00
Cassin's Vireo *Vireo cassinii*	N	21	5	3	19.85	8.72	5.82
Warbling Vireo *V. gilvus*	N	37	10	8	34.97	17.44	15.52
Steller's Jay *Cyanocitta stelleri*	R	1	0	0	0.95	0.00	0.00
Mountain Chickadee *Poecile gambeli*	R	3	1	20	2.84	1.74	38.81
Black-capped Chickadee *P. atricapillus*	R	1	0	0	0.95	0.00	0.00
Red-breasted Nuthatch *Sitta canadensis*	R	13	54	4	12.29	94.16	7.76
Brown Creeper *Certhia americana*	R	15	17	1	14.18	29.64	1.94
Winter Wren *Troglodytes troglodytes*	T	2	3	0	1.89	5.23	0.00
House Wren *T. aedon*	N	7	3	3	6.62	5.23	5.82
Golden-crowned Kinglet *Regulus satrapa*	T	21	32	3	19.85	55.80	5.82
Ruby-crowned Kinglet *R. calendula*	T	501	129	137	473.53	224.93	265.85
Townsend's Solitaire *Myadestes townsendi*	T	39	2	1	36.86	3.49	1.94
American Robin *Turdus migratorius*	T	3	1	0	2.84	1.74	0.00
Swainson's Thrush *Catharus ustulatus*	N	9	2	0	8.51	3.49	0.00

Table 1 (*Continued*)

Species	Category[b]	Totals			Capture rate[c]		
		MS	WR	OWY	MS	WR	OWY
Hermit Thrush *C. guttatus*	T	19	6	15	17.96	10.46	29.11
Cedar Waxwing *Bombycilla cedrorum*	T	2	0	0	1.89	0.00	0.00
Nashville Warbler *Vermivora ruficapilla*	N	16	7	0	15.12	12.21	0.00
Orange-crowned Warbler *V. celata*	N	48	10	14	45.37	17.44	27.17
Yellow Warbler *Dendroica petechia*	N	6	5	1	5.67	8.72	1.94
Yellow-rumped Warbler *D. coronata*	T	16	14	101	15.12	24.41	195.99
Blackpoll Warbler *D. striata*	N	0	1[d]	0	0.00	1.74	0.00
Townsend's Warbler *D. townsendi*	N	19	4	0	17.96	6.97	0.00
MacGillivray's Warbler *Oporornis tolmiei*	N	32	16	17	30.25	27.90	32.99
Wilson's Warbler *Wilsonia pusilla*	N	16	4	4	15.12	6.97	7.76
Western Tanager *Piranga ludoviciana*	N	19	12	0	17.96	20.92	0.00
Black-headed Grosbeak *Pheucticus melanocephalus*	N	5	2	0	4.73	3.49	0.00
Lazuli Bunting *Passerina amoena*	N	7	10	0	6.62	17.44	0.00
Spotted Towhee *Pipilo maculatus*	T	66	27	3	62.38	47.08	5.82
Green-tailed Towhee *P. chlorurus*	T	0	0	11	0.00	0.00	21.35
Chipping Sparrow *Spizella passerina*	N	6	20	1	5.67	34.87	1.94
Brewer's Sparrow *S. breweri*	N	1	16	9	0.95	27.90	17.46
Vesper Sparrow *Pooecetes gramineus*	T	4	4	0	3.78	6.97	0.00
Savannah Sparrow *Passerculus sandwichensis*	T	0	1	0	0.00	1.74	0.00
White-crowned Sparrow *Zonotrichia leucophrys*	T	105	164	72	99.29	285.96	139.72
Golden-crowned Sparrow *Z. atricapilla*	T	1	1	0	0.95	1.74	0.00
Fox Sparrow *Passerella iliaca*	T	10	1	12	9.45	1.74	23.29
Lincoln's Sparrow *Melospiza lincolnii*	N	2	2	2	1.89	3.49	3.88
Dark-eyed Junco *Junco hyemalis*	T	390	296	164	368.62	516.13	318.24
Pine Siskin *Carduelis pinus*	R	0	2	2	0.00	3.49	3.88

Table 1 (*Continued*)

Species	Category[b]	Totals MS	Totals WR	Totals OWY	Capture rate[c] MS	Capture rate[c] WR	Capture rate[c] OWY
Cassin's Finch *Carpodacus cassinii*	R	2	0	2	1.89	0.00	3.88
Red Crossbill *Loxia curvirostra*	R	0	4	0	0.00	6.97	0.00
Sum of captures		1544	920	626	1460[e]	1604[e, f]	1215[e]
Mist-net hours (mnh)		1057.5	573.5	515.3	–	–	–
Capture rate (birds/1000 mnh)[e]		1460	1604	1215	–	–	–
Neotropical migrants		325	160	77	307.34[e,f]	278.99[e]	149.43[e]
Temperate-zone migrants		1183	681	519	1118.68[e]	1187.45[e, f]	1007.18[e]
Residents/irruptive migrants		36	79	30	34.04[e]	137.75[e, f]	58.2[e]
Number of species (uncorrected)		47	41	28	–	–	–
Projected $E[S_n]$ at N of 400 (rarefaction)		34	34	26	–	–	–

[a]MS, mountain shrubland, Lucky Peak, Boise Foothills; WR, willow riparian, Lucky Peak, Boise Foothills; OWY, War Eagle Mountain, Owyhee Mountains.

[b]N, neotropical migrant; T, temperate-zone migrant; R, resident/irruptive migrant.

[c]Birds per 1000 mist-net hours.

[d]Captured on 2 September 1998; one of four Blackpoll Warblers captured on Lucky Peak 29 August–5 September 1998 (others captured on dates not included in this analysis). These are the first Blackpoll Warblers to be substantiated in Idaho (Trochlell 1999), although the species is now known to be a rare but nearly annual fall migrant in the state.

[e]Projected number of new captures in 1000 mist-net hours.

[f]Highest capture rate in this comparison; capture rates differed significantly according to a χ^2 test after sequential Bonferroni procedure.

ning of the study (end of August) and declined steadily throughout September (Figure 3). Temperate-zone migrants peaked between early September and early October, but capture rates at the Owyhee site peaked and waned earlier than at the two Boise Foothills sites (Figure 4). The early peak at the Owyhee site was driven largely by Yellow-rumped Warblers (*Dendroica coronata*), which were captured more frequently at the Owyhee site than at either Boise Foothills site (Table 1).

DISCUSSION

The assemblage of migrants at all sites consisted of a similar group of species, but the abundance of many species differed from site to site. Although distance from breeding area to stopover site is a factor contributing to differences from site to site in the occurrence of migrants (Kelly et al. 1999), the only known difference in the list of breeding birds between the two mountain ranges we studied is the absence of the Green-tailed Towhee in the Boise Foothills (the Green-tailed Towhee breeds both north and south of the Snake River but occurs only rarely in the Boise Foothills). Thus the differences we observed between the two ranges in species composition of migrants were unlikely to have been driven primarily by differences in breeding ranges.

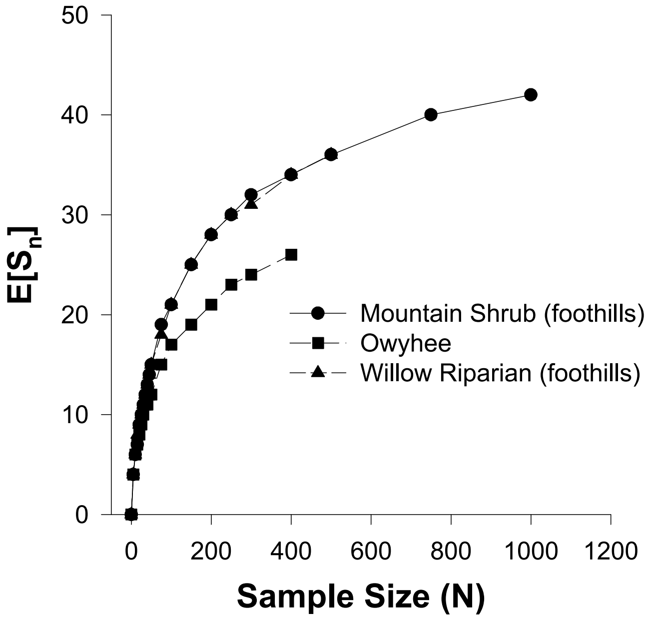

Figure 2. Rarefaction curves for capture data (all species) from mountain shrub, willow riparian (both Boise Foothills), and Owyhee banding sites. Curves compare species richness by providing the expected number of species ($E[S_n]$) detected for a given sample size (number of total birds captured; N).

Capture rates were high in both mountain ranges, but we detected more migrants in the Boise Foothills, suggesting that migrants use this area more heavily than the Owyhees. Since this study is based on a single season, some differences might disappear with more years of study. On the other hand, results of long-term monitoring in the mountain shrubland of the Boise Foothills have been relatively consistent from year to year for most species (Carlisle et al. 2004, 2005).

Although this study did not sample from late July through mid-August, a period during which several neotropical migrants pass through the region, most such migrants were still migrating through until mid- or late September (Carlisle et al. 2005). Neotropical migrants were more abundant and represented by more species at both Boise Foothills sites than at the Owyhee site. Future study would be required to determine if this pattern holds throughout the entire season of these species' migration (mid-July through late September; Carlisle et al. 2005). For temperate-zone migrants, the pattern of higher abundance in the Boise Foothills is similar but less striking. We are unable to infer differences in habitat suitability or migration volume between these ranges, however, without further sampling.

Interestingly, we captured three conifer-associated species most frequently

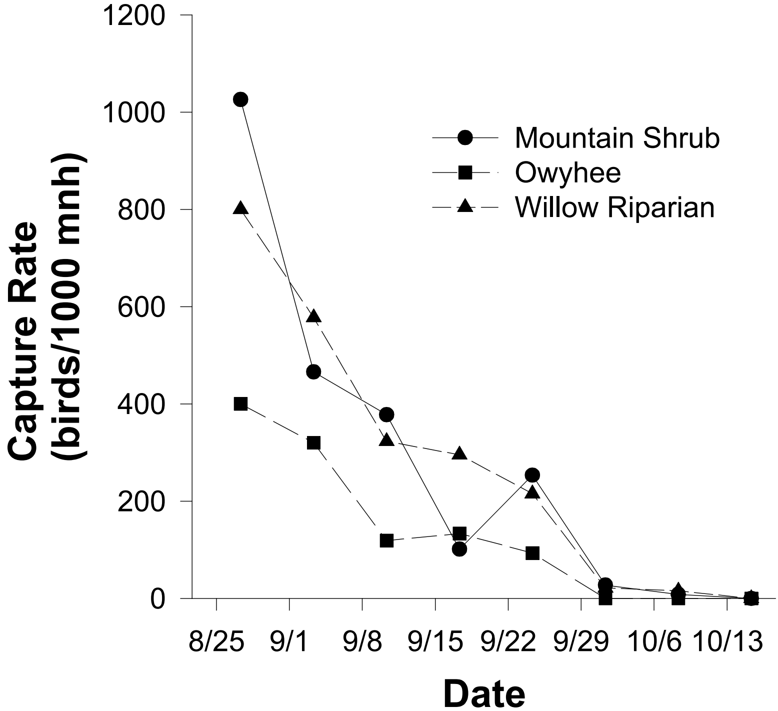

Figure 3. Capture rates (birds/1000 mist-net-hours) for neotropical migrants by week from willow riparian, mountain shrub (both Boise Foothills), and Owyhee banding sites. Capture data used are from three consecutive banding days separated by four-day intervals. Date is first of each three-day session.

in the willow riparian habitat in the Boise Foothills: the Red-breasted Nuthatch (*Sitta canadensis*), Brown Creeper (*Certhia americana*), and Golden-crowned Kinglet (*Regulus satrapa*) (Table 1). Both the nuthatch and creeper were experiencing irruptions during 1998.

Because of the short distance between the mountain shrubland and willow riparian banding sites, it is not surprising that the community overlap between these sites was greatest. It is interesting, however, that the communities at the two sites in the most similar habitats (willow riparian and Owyhee) overlapped the least.

Implications

This study provides further evidence that western landbirds use montane habitats during autumn migration (Austin 1970, Blake 1984, Hutto 1985, Carlisle et al. 2004). In comparing the composition of migrants in the two mountain ranges we studied, we were limited by having sampled at only three sites, two of which are adjacent and arguably dependent in many regards.

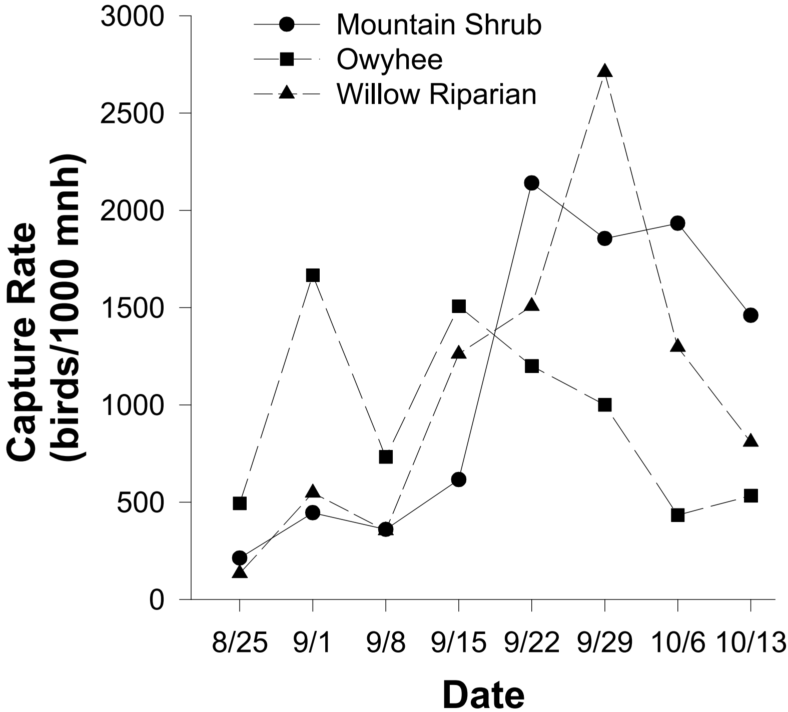

Figure 4. Capture rates (birds/1000 mist-net-hours) for temperate-zone migrants by week from willow riparian, mountain shrub (both Boise Foothills), and Owyhee banding sites. Capture data used are from three consecutive banding days separated by four-day intervals. Date is first of each three-day session.

Factors deserving further study include habitat quality, habitat diversity, and geographical isolation (Johnson 1975, Brown and Kodrick-Brown 1977, Behle 1978, Kelly et al. 1999). For instance, Johnson (1975) found fewer species of forest birds breeding on small isolated ranges within the Great Basin than in the continuous forests of the Rocky Mountains or Sierra Nevada but that habitat quality and diversity are factors more important than isolation distance in explaining the difference. Too little is known about autumn migration routes among western passerines for speculation about how the Snake River Plain affects migrants' orientation. Thus what ramifications, if any, the relative isolation of the Owyhees has for migrating landbirds are unknown. Since migrating birds are likely less affected by isolation than are residents (Behle 1978) or breeding birds, the effects of habitat diversity, quality, and isolation should be examined further for migrants.

Given migrants' capacity for long-distance travel (Bolshakov et al. 2003a, b), it seems unlikely that a desert 80 km wide would prove to be a substantial barrier. But even narrow bodies of water may funnel the paths of actively migrating birds around lakes (Kerlinger 1989). How a desert crossing compares to water in the decision-making of a migrating bird is unknown, but crossing a desert seems less risky. Does the desert dividing the Rocky Mountains and isolated ranges of the Great Basin influence migratory behavior enough to result in a greater concentration of migrants on the north side during fall? If so, would we see a reverse pattern (of higher bird concentration in the Owyhees and other isolated ranges south of the Snake River) during spring migration?

Even if the Snake River Plain does influence migratory behavior, it seems likely that, as with distributions of breeding birds (Johnson 1975), migration patterns of woodland birds in the Intermountain West are shaped primarily by the distribution and abundance of suitable woodland habitats. Given the habitat and climatic gradients in this region, further study of migrants' habitat use seems warranted.

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