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Breeding Bird Diversity, Abundance and Density at Indian Cave and Ponca State Parks, Nebraska, 2012-2014

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Unless otherwise noted, all photographs by Joel G. Jorgensen.

Indian Cave State Park (ICSP) and Ponca State Park (PSP) are important conservation properties in Nebraska that are owned and managed by the Nebraska Game and Parks Commission (NGPC). Both parks border the Missouri River and are two of the largest continuous tracts of undeveloped upland deciduous oak forest in Nebraska (Kaul and Rolfsmeier 1993). ICSP totals 1,336 hectares (ha) and is located in northeast Richardson and southeast Nemaha counties (Figure 1). PSP totals 813 ha and is located in northeast Dixon County. Both parks are part of Biologically Unique Landscapes identified by the Nebraska Natural Legacy Project (Schneider et al. 2011).

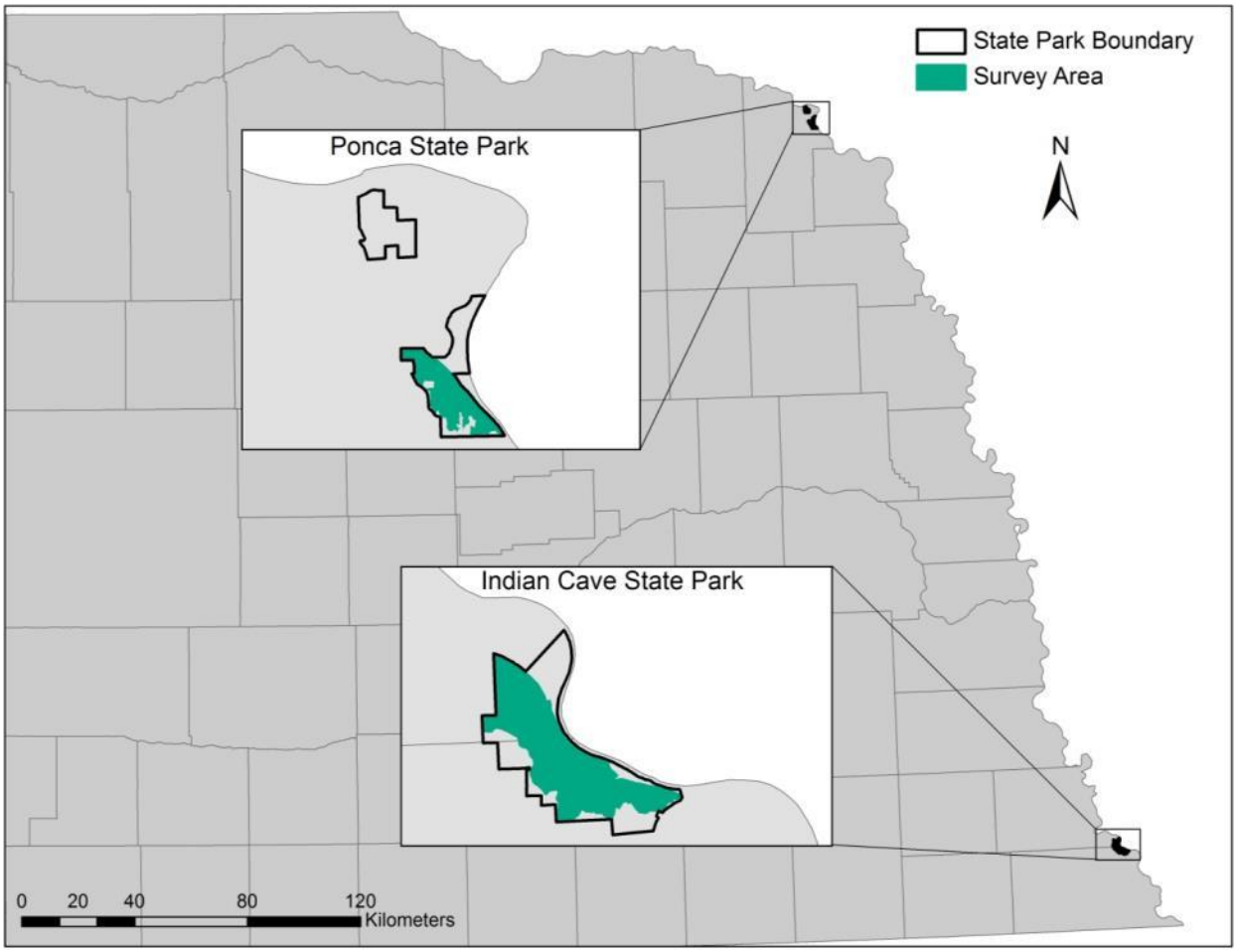

Figure 1. Indian Cave and Ponca State Park location, boundary, and survey area.

Changes in grazing and fire regimes have altered oak forests, woodlands and savannas in the Midwestern United States (Apfelbaum and Haney 1987). Oak (Quercus spp.) woodlands and savannas are disturbance-mediated ecosystems that require periodic fires. Fires burn understory, foster oak regeneration and increase the density and diversity of ground-layer vegetation. A dense woody understory of shade-tolerant trees and shrubs will grow in absence of fire reducing oak regeneration. Fire has been absent at both ICSP and PSP for decades, if not over a century, and a dense understory of trees and shrubs has indeed developed. Furthermore, the understory has been invaded by non-native plants such as common buckthorn (*Rhamnus catharitica),* honeysuckles *(Lonicera spp.)* and garlic mustard *(Allaria petiolata)*.

NGPC recently implemented management actions, specifically prescribed burns and tree-thinning, at ICSP and PSP. Prescribed fire was applied to 975 ha at ICSP and 80 ha at PSP from fall 2012 through

spring 2014. Woodland thinning through "hack-and-squirt" treatments was applied to 242 ha at ICSP from the spring 2011 through spring 2013. "Hack-and-squirt" was applied to approximately 100 ha at PSP in both 2012 and 2013. The management goals at both parks are to reduce the abundance of shade-tolerant shrubs and mid-canopy trees, stimulate oak regeneration, increase native plant (groundlayer) diversity and abundance, control invasive plant species, and improve wildlife habitat. The overall goal is to reestablish a mosaic of plant communities found at the parks prior to settlement including: 1) dense forests of basswood and other fire-intolerant trees in bottoms and on north- and east-facing slopes, 2) oak woodlands primarily on mid–slopes and 3) tallgrass prairie and oak savanna on some higher ridgetops and upper south- and west-facing slopes. It is expected to take several decades of management to achieve many of these objectives.

Management actions that alter the vegetative community and structure will affect the fauna, which includes several species of high conservation concern (Schneider et al. 2011, Rich et al. 2004). Avifauna is the focus of this project and report. Fire and tree thinning have been reintroduced to similar ecosystems elsewhere in the Midwest and impacts on avifauna have been studied. It should be noted, however, that the forest, woodlands or savannas examined in these studies are both similar and different than those found in eastern Nebraska. Furthermore, management objectives may have been very different than those outlined for ICSP and PSP.

Davis et al. (2000) studied an oak savanna restoration site in east-central Minnesota where fire was used as a management tool for 31 years. Tree density ranged from 80 to 648 trees/ha. Their study showed that different guilds of birds responded differently to changes in woodland structure; omnivorous species that forage on the ground and insectivorous bark gleaner's (woodpeckers, nuthatches) increased in abundance and insectivorous species that forage in the upper canopy decreased in abundance. Specifically, abundances of Red-headed Woodpecker (Appendix A provides scientific names for all birds species), Baltimore Oriole, Eastern Kingbird, Vesper Sparrow, Field Sparrow, Lark Sparrow, Brown Thrasher, American Goldfinch and Brown-headed Cowbird increased.

Rodewald and Smith (1998) estimated bird abundance in mature unmanaged and managed plots of oak-hickory forests in northwestern Arkansas. Two nesting guilds and 7 of 14 species showed significant treatment effects. Ovenbird, Worm-eating Warbler, Acadian Flycatcher and the understory nesting guild were more numerous in the mature, unmanaged, plots. Indigo Bunting, White-breasted Nuthatch and Eastern Wood-Pewee were more numerous on full treatment plots. The canopy-nesting guild was most abundant in mature forest and understory treatment plots. Rodewald and Smith (1998) concluded removal of understory will negatively affect ground– and shrub–nesting interior-forest species and will positively affect edge and some canopy-nesting species.

Artman et al. (2001) investigated effects of burning mixed-oak forests in southern Ohio on breeding bird populations. Their results showed decreased densities of Ovenbird, Worm-eating Warbler, and Hooded Warbler. Their results also showed increased densities of American Robin and Eastern Wood-Pewee, however, the increases were not observed until several years post-burning. In a related study, Artman and Downhower (2003) showed neither density nor nest success of Wood Thrushes was different between recently burned and unburned sites in Ohio. Wood Thrushes used different habitat niches in recently burned and unburned sites.

Brawn (2006) studied bird communities and nest success at restored oak savannas in Illinois where canopy coverage ranged from 40–70%. Of 31 focal species, Brawn (2006) found that disturbance (fire) and restoration was favored by Northern Bobwhite, Mourning Dove, Red-headed Woodpecker, Indigo Bunting and Baltimore Oriole. Those that favored undisturbed, closed-canopy, sites included Ovenbird

and Wood Thrush. Brawn (2006) concluded the following regarding the use of fire to restore oak savanna habitats in Illinois:

> *"The fundamental result from this study is that restoration of oak savannas or woodlands has pronounced effects on constituent populations and communities of birds. Local abundances of several species change in response to restoration, and bird community structure is markedly different. Moreover, for six species, reproductive success is greater in restored savannas than within undisturbed forests".*

Brawn (2006) further acknowledged that savanna restoration presents a trade-off for avian conservation.

Wilhelm and Rericha (2007) provided an extensive review of oak savanna and management results for the Timberhill Oak Savanna in Decatur County, Iowa. This site has been managed since 1995 and Wilhelm and Rericha (2007) provided study results for a wide range of flora and fauna, including birds. While their results have been positive, the findings pertaining to birds are largely drawn from four days of observations during spring migration. Thus, limited inferences can be drawn about bird response.

Gubanyi (2001) studied the effects of high deer abundance on forest sites along the Missouri and Lower Platte Rivers in eastern Nebraska. One of his study sites was ICSP and birds were a focus of his work. Deer are browsers and high densities can alter forest structure by reducing forest understory. Gubanyi (2001) classified ICSP as having low deer abundance. Gubanyi (2001) found that Louisiana Waterthrush and Kentucky Warbler were absent from sites with high deer abundance. Eastern Towhee and Gray Catbird responded unfavorably to upland forests with high deer density. Woodpeckers, White-breasted Nuthatch, Eastern Wood-Pewee and Great-crested Flycatcher responded favorably to sites with high deer density. Gubanyi's (2001) work is also important because it includes habitat measures (e.g., shrub density, page 58) at ICSP from 1994.

Both ICSP and PSP are regularly visited by birders and each was included in the first and current Nebraska Breeding Bird Atlases (Mollhoff 2001). However, neither site has been intensely surveyed using a statistically-based design that produces estimates of abundance or density. Thus, while the species that occur and likely breed in the parks is known, estimates of breeding numbers are not readily available.

Several bird species typical of oak forest, woodlands and savanna have limited breeding distribution in Nebraska and breed at only a few sites or areas that include ICSP, and to a lesser degree PSP. Several of these birds are species of high conservation concern and are classified at Tier I or Tier II species by the Nebraska Natural Legacy Project (Table 1; Schneider et al. 2011). As noted above from relevant studies, current management will affect species differently, with both positive and negative responses.

Understory species are negatively affected by the reintroduction of fire regimes in oak woodlands (Rodewald and Smith 1998). Understory species of conservation concern that breed at ICSP include Wood Thrush, Acadian Flycatcher, Louisiana Waterthrush, and Kentucky Warbler. The Eastern Whip-poor-will and the Chuck-will's-widow are both ground-nesting species, but both prefer open understory and should benefit from management of the oak woodlands (Cink 2002, Straight and Cooper 2000). The Chuck-will's-widow is also found in more open habitats than the Eastern Whip-poor-will (Straight and Cooper 2000).

Carolina and House Wren, Gray Catbird, Ovenbird, Kentucky Warbler and Eastern Towhee are species expected to be negatively impacted by loss of a developed understory. Of these, Carolina and House Wren, Gray Catbird and Eastern Towhee are relatively common species with large ranges. The Kentucky

Warbler may be one species particularly sensitive to changes in understory (Casey and Hein 1983). The Kentucky Warbler is a ground-nesting warbler that requires "well-developed ground cover for nesting" and a "thick understory" (McDonald 1998). It is also a forest-interior species (McShea et al. 1995) and at ICSP it generally occupies deep ravines. These areas of ICSP, however, are expected to be minimally altered by management, as they are not conducive for burning. Kentucky Warblers have long been a fixture of oak forest in eastern Nebraska. Bruner et al. (1904) described the Kentucky Warbler as a "common summer resident in wooded ravines of the bluffs along the Missouri river, rarely as far west as Lincoln". Thus, it seems reasonable that natural fire regimes maintained dense understory in deep ravines prior to settlement by Europeans.

Some species are expected to be negatively affected by management, other species are expected to benefit. Species of conservation concern that may benefit from restoration at ICSP include Summer Tanager and possibly Cerulean Warbler. Cerulean Warbler breeding habitat is described as mature forests with large tall trees and an open understory (Hamel 2000). However, several authors have indicated that gaps or openings in the canopy are important for the species. Kahl et al. (1985) showed that canopy cover averaged 85% and had a minimum value of 65% in Missouri where the species occurred. Silcock et al. (2005) suggested Cerulean Warblers have very specific habitat requirements and have a limited distribution in Nebraska. Other species or species groups that may benefit from woodland restoration include several woodpeckers, White-breasted Nuthatch, Eastern Wood-Pewee, America Robin, Indigo Bunting, and Baltimore Oriole. Northern Bobwhite, a species generally not associated with either ICSP or PSP, may also benefit from management.

ICSP and PSP provide important habitat for numerous breeding birds, including numerous species of conservation concern. Woodland enhancement at ICSP and PSP will alter the breeding bird communities, but is expected, overall, to be positive. However, there is a need to evaluate management and its effect on breeding bird use. Here, we present results from a breeding bird survey conducted in 2012–2014 at ICSP and PSP that is intended to be the foundation for a long-term monitoring program. We used a random sampling design using distance sampling. We compare diversity and community similarity between sites (ICSP and PSP) and between management units (burned and unburned) within ICSP. We provide relative abundance and density estimates for species and compare these values across years, site (ICSP and PSP) and management units (burned and unburned). We comment on initial results and observations.

Table 1. Woodland breeding bird species at ICSP and PSP separated into Tier I, Tier II, and other species. Non-regular or very rare species are excluded. Species in red are those that were impacted negatively by woodland and/or savanna restoration based on published studies. Species in green are those that were impacted positively by woodland and/or savanna restoration based on published studies. Species with an (I) only occurred at ICSP and species with a (p) only occurred at PSP.

Tier I Species	*Tier II Species*	*Other breeding species*
Wood Thrush	**Chuck-will's-widow**(I)	Mourning Dove
Cerulean Warbler(I)	**Eastern Whip-poor-will**(I)	Yellow-billed Cuckoo
	Ruby-throated Hummingbird	Black-billed Cuckoo(I)
	Pileated Woodpecker(I)	Barred Owl(I)
	Acadian Flycatcher(I)	**Red-headed Woodpecker**
	Yellow-throated Vireo	**Red-bellied Woodpecker**
	Tufted Titmouse(I)	**Downy Woodpecker**
	Carolina Wren(I)	**Hairy Woodpecker**
	Louisiana Waterthrush	**Northern Flicker**
	Black-n-white Warbler(p)	**Eastern Wood-Pewee**
	Kentucky Warbler	Eastern Phoebe
	Summer Tanager	Great-crested Flycatcher
		Warbling Vireo
		Red-eyed Vireo
		Blue Jay
		American Crow
		Black-capped Chickadee
		White-breasted Nuthatch
		House Wren
		Blue-gray Gnatcatcher
		Eastern Bluebird
		American Robin
		Gray Catbird
		Brown Thrasher(I)
		Cedar Waxwing
		Ovenbird
		Common Yellowthroat
		American Redstart
		Northern Parula
		Yellow Warbler
		Eastern Towhee
		Scarlet Tanager
		Northern Cardinal
		Rose-breasted Grosbeak
		Indigo Bunting
		Brown-headed Cowbird
		Orchard Oriole
		Baltimore Oriole
		American Goldfinch

METHODS

We defined study areas within ICSP and PSP property boundaries. The ICSP study area was based on existing management units and totaled 907 ha. The PSP study area was delineated manually by excluding peripheral areas of the park that were not wooded. The PSP study area totaled 327 ha. We used a random sampling design using point transects and distance sampling to survey ICSP and PSP. We established 200 point transects at ICSP. We established 90 point transects at PSP. All 90 points at PSP were surveyed in 2012, but only 56 randomly selected point transects from the original 90 were surveyed in 2013 and 70 randomly selected point transects from the original 90 were surveyed in 2014. Distance sampling is a method used to survey birds where density, rather than relative abundance, is estimated and adjusted for detectability (Buckland et al. 2001). Three keys of distance sampling are 1) objects directly on the line or point are always detected, 2) objects are detected at their initial locations, prior to any movement in response to the observer, and, 3) distances are measured accurately.

We used a random point generator utility in ArcMap to locate point transects. We used hand-held global positioning system (GPS) units to navigate to point transects. All surveys were conducted from 26 May – 20 June in 2012, 2013 and 2014. All point transects were conducted between sunrise and 11:00 a.m. Surveys were not conducted during heavy precipitation or when wind speeds were > 20 kph. We conducted five-minute point transect surveys in which surveyors located and identified all birds seen or heard from the point transect. Visual detections were distinguished from auditory detections. Distances to all visual detections were measured using a laser range-finder. Distances to all auditory detections were estimated. Detections involving species considered to be late spring migrants were excluded.

We estimated and compared species diversity at ICSP and PSP using the Shannon-Weiner Diversity Index. We also compared species diversity for burned and unburned management units and thinned and un-thinned management units at ICSP using the Shannon-Weiner Diversity Index. We used Jaccard's Index to estimate community similarity for ICSP and PSP, ICSP burned and unburned management units, and ICSP management units in which tree density was reduced (thinned) and those that were not thinned (un-thinned). We calculated relative abundance for all breeding species detected.

We chose to use relative abundance after field data were collected because we were interested in comparing bird use between different areas. The number of detections for several species was less than the minimum number recommended by Buckland et al. (2001) when using distance sampling. We compared species' relative abundances between ICSP and PSP and between burned and unburned management units at ICSP. We used two-tail t-tests to determine whether differences in relative abundances between different areas were statistically significant. In this analysis we only included regular woodland breeding species; non-regular or very rare species were excluded.

We used Program DISTANCE 6.0 (Thomas et al. 2010) to estimate density. Program DISTANCE estimates density by fitting observer detection as a function of distance to a set of models. We used the six candidate models suggested by Buckland et al. (2001, p. 42-50) to analyze data. We pooled data from all years. We used all available data to estimate global density and evaluate model fit for ICSP and PSP. For the global density analyses we manually set 10 m intervals and set the truncation distance to 60 m. We also ran models and estimated densities for individual species that were detected ≥ 68 times (Buckland et al. 2001). For individual species analyses we did not manually set an interval and truncated all detection > 49 m. Akaike's Information Criterion (AIC) was used to determine relative fit of models. The model with the lowest AIC value was selected and goodness-of-fit tests were used to support model selection decisions. We used density estimates to calculate predictions of absolute number of individuals for each species in which the individual models were run.

Jorgensen developed study design and methods and conducted DISTANCE analyses. Brogie (all years), Silcock (all years), Rink (2013, 2014), Klaphake (2013) and Jorgensen (2014) conducted surveys. Dinan provided GIS support and conducted DISTANCE analyses. Steinauer has been one of the architects of management and provided information and insights pertaining to that aspect of the project.

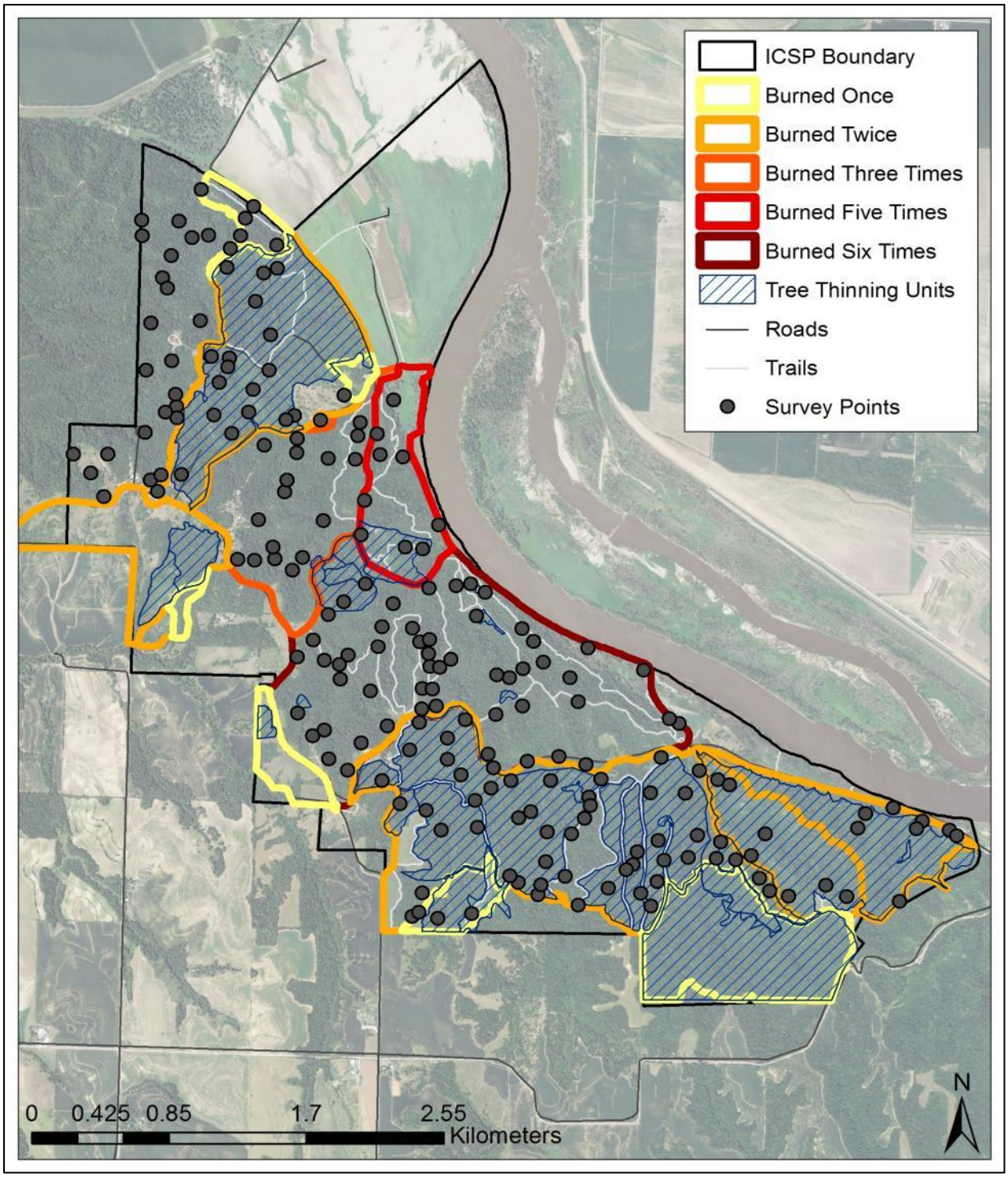

Figure 2. Indian Cave State Park boundary, management units, and distribution of random breeding bird survey point transects.

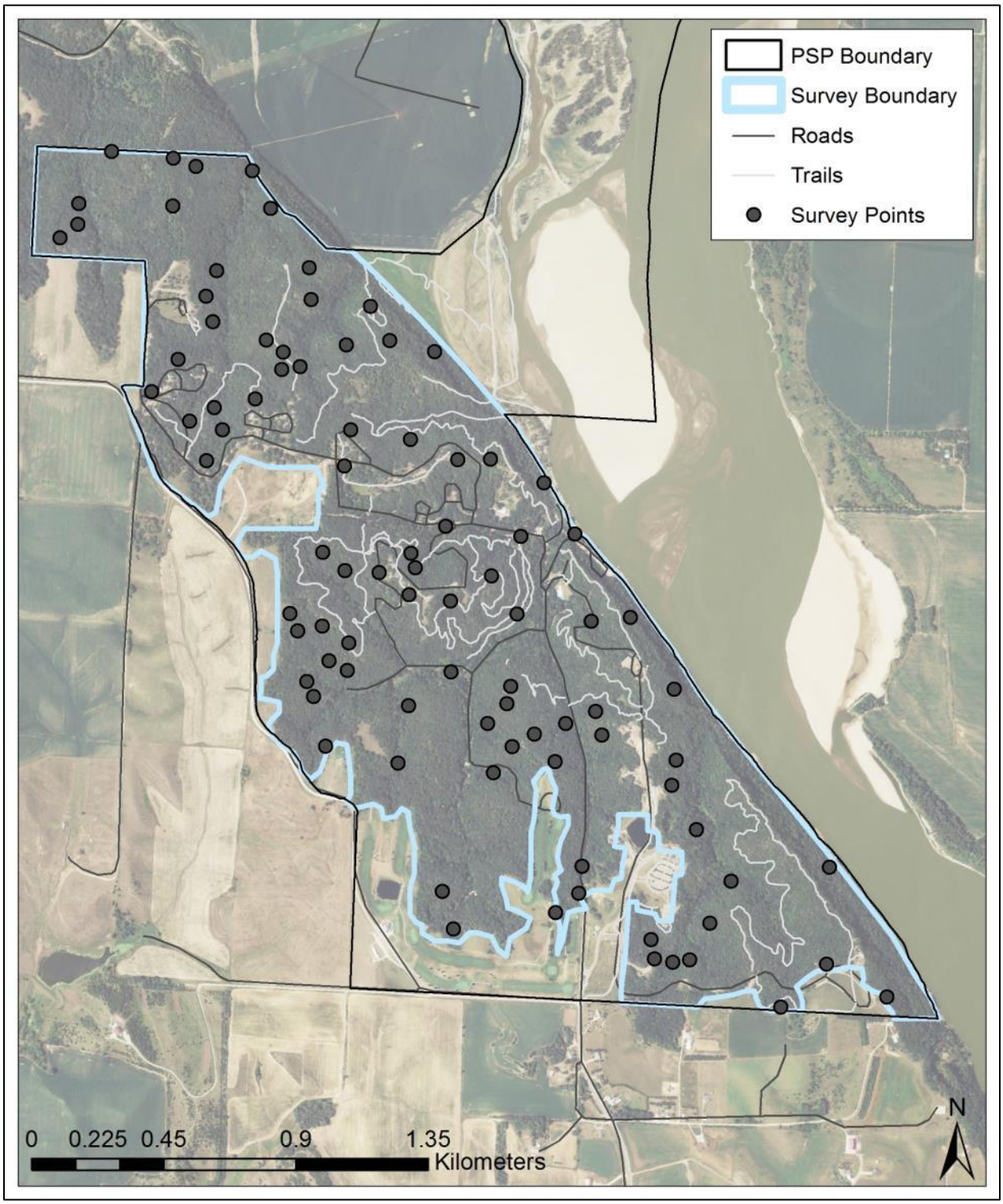

Figure 3. Ponca State Park boundary, survey area, and distribution of random breeding bird survey point transects. Note: a disjunct portion of PSP is not shown in this graphic.

RESULTS

Across the three-year study period, we detected a total of 81 species. We recorded 3,786 detections of birds representing 68 different species at ICSP and 1,162 detections of birds representing 65 species at PSP (Tables 2 and 3). Sixteen species were observed only at ICSP and 13 species were observed only at PSP. At ICSP, 65 species were detected in burned management units and 52 species were detected in unburned management units (Tables 4 and 5). Sixteen of those species were only observed in burned management units and three species were only detected in unburned management units.

The Shannon-Weiner Diversity Index was 3.49 and 3.34, at PCP and ICSP, respectively. Within ICSP, the Shannon-Weiner Diversity Index was 3.48 on burned management units and 3.42 on unburned management units and 3.29 and 3.50 on thinned and un-thinned management units, respectively. Using Jaccard's Index to compare the composition of the breeding bird communities, we found that ICSP and PSP were 64% similar. The breeding bird communities found on burned and unburned management units at ICSP were 72% similar and the birds communities on thinned and un-thinned management units were 65% similar.

We calculated relative abundance by site (ICSP and PSP) each year, and at burned and unburned management units at ICSP, for 42 of the 81 species detected (Appendix B and C). The relative abundance of several species differed sharply between ICSP and PSP. Of 42 species, the relative abundance of 30 species was statistically different between the two sites (Table 6). The relative abundance of five of 42 species was statistically different between burned and unburned management units at ICSP (Table 7).

We estimated relative abundance for 19 of the 23 species we predicted would be either negatively or positively affected by management based on our literature review. Of the eight species predicted to be negatively affected by management, none of them had significantly higher abundance in unburned management units compared to burned management units. Ovenbird relative abundance was greater in unburned management units (0.18 ± 0.06) compared to burned management units (0.10 ± 0.01), but the difference approached statistical significance (t_{571} = 1.76, P = 0.08). Larger sample sizes may have produced a statistically different result. House Wren relative abundance in unburned management units (0.09 ± 0.03) compared to burned management units (0.06 ± 0.01) was not statistically different (t_{571} = 0.91, P = 0.36). The relative abundance of Eastern Towhee in unburned management units (0.15 ± 0.04) and burned management units (0.12 ± 0.02) was not statistically significant (t_{571} = 0.73, P = 0.47).

Three species predicted to be negatively affected by management had similar relative abundance in burned and unburned management units. Gray Catbird relative abundance was similar at unburned management units (0.03 ± 0.02) and burned management units (0.02 ± 0.01) with no statistical difference between the two management units (t_{571} = 0.03, P = 0.98). Kentucky Warbler relative abundance was similar at unburned management units (0.11 ± 0.04) and burned management units (0.11 ± 0.01) with no statistical difference between the two management units (t_{571} = 0.13, P = 0.90). The relative abundance of Wood Thrush was similar at unburned management units (0.15 ± 0.05) and burned management units (0.16 ± 0.02) with no statistical difference between the two management units (t_{571} = 0.17, P = 0.87).

Two species predicted to be negatively affected by management had higher relative abundance in burned compared to unburned management units, contrary to our prediction. Carolina Wren relative abundance was higher in burned management units (0.06 ± 0.01) compared to unburned management units (0.01 ± 0.01), but the difference was not statistically significant (t_{571} = 1.68, P = 0.09). Acadian Flycatcher relative

abundance was higher in burned management units (0.21 ± 0.02) compared to unburned management units (0.09 ± 0.03), and the difference was statistically significant (t_{571} = 2.31, P = 0.02).

Of the eleven species predicted to be positively affected by management, two species had significantly higher relative abundances in burned management units compared to unburned management units. Red-headed Woodpecker relative abundance was significantly greater in burned management units (0.13 ± 0.02) compared to unburned (0.03 ± 0.02; t_{571} = 2.76, P = 0.01). Indigo Bunting relative abundance was significantly greater in burned management units (0.31 ± 0.03) compared to unburned management units (0.14 ± 0.04; t_{571} = 2.68, P = 0.01).

Five species predicted to be positively affected by management had higher, but not statistically different, relative abundance in burned management units compared to unburned management units. Red-bellied Woodpecker relative abundance in burned management units (0.28 ± 0.02) compared to unburned management units (0.25 ± 0.05) was not statistically different (t_{571} = 0.49, P = 0.62). Hairy Woodpecker relative abundance in burned management units (0.03 ± 0.01) compared to unburned management units (0.01 ± 0.01) was not statistically different (t_{571} = 1.04, P = 0.30). Northern Flicker relative abundance in burned management units (0.03 ± 0.01) compared to unburned management units (0.01 ± 0.01) was not statistically different (t_{571} = 0.97, P = 0.33). American Robin relative abundance in burned management units (0.15 ± 0.02) compared to unburned management units (0.14 ± 0.04) was not statistically different (t_{571} = 0.21, P = 0.83). Summer Tanager relative abundance in burned management units (0.11 ± 0.02) compared to unburned management units (0.06 ± 0.03) was not statistically different (t_{571} = 1.18, P = 0.24).

Three species predicted to be positively affected by management had similar relative abundance in burned and unburned management units. Downy Woodpecker relative abundance at burned management units (0.08 ± 0.01) and unburned management units (0.08 ± 0.03) was not statistically different between the two management units (t_{571} = 0.12, P = 0.91). Eastern Wood Pewee relative abundance at burned management units (0.35 ± 0.02) and unburned management units (0.34 ± 0.06) was not statistically different between the two management units (t_{571} = 0.15, P = 0.88). Baltimore Oriole relative abundance at burned management units (0.08 ± 0.01) and unburned management units (0.08 ± 0.03) was similar and not statistically different between the two management units (t_{571} = 0.17, P = 0.87).

One species predicted to be positively affected by management had greater relative abundance in unburned compared to burned management units, contrary to our prediction. White-breasted Nuthatch relative abundance was greater in unburned management units (0.25 ± 0.05) compared to burned management units (0.23 ± 0.02), but the difference was not statistically different (t_{571} = 0.34, P = 0.73).

For the global density analysis, the hazard rate + simple polynomial model best fit ICSP data and the uniform + simple polynomial model best fit PSP data (Table 8). Estimated global density of all breeding bird species was 15.083 birds/ha (95% C.I.: 13.345, 17.046; CV: 0.062) at ICSP and 13.951 birds/ha (95% C.I.: 10.129, 19.216; CV: 0.164) at PSP. We produced density estimates for 19 species at ICSP (Table 9) and four species at PSP (Table 10). Rose-breasted Grosbeak, Tufted Titmouse, American Redstart, Northern Cardinal, and White-breasted Nuthatch had the highest estimated densities of all species at ICSP. Black-capped Chickadee and House Wren had the highest estimated densities of all species at PSP. We generated predictions of absolute numbers for the 19 species at ICSP (Table 11) and four species at PSP (Table 12) in which density estimates were produced.

Table 2. Number of points surveyed, birds detected, and species detected at ICSP and PSP each year (includes all detections recorded including migrants and non-woodland breeding species).

	Indian Cave State Park			Ponca State Park		
Year	Points	Detections	Species	Points	Detections	Species
2012	196	1135	60	90	481	45
2013	186	1352	57	56	324	51
2014	191	1299	53	70	357	45
Total	**573**	**3786**	**68**	**216**	**1162**	**65**

Table 3. Species detected and the number of detections recorded at ICSP and PSP during the 2012, 2013 and 2014 breeding bird surveys (doesn't include migrants).

	Indian Cave State Park				Ponca State Park			
Species	2012	2013	2014	Total	2012	2013	2014	Total
Wood Duck	0	1	0	1	0	1	1	2
Wild Turkey	4	11	13	28	0	1	2	3
Great Blue Heron	0	1	0	1	0	0	1	1
Turkey Vulture	1	7	2	10	0	1	0	1
Cooper's Hawk	1	0	0	1	0	0	0	0
Broad-winged Hawk	1	0	0	1	0	0	0	0
Red-tailed Hawk	1	0	2	3	0	1	0	1
Mourning Dove	12	51	19	82	3	4	5	12
Yellow-billed Cuckoo	22	15	58	95	0	0	2	2
Black-billed Cuckoo	1	0	2	3	0	0	0	0
Great Horned Owl	0	0	0	0	0	0	1	1
Barred Owl	3	3	0	6	0	0	0	0
Chuck-will's-widow	1	0	0	1	0	0	0	0
Eastern Whip-poor-will	0	0	1	1	0	0	0	0
Ruby-throated Hummingbird	1	1	4	6	1	0	6	7
Red-headed Woodpecker	30	22	16	68	0	2	0	2
Red-bellied Woodpecker	53	50	54	157	8	5	5	18
Downy Woodpecker	12	14	19	45	22	9	6	37
Hairy Woodpecker	6	4	8	18	5	4	4	13
Northern Flicker	6	7	4	17	3	0	1	4
Pileated Woodpecker	4	16	5	25	0	0	0	0
Eastern Wood-Pewee	36	76	86	198	21	18	11	50
Acadian Flycatcher	42	35	32	109	0	0	0	0
Eastern Phoebe	1	1	1	3	1	0	0	1
Great-crested Flycatcher	65	54	73	192	6	7	11	24
Eastern Kingbird	0	0	0	0	3	0	1	4
Yellow-throated Vireo	5	11	15	31	3	3	2	8
Warbling Vireo	7	12	3	22	7	2	2	11
Red-eyed Vireo	55	66	80	201	21	18	16	55
Blue Jay	37	59	35	131	19	9	8	36
American Crow	4	16	7	27	1	1	1	3
Tree Swallow	0	0	0	0	0	0	1	1

Table 3: Continued

	Indian Cave State Park				Ponca State Park			
Species	2012	2013	2014	Total	2012	2013	2014	Total
Barn Swallow	0	0	0	0	0	0	2	2
Black-capped Chickadee	32	13	10	55	41	14	13	68
Tufted Titmouse	35	88	89	212	0	0	0	0
White-breasted Nuthatch	73	33	28	134	31	14	14	59
Carolina Wren	3	13	13	29	0	0	0	0
House Wren	12	13	10	35	70	38	46	154
Blue-gray Gnatcatcher	12	4	13	29	7	7	7	21
Eastern Bluebird	1	0	0	1	1	1	1	3
Wood Thrush	32	30	28	90	6	3	2	11
American Robin	27	44	13	84	22	17	20	59
Gray Catbird	4	6	4	14	5	8	2	15
Brown Thrasher	0	3	3	6	0	0	0	0
Cedar Waxwing	0	4	0	4	6	3	5	14
Ovenbird	11	29	24	64	15	4	10	29
Louisiana Waterthrush	2	1	0	3	1	2	1	4
Black-n-white Warbler	0	0	0	0	1	0	0	1
Kentucky Warbler	19	18	25	62	1	0	0	1
Common Yellowthroat	4	2	2	8	0	1	0	1
American Redstart	63	57	63	183	34	23	31	88
Cerulean Warbler	3	0	0	3	0	0	0	0
Northern Parula	9	8	15	32	0	1	0	1
Yellow Warbler	7	7	16	30	3	4	3	10
Eastern Towhee	21	31	19	71	22	13	14	49
Chipping Sparrow	3	6	2	11	3	6	6	15
Field Sparrow	1	4	3	8	1	0	1	2
Lark Sparrow	0	0	0	0	1	1	0	2
Grasshopper Sparrow	1	0	0	1	1	0	0	1
Summer Tanager	24	19	16	59	1	0	0	1
Scarlet Tanager	12	9	22	43	5	5	7	17
Northern Cardinal	99	84	71	254	7	4	5	16
Rose-breasted Grosbeak	108	144	122	374	33	24	38	95
Indigo Bunting	46	49	69	164	2	3	5	10
Dickcissel	2	3	0	5	2	1	0	3
Red-winged Blackbird	2	5	3	10	0	0	0	0
Common Grackle	0	0	0	0	0	1	0	1
Brown-headed Cowbird	38	57	45	140	17	9	14	40
Orchard Oriole	4	6	7	17	2	5	1	8
Baltimore Oriole	11	19	16	46	13	6	14	33
House Finch	0	0	0	0	0	1	0	1
American Goldfinch	2	8	8	18	3	13	8	24
House Sparrow	0	1	0	1	0	1	0	1

Table 4. Number of points surveyed, birds detected, and species detected at ICSP at burned and unburned management units each year (includes all detections recorded including migrants and non-woodland species).

	Burned			Unburned		
Year	Points	Detections	Species	Points	Detections	Species
2012	165	1010	59	31	125	30
2013	163	1114	54	23	238	42
2014	165	1157	51	26	142	37
Total	**493**	**3281**	**65**	**80**	**505**	**52**

Table 5. Species detected and the number of detections recorded at ICSP at burned and unburned management units during the 2012, 2013 and 2014 breeding bird surveys (doesn't include migrants).

	Burned				Unburned			
Species	2012	2013	2014	Total	2012	2013	2014	Total
Wood Duck	0	1	0	1	0	0	0	0
Wild Turkey	4	10	12	26	0	1	1	2
Great Blue Heron	0	1	0	1	0	0	0	0
Turkey Vulture	1	5	2	8	0	2	0	2
Cooper's Hawk	1	0	0	1	0	0	0	0
Broad-winged Hawk	1	0	0	1	0	0	0	0
Red-tailed Hawk	1	0	2	3	0	0	0	0
Mourning Dove	11	40	14	65	1	11	5	17
Yellow-billed Cuckoo	22	13	53	88	0	2	5	7
Black-billed Cuckoo	1	0	2	3	0	0	0	0
Barred Owl	3	3	0	6	0	0	0	0
Chuck-will's-widow	1	0	0	1	0	0	0	0
Eastern Whip-poor-will	0	0	0	0	0	0	1	1
Ruby-throated Hummingbird	1	0	4	5	0	1	0	1
Red-headed Woodpecker	30	21	15	66	0	1	1	2
Red-bellied Woodpecker	51	42	44	137	2	8	10	20
Downy Woodpecker	8	13	18	39	4	1	1	6
Hairy Woodpecker	6	4	7	17	0	0	1	1
Northern Flicker	6	7	3	16	0	0	1	1
Pileated Woodpecker	4	13	5	22	0	3	0	3
Eastern Wood-Pewee	31	58	82	171	5	18	4	27
Acadian Flycatcher	39	32	31	102	3	3	1	7
Eastern Phoebe	1	0	1	2	0	1	0	1
Great-crested Flycatcher	59	46	59	164	6	8	14	28
Yellow-throated Vireo	5	7	13	25	0	4	2	6
Warbling Vireo	7	12	3	22	0	0	0	0
Red-eyed Vireo	51	56	71	178	4	10	9	23
Blue Jay	34	47	29	110	3	12	6	21
American Crow	3	12	6	21	1	4	1	6
Black-capped Chickadee	20	13	10	43	12	0	0	12
Tufted Titmouse	34	77	77	188	1	11	12	24

Table 5: Continued

	Burned				Unburned			
Species	2012	2013	2014	Total	2012	2013	2014	Total
White-breasted Nuthatch	61	26	27	114	12	7	1	20
Carolina Wren	3	13	12	28	0	0	1	1
House Wren	10	9	9	28	2	4	1	7
Blue-gray Gnatcatcher	7	4	13	24	5	0	0	5
Eastern Bluebird	1	0	0	1	0	0	0	0
Wood Thrush	29	25	24	78	3	5	4	12
American Robin	24	39	10	73	3	5	3	11
Gray Catbird	4	4	4	12	0	2	0	2
Brown Thrasher	0	1	2	3	0	2	1	3
Cedar Waxwing	0	2	0	2	0	2	0	2
Ovenbird	10	20	20	50	1	9	4	14
Louisiana Waterthrush	2	1	0	3	0	0	0	0
Kentucky Warbler	17	14	22	53	2	4	3	9
Common Yellowthroat	3	2	2	7	1	0	0	1
American Redstart	55	50	61	166	8	7	2	17
Cerulean Warbler	3	0	0	3	0	0	0	0
Northern Parula	7	8	14	29	2	0	1	3
Yellow Warbler	7	6	15	28	0	1	1	2
Eastern Towhee	16	26	17	59	5	5	2	12
Chipping Sparrow	2	3	2	7	1	3	0	4
Field Sparrow	0	3	2	5	1	1	1	3
Grasshopper Sparrow	1	0	0	1	0	0	0	0
Summer Tanager	21	18	15	54	3	1	1	5
Scarlet Tanager	12	9	19	40	0	0	3	3
Northern Cardinal	93	68	58	219	6	16	13	35
Rose-breasted Grosbeak	98	113	106	317	10	31	16	57
Indigo Bunting	40	44	69	153	6	5	0	11
Dickcissel	2	2	0	4	0	1	0	1
Red-winged Blackbird	2	5	3	10	0	0	0	0
Brown-headed Cowbird	27	41	39	107	11	16	6	33
Orchard Oriole	4	4	5	13	0	2	2	4
Baltimore Oriole	10	14	16	40	1	5	0	6
American Goldfinch	2	6	8	16	0	2	0	2
House Sparrow	0	0	0	0	0	1	0	1

Table 6. T-test results comparing relative abundance (± SE) at ICSP and PSP. Species with significantly higher relative abundance at ICSP are shown in table A and species with significantly higher relative abundance at PSP are shown in table B.

A. Species with significantly higher relative abundance at ICSP than at PSP.

Species	ICSP Abundance	PSP Abundance	
Mourning Dove	0.14 ± 0.02	0.06 ± 0.02	$t = 3.18$, $P < 0.01$, df = 787
Yellow-billed Cuckoo	0.17 ± 0.02	0.01 ± 0.01	$t = 5.58$, $P < 0.01$, df = 787
Red-headed Woodpecker	0.12 ± 0.01	0.01 ± 0.01	$t = 4.81$, $P < 0.01$, df = 787
Red-bellied Woodpecker	0.27 ± 0.02	0.08 ± 0.02	$t = 5.61$, $P < 0.01$, df = 787
Pileated Woodpecker	0.04 ± 0.01	0.00 ± 0.00	$t = 3.14$, $P < 0.01$, df = 787
Eastern Wood-Pewee	0.35 ± 0.02	0.23 ± 0.03	$t = 2.83$, $P < 0.01$, df = 787
Acadian Flycatcher	0.19 ± 0.02	0.00 ± 0.00	$t = 6.48$, $P < 0.01$, df = 787
Great-crested Flycatcher	0.34 ± 0.02	0.11 ± 0.02	$t = 5.44$, $P < 0.01$, df = 787
Red-eyed Vireo	0.35 ± 0.02	0.25 ± 0.03	$t = 2.24$, $P = 0.03$, df = 787
American Crow	0.05 ± 0.01	0.01 ± 0.01	$t = 2.18$, $P = 0.03$, df = 787
Tufted Titmouse	0.37 ± 0.02	0.00 ± 0.00	$t = 9.65$, $P < 0.01$, df = 787
Carolina Wren	0.05 ± 0.01	0.00 ± 0.00	$t = 3.39$, $P < 0.01$, df = 787
Wood Thrush	0.16 ± 0.02	0.05 ± 0.01	$t = 3.65$, $P < 0.01$, df = 787
Kentucky Warbler	0.11 ± 0.01	0.00 ± 0.00	$t = 4.61$, $P < 0.01$, df = 787
Northern Parula	0.06 ± 0.01	0.00 ± 0.00	$t = 3.12$, $P < 0.01$, df = 787
Summer Tanager	0.10 ± 0.01	0.00 ± 0.00	$t = 4.32$, $P < 0.01$, df = 787
Northern Cardinal	0.44 ± 0.03	0.07 ± 0.02	$t = 8.55$, $P < 0.01$, df = 787
Rose-breasted Grosbeak	0.65 ± 0.03	0.44 ± 0.04	$t = 3.54$, $P < 0.01$, df = 787
Indigo Bunting	0.29 ± 0.02	0.05 ± 0.01	$t = 6.38$, $P < 0.01$, df = 787

B. Species with significantly higher relative abundance at PSP than at ICSP.

Species	ICSP Abundance	PSP Abundance	
Ruby-throated Hummingbird	0.01 ± 0.00	0.03 ± 0.01	$t = 2.16$, $P = 0.03$, df = 787
Downy Woodpecker	0.08 ± 0.01	0.17 ± 0.03	$t = 3.64$, $P < 0.01$, df = 787
Black-capped Chickadee	0.10 ± 0.01	0.31 ± 0.03	$t = 7.19$, $P < 0.01$, df = 787
House Wren	0.06 ± 0.01	0.71 ± 0.05	$t = 19.28$, $P < 0.01$, df = 787
Blue-gray Gnatcatcher	0.05 ± 0.01	0.10 ± 0.02	$t = 2.40$, $P = 0.02$, df = 787
American Robin	0.15 ± 0.02	0.27 ± 0.04	$t = 3.53$, $P < 0.01$, df = 787
Gray Catbird	0.02 ± 0.01	0.07 ± 0.02	$t = 2.65$, $P = 0.01$, df = 787
Cedar Waxwing	0.01 ± 0.00	0.06 ± 0.02	$t = 4.92$, $P < 0.01$, df = 787
Eastern Towhee	0.12 ± 0.01	0.23 ± 0.03	$t = 3.48$, $P < 0.01$, df = 787
Baltimore Oriole	0.08 ± 0.01	0.15 ± 0.03	$t = 2.74$, $P = 0.01$, df = 787
American Goldfinch	0.03 ± 0.01	0.11 ± 0.02	$t = 4.50$, $P < 0.01$, df = 787

Table 7. T-test results comparing relative abundance (± SE) at burned and unburned management units at ICSP. Species with significantly higher relative abundance in burned management units are shown in table A and species with significantly higher relative abundance in unburned management unites are shown in table B.

A. Species with significantly higher relative abundance at burned management units than unburned management units.

Species	Burned Abundance	Unburned Abundance	
Red-headed Woodpecker	0.13 ± 0.02	0.03 ± 0.02	t = 2.76, P = 0.01, df = 571
Acadian Flycatcher	0.21 ± 0.02	0.09 ± 0.03	t = 2.31, P = 0.02, df = 571
Indigo Bunting	0.31 ± 0.03	0.14 ± 0.04	t = 2.68, P = 0.01, df = 571

B. Species with significantly higher relative abundance at unburned management units than burned management units.

Species	Burned Abundance	Unburned Abundance	
Cedar Waxwing	0.00 ± 0.00	0.03 ± 0.02	t = 2.09, P = 0.04, df = 571
Brown-headed Cowbird	0.22 ± 0.02	0.41 ± 0.06	t = 3.49, P < 0.01, df = 571

Table 8. Models of global (all species pooled) bird density at Indian Cave (A) and Ponca (B) State Parks. *K* is the number of parameters, and ΔAIC is the difference in AIC from the top model, μ D is mean density, D LCL is the density 95% lower confidence level, D UCL is the density 95% upper confidence level, and CV is the coefficient of variation.

A. Indian Cave State Park

Model +series expansion [a]	K	Δ AIC[b]	μ D	D LCL	D UCL	D CV
half normal + cosine	3	26.970	15.686	13.616	18.071	0.072
half normal + hermite polynomial	2	23.220	15.900	14.388	17.571	0.051
uniform + cosine	5	2.880	15.521	12.666	19.021	0.104
uniform + simple polynomial	2	40.739	17.305	16.661	17.973	0.019
hazard rate + cosine	2	36.739	14.576	13.956	15.225	0.022
hazard rate + simple polynomial	5	0.000	15.083	13.345	17.046	0.062

[a]Model and series expansion recommended by Buckland et al. (2001)
[b]lowest AIC value for the top model was 11953.150

B. Ponca State Park

Model +series expansion [a]	K	Δ AIC[b]	μ D	D LCL	D UCL	D CV
half normal + cosine	5	32.028	21.300	14.877	30.496	0.184
half normal + hermite polynomial	4	109.463	11.318	9.720	13.178	0.078
uniform + cosine	5	14.142	14.536	10.205	20.705	0.182
uniform + simple polynomial	5	0.000	13.951	10.129	19.216	0.164
hazard rate + cosine	2	152.118	8.427	8.114	8.751	0.019
hazard rate + simple polynomial	3	105.581	10.086	9.308	10.929	0.041

[a]Model and series expansion recommended by Buckland et al. (2001)
[b]lowest AIC value for the top model was 3597.677

Table 9. Preliminary mean (μ D), 95% upper confidence level (D UCL), and 95% lower confidence level (D LCL) density estimates (birds/ha) and coefficient of variation (CV) estimates for all species with > 68 detections at ICSP.

Species	μ D	D LCL	D UCL	CV
Mourning Dove	0.139	0.139	0.140	0.002
Yellow-billed Cuckoo	0.283	0.225	0.355	0.115
Red-headed Woodpecker	0.127	0.094	0.172	0.151
Red-bellied Woodpecker	0.406	0.350	0.472	0.076
Eastern Wood-Pewee	0.622	0.498	0.776	0.113
Acadian Flycatcher	0.524	0.374	0.735	0.172
Great-crested Flycatcher	0.576	0.414	0.800	0.168
Red-eyed Vireo	0.660	0.556	0.784	0.087
Blue Jay	0.450	0.296	0.683	0.213
Tufted Titmouse	0.946	0.853	1.050	0.053
White-breasted Nuthatch	0.813	0.732	0.904	0.053
Wood Thrush	0.166	0.136	0.202	0.099
American Robin	0.659	0.393	1.104	0.263
American Redstart	0.923	0.768	1.109	0.093
Eastern Towhee	0.215	0.158	0.292	0.155
Northern Cardinal	0.820	0.736	0.914	0.055
Rose-breasted Grosbeak	1.544	1.472	1.620	0.024
Indigo Bunting	0.571	0.437	0.747	0.136
Brown-headed Cowbird	0.615	0.502	0.754	0.103

Table 10. Preliminary mean (μ D), 95% upper confidence level (D UCL), and 95% lower confidence level (D LCL) density estimates (birds/ha) and coefficient of variation (CV) estimates for all species with > 68 detections at PSP.

Species	μ D	D LCL	D UCL	CV
Black-capped Chickadee	1.726	1.362	2.188	0.120
House Wren	1.477	1.115	1.956	0.143
American Redstart	1.294	0.634	2.641	0.370
Rose-breasted Grosbeak	1.435	0.456	4.513	0.623

Table 11. Lower confidence level (N LCL), mean (μ N), and upper confidence level (N UCL) for the predicted absolute number of individuals for all species with > 68 detections at ICSP. Predictions were generated multiplying density estimates from Program Distance by area (907 ha).

Species	N LCL	μ N	N UCL
Mourning Dove	126	126	127
Yellow-billed Cuckoo	204	257	322
Red-headed Woodpecker	85	115	156
Red-bellied Woodpecker	317	368	428
Eastern Wood-Pewee	452	564	704
Acadian Flycatcher	339	475	667
Great-crested Flycatcher	376	522	726
Red-eyed Vireo	504	599	711
Blue Jay	268	408	619
Tufted Titmouse	774	858	952
White-breasted Nuthatch	664	738	820
Wood Thrush	123	150	183
American Robin	357	598	1002
American Redstart	696	837	1006
Eastern Towhee	143	195	265
Northern Cardinal	667	744	829
Rose-breasted Grosbeak	1335	1401	1470
Indigo Bunting	396	518	677
Brown-headed Cowbird	455	558	684

Table 12. Lower confidence level (N LCL), mean (μ N), and upper confidence level (N UCL) for the predicted absolute number of individuals for all species with > 68 detections at PSP. Predictions were generated multiplying density estimates from Program Distance by area (327 ha).

Species	N LCL	μ N	N UCL
Black-capped Chickadee	445	564	715
House Wren	365	483	640
American Redstart	207	423	864
Rose-breasted Grosbeak	149	469	1476

DISCUSSION

The impetus for this study was a desire to evaluate effects of woodland management on the breeding bird communities at ICSP and PSP. This initial phase collected data during three years and provides a foundation to evaluate future changes in breeding bird communities. We reviewed existing literature to make cursory predictions about how management would affect individual species. Our initial results suggest that recent management has had a positive effect on the breeding bird community, particularly at ICSP. We observed higher relative abundances in burned management units for most species we predicted to be positively affected by management. The opposite was not the case; we observed decreased abundance for very few species (Ovenbirds, House Wren, and Eastern Towhee) in burned management units and no result was statistically significant, including those species predicted to be negatively affected by management. Furthermore, and most notably, in case of the Acadian Flycatcher, the observed response was contrary to the predicted response. Similar abundances of two species of high conservation concern in Nebraska, Wood Thrush and Kentucky Warbler, predicted to be negatively affected by management were observed in nearly equal abundance in both burned and unburned management units. More species were detected on the burned management units than the unburned management units.

As expected, more species were recorded at ICSP than PSP. However, the difference in occurrence of a few common species between PSP and ICSP was not anticipated. For example, the relative abundance of House Wren at PSP was 12 times greater than it was at ICSP. The relative abundance of Indigo Bunting was 6 times greater at ICSP than it was at PSP. We encourage managers to consider the similarities and differences of the breeding bird communities at the two sites when developing management plans.

This study showed that two species, the Pileated Woodpecker and Acadian Flycatcher, have established strong footholds at ICSP. The Pileated Woodpecker was extirpated as a breeding species from Nebraska following settlement by European American up until 1999, when the species nested at Fontenelle Forest, Sarpy County (Sharpe et al. 2001). Pileated Woodpeckers first nested at ICSP in 2002. Pileated Woodpecker was detected 25 times on point transects and several additional observations were made during the study period. The number of Acadian Flycatchers both detected and estimated was also surprising. This species was rare in summer anywhere in Nebraska, including ICSP, a little over ten years ago. Acadian Flycatchers were known to nest in the Missouri River valley in the mid-1900s (Sharpe et al. 2001). The species was essentially absent from the state in the latter part of the 20th Century, prior to 1988. Acadian Flycatchers had been slowly expanding their range and increasing in numbers over the past two decades. However, the estimate that 399 to 667 Acadian Flycatchers summer and presumably breed at ICSP will force a re-evaluation of this species' status in Nebraska. On the other hand, Carolina Wren was scarce at ICSP. Carolina Wren is generally an uncommon to fairly common resident of southeastern woodlands, but this species was only detected 29 times at ICSP throughout the three year study.

The ranges of a few southeastern species, which are typical inhabitants of ICSP, generally do not extend north to PSP. The breeding range of Kentucky Warbler reaches its northwestern limits along the Missouri River Valley of Nebraska. This species is most often found in association with mature forests with dense understory (Robbins et al. 1989). McShea et al. (1995) found this warbler most often in locations that contained streams and areas with low white-tailed deer densities. As expected, Kentucky Warblers were frequently encountered (62 detections) during this study at ICSP. This species has been reported annually since 1981 in Nemaha and Richardson counties (Sharpe et al. 2001).

Louisiana Waterthrush is restricted as a breeding species to the lower Missouri River Valley in Nebraska (Sharpe et al. 2001). However; recently this species has been recorded in Jefferson County (JGJ) and northeastern Nebraska. It has been found regularly in summer at PSP for the past several summers and it was recorded in low numbers all three years of this study. An important component of this species' habitat is clear flowing streams. Due to Louisiana Waterthrushes' dependence on riparian systems for food and nesting, this species may serve as an effective biological indicator of stream biotic integrity (Mattsson 2006).

The number of Black-billed Cuckoo detections and observations cements emerging opinions that this species has declined in Nebraska, a trend that is likely occurring independent of local management. Sharpe et al. (2001) listed the Black-billed Cuckoo as a fairly common breeding species just over a decade ago. Only three Black-billed Cuckoos were detected during this study. There has also been concern about declines in the Yellow-billed Cuckoo. During the first two years of this study only 37 Yellow-billed Cuckoos were detected all at ICSP. In 2014, 58 and two Yellow-billed Cuckoos were detected at ICPS and PSP, respectively. These results suggest that certain species abundance can change markedly from year to year and caution should be used when interpreting results from a single year.

In addition to Yellow-billed Cuckoo, the number of detections for other species was also variable between the three years. Some natural variation is expected. However, climate patterns between the three years were different. In Nebraska, the first half of 2012 (January to June) was one of the warmest and driest on record, the first half of 2013 had average temperatures and precipitation, and the first half of 2014 was average in terms of temperature, but above average precipitation was recorded. June 2014 was one of the wettest on record (National Climatic Data Center 2014). It is unclear if or how the different climate patterns affected bird density, phenology or detection rates. Nonetheless, it is important to note this point when comparing results from the three years.

This study establishes an important baseline for evaluating future changes in breeding bird numbers that may occur either in response to local management or reflect broader regional trends. Caution should be exercised when interpreting results from this study, however. The lack of control sites or data prior to management treatments or an experimental design limits our ability to make inferences regarding changes in bird abundance at ICSP or PSP at this time. Furthermore, we only measured bird use. We did not evaluate whether there were demographic consequences (e.g, differences in nest success, nestling survival) to management. The breeding bird monitoring conducted at ICSP and PSP from 2012 to 2014 is expected to be the initial time interval in what is anticipated to be a long-term, but not annual, monitoring program.

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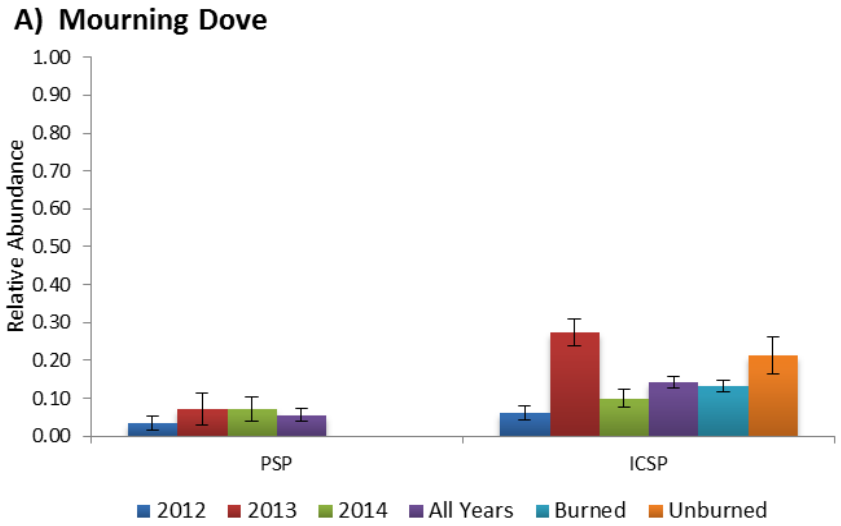
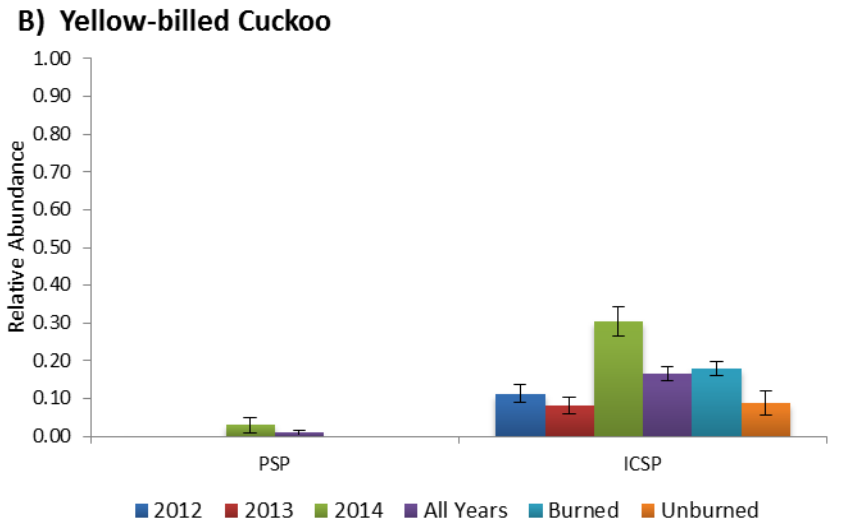
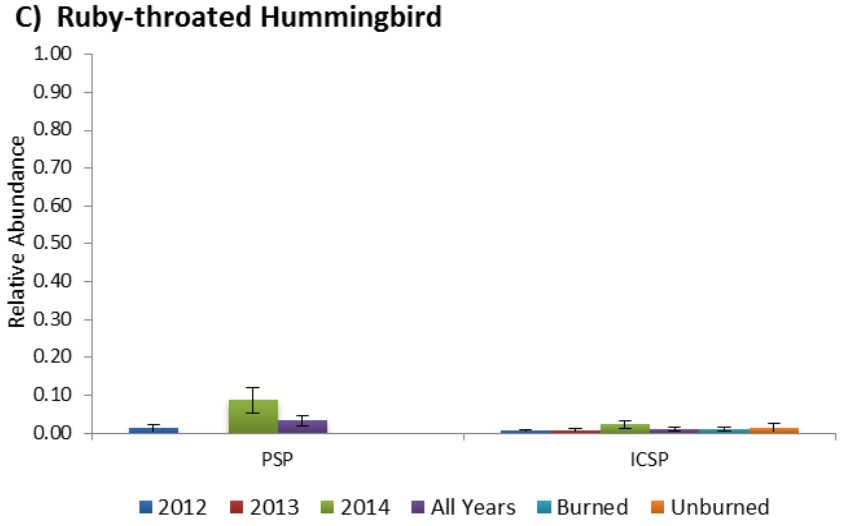
Appendix A. Common and scientific bird names for all species mentioned in text.

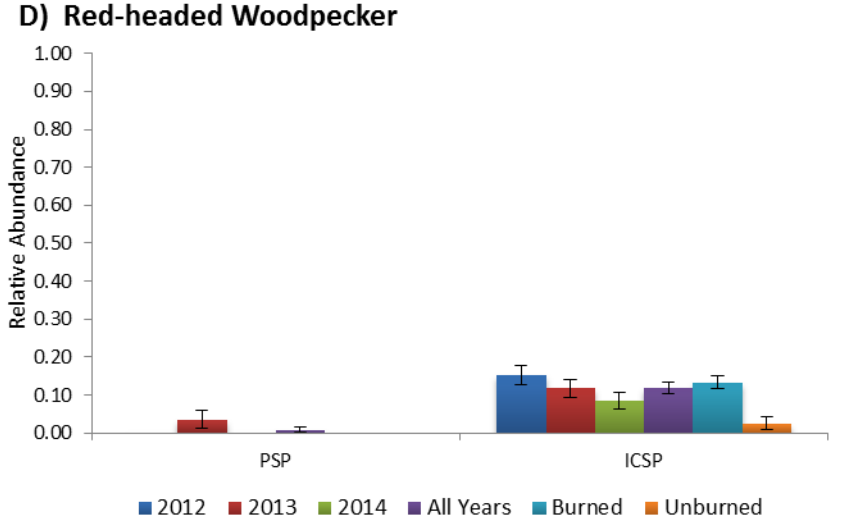
Wild Turkey (*Meleagris gallopavo*)
Turkey Vulture, (*Cathartes aura*)
Cooper's Hawk (*Accipiter cooperii*)
Broad-winged Hawk (*Buteo platypterus*)
Red-tailed Hawk (*Buteo jamaicensis*)
Mourning Dove (*Zenaida macroura*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)
Yellow-billed Cuckoo (*Coccyzus americanus*)
Barred Owl (*Strix varia*)
Chuck-will's-widow (*Caprimulgus carolinensis*)
Whip-poor-will (*Caprimulgus vociferus*)
Ruby-throated Hummingbird (*Archilochus colubris*)
Red-headed Woodpecker (*Melanerpes erythrocephalus*)
Red-bellied Woodpecker (*Melanerpes carolinus*)
Downy Woodpecker (*Picoides pubescens*)
Hairy Woodpecker (*Picoides villosus*)
Northern Flicker (*Colaptes auratus*)
Pileated Woodpecker (*Dryocopus pileatus*)
Olive-sided Flycatcher (*Contopus cooperi*)
Eastern Wood-Pewee (*Contopus virens*)
Acadian Flycatcher (*Empidonax virescens*)
Eastern Phoebe (*Sayornis phoebe*)
Great Crested Flycatcher (*Myiarchus crinitus*)
Eastern Kingbird (*Tyrannus tyrannus*)
Yellow-throated Vireo (*Vireo flavifrons*)
Warbling Vireo (*Vireo gilvus*)
Red-eyed Vireo (*Vireo olivaceus*)
Blue Jay, (*Cyanocitta cristata*)
American Crow (*Corvus brachyrhynchos*)
Barn Swallow (*Hirundo rustica*)
Black-capped Chickadee (*Poecile atricapillus*)
Tufted Titmouse (*Baeolophus bicolor*)
White-breasted Nuthatch (*Sitta carolinensis*)
Carolina Wren (*Thryothorus ludovicianus*)
House Wren (*Troglodytes aedon*)
Blue-gray Gnatcatcher (*Polioptila caerulea*)
Eastern Bluebird (*Sialia sialis*)
Wood Thrush (*Hylocichla mustelina*)
American Robin (*Turdus migratorius*)
Gray Catbird (*Dumetella carolinensis*)
Brown Thrasher (*Toxostoma rufum*)
Cedar Waxwing, (*Bombycilla cedrorum*)
Northern Parula (*Setophaga americana*)
Yellow Warbler (*Setophaga petechia*)
Cerulean Warbler (*Dendroica cerulea*)
American Redstart (*Setophaga ruticilla*)
Worm-eating Warbler (*Helmitheros vermivorus*)
Ovenbird (*Seiurus aurocapilla*)
Louisiana Waterthrush (*Parkesia motacilla*)
Kentucky Warbler (*Geothlypis formosa*)
Common Yellowthroat (*Geothlypis trichas*)
Hooded Warbler (*Setophaga citrina*)
Summer Tanager (*Piranga rubra*)
Scarlet Tanager (*Piranga olivacea*)
Eastern Towhee (*Pipilo erythrophthalmus*)
Chipping Sparrow (*Spizella passerina*)
Field Sparrow (*Spizella pusilla*)
Lark Sparrow (*Chondestes grammacus*)
Grasshopper Sparrow (*Ammodramus savannarum*)
Northern Cardinal (*Cardinalis cardinalis*)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)
Indigo Bunting (*Passerina cyanea*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Brown-headed Cowbird (*Molothrus ater*)
Orchard Oriole (*Icterus spurius*)
Baltimore Oriole (*Icterus galbula*)

Appendix B. Species relative abundance at ICSP and PSP each year and total relative abundance at ICSP at burned and unburned management units for all three years combined. Only includes regular woodland breeding species.

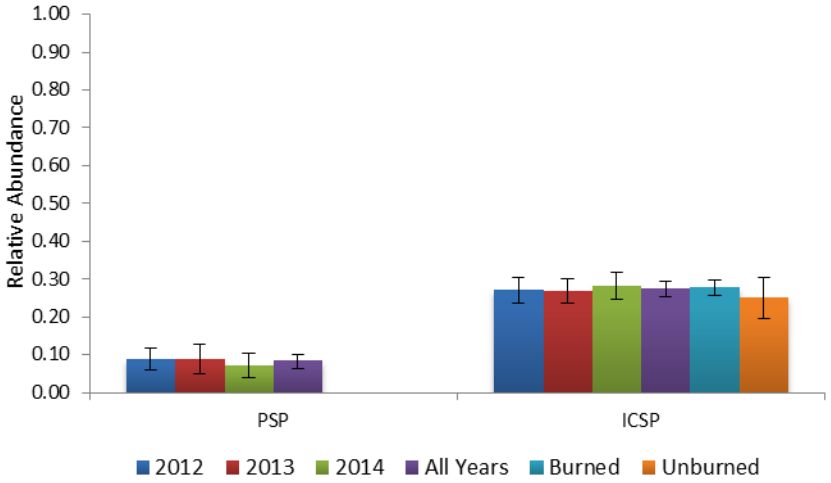




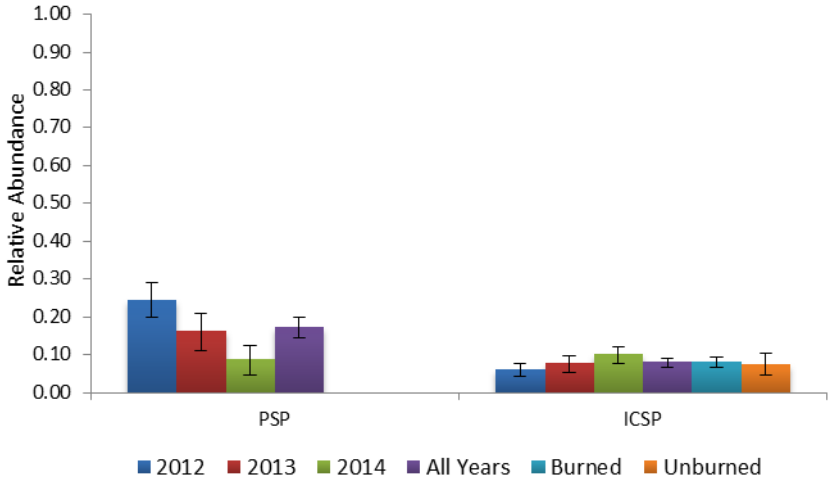




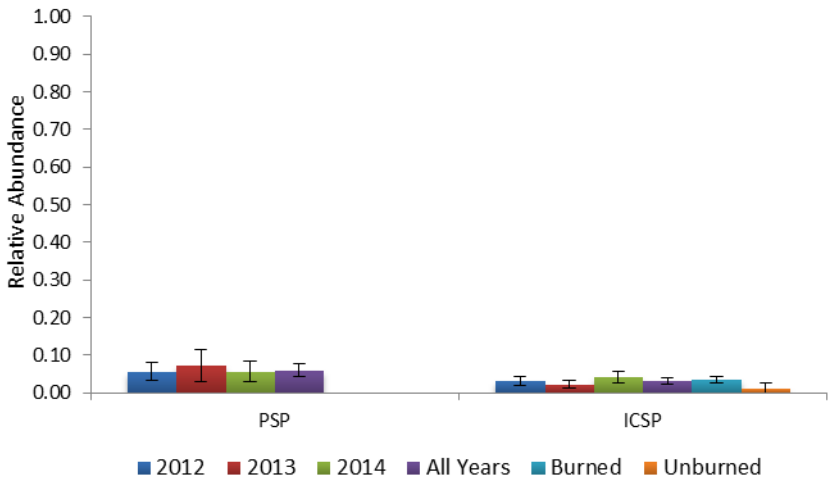
E) Red-bellied Woodpecker



F) Downy Woodpecker



G) Hairy Woodpecker



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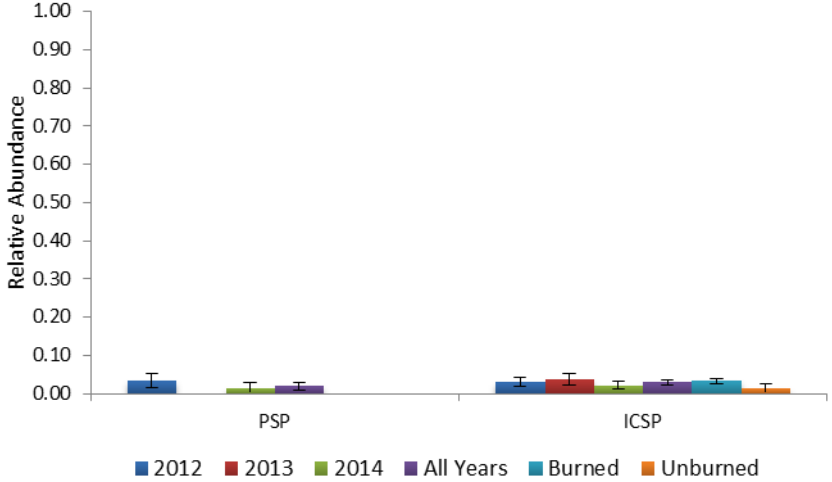
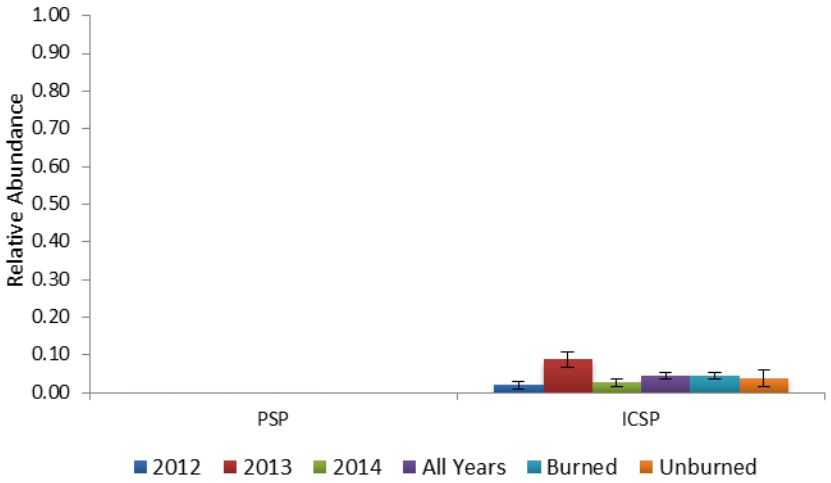
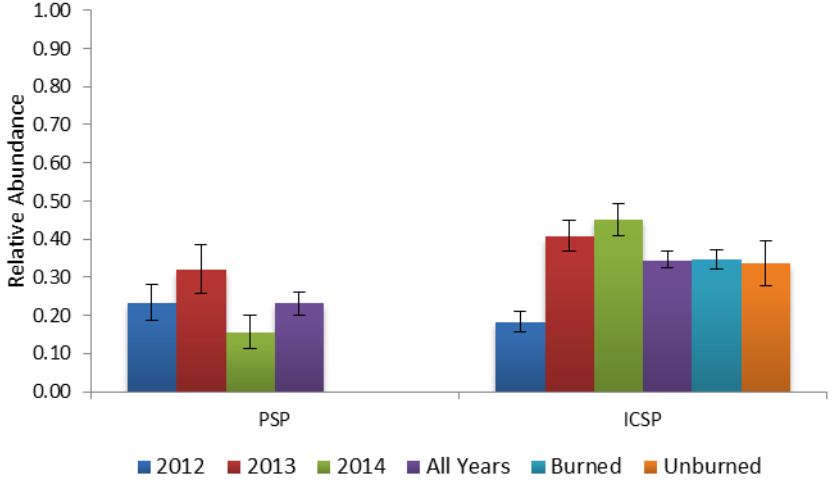


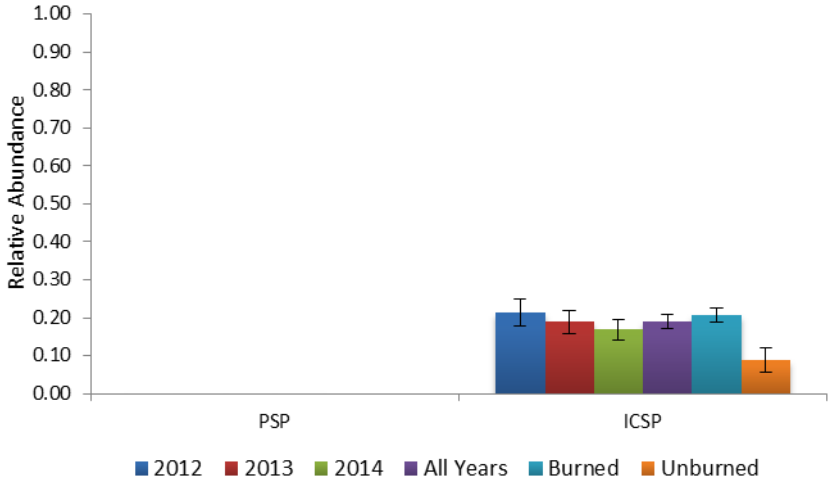
I) Pileated Woodpecker



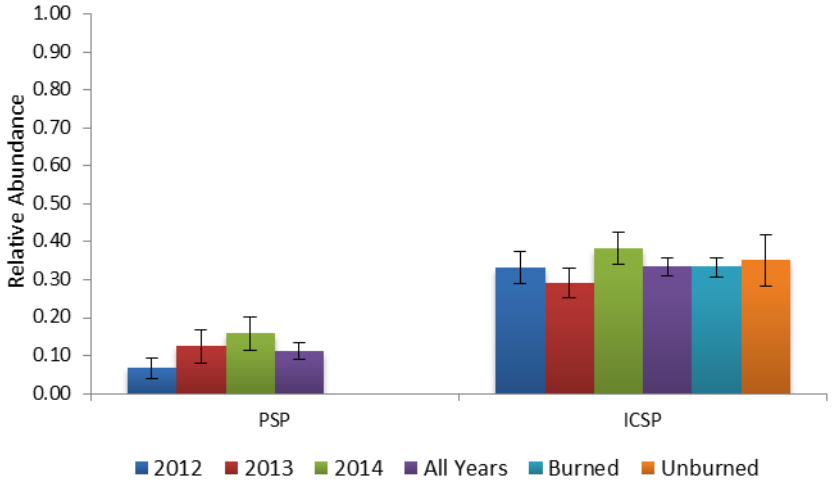
J) Eastern Wood-Pewee



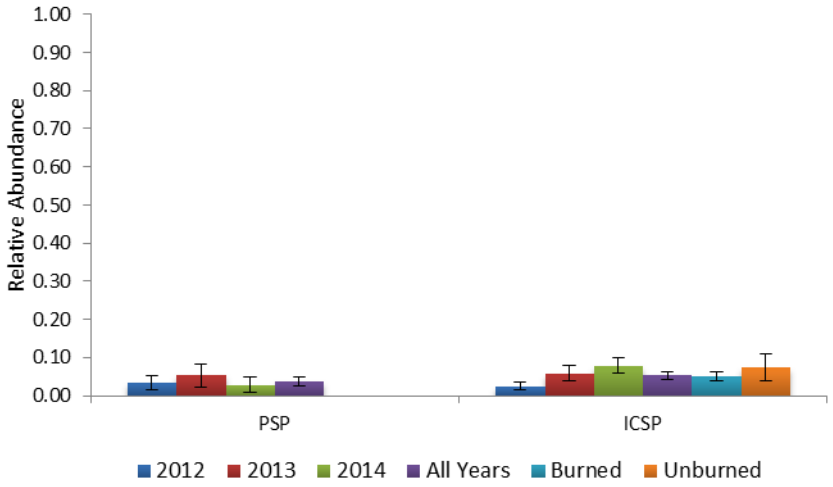
K) Acadian Flycatcher



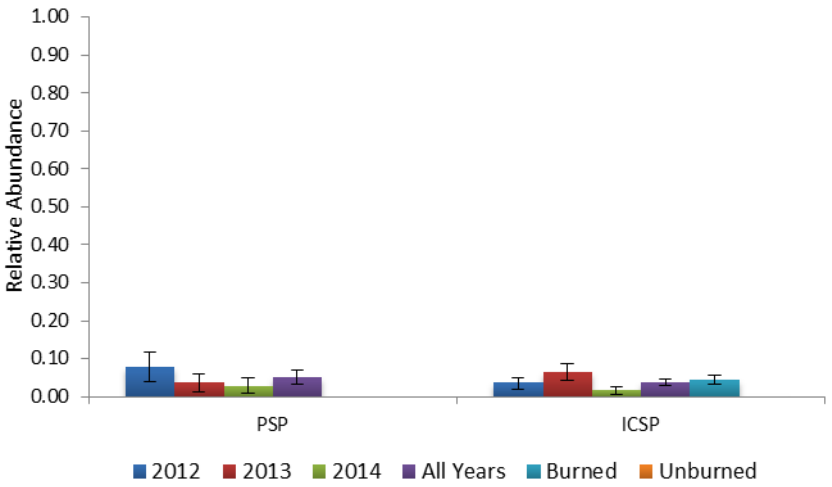
L) Great-crested Flycatcher



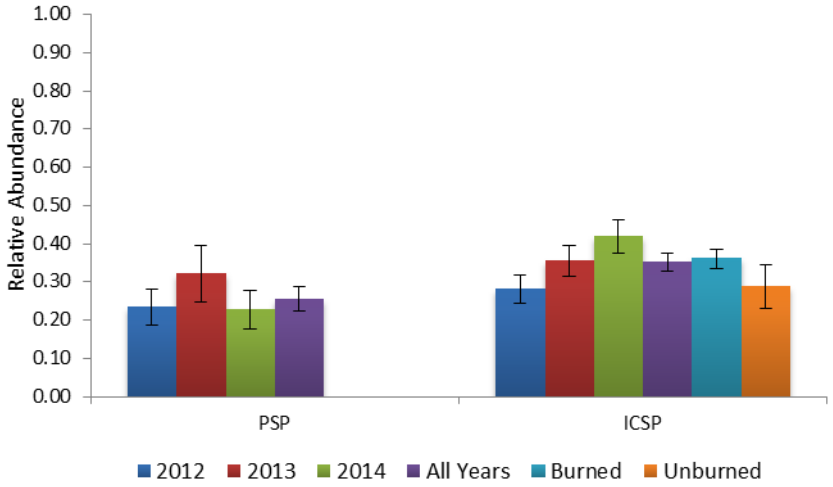
M) Yellow-throated Vireo



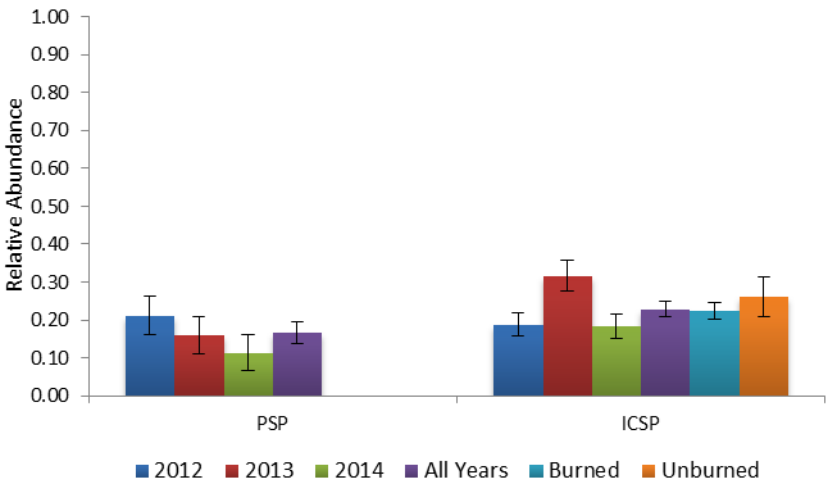
N) Warbling Vireo



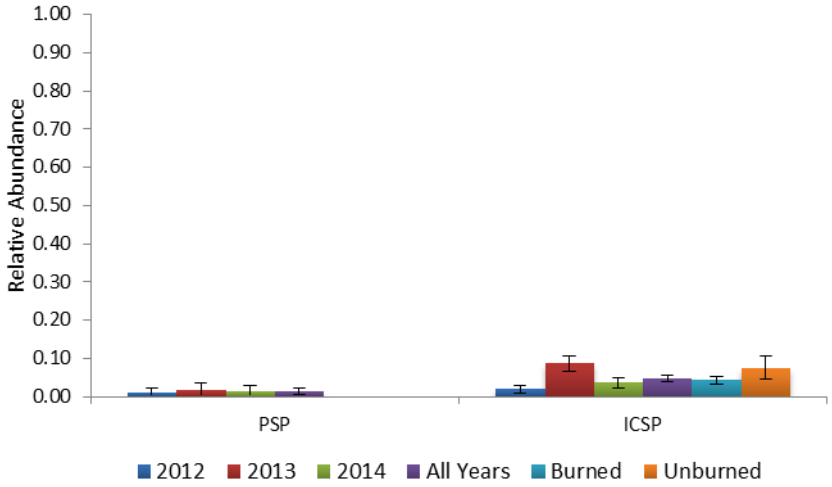
O) Red-eyed Vireo



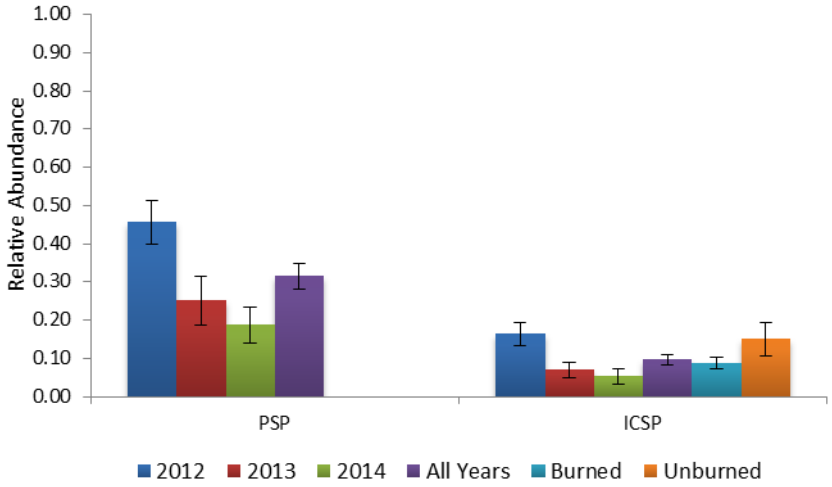
P) Blue Jay



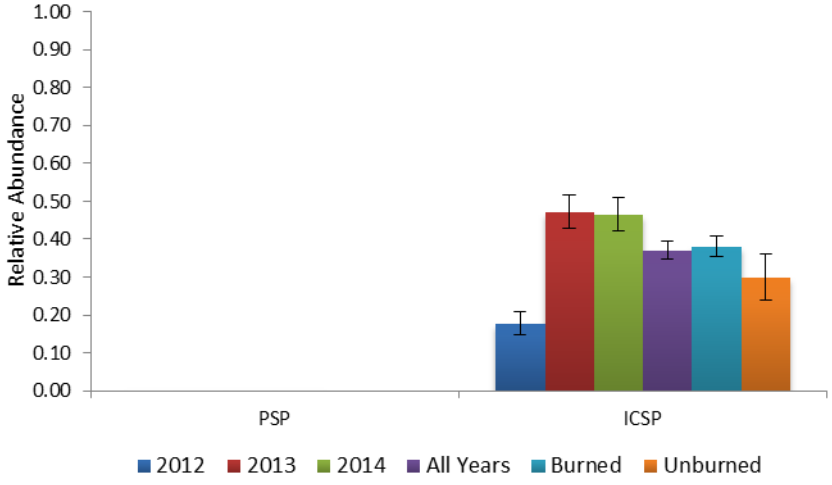
Q) American Crow



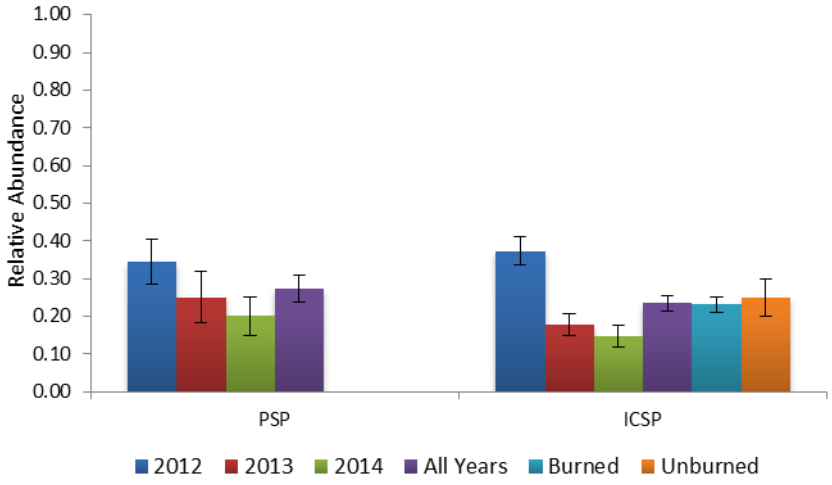
R) Black-capped Chickadee



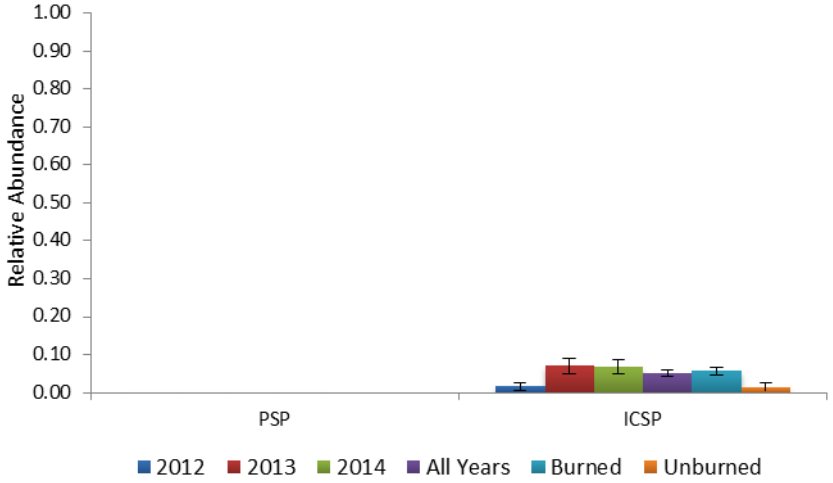
S) Tufted Titmouse



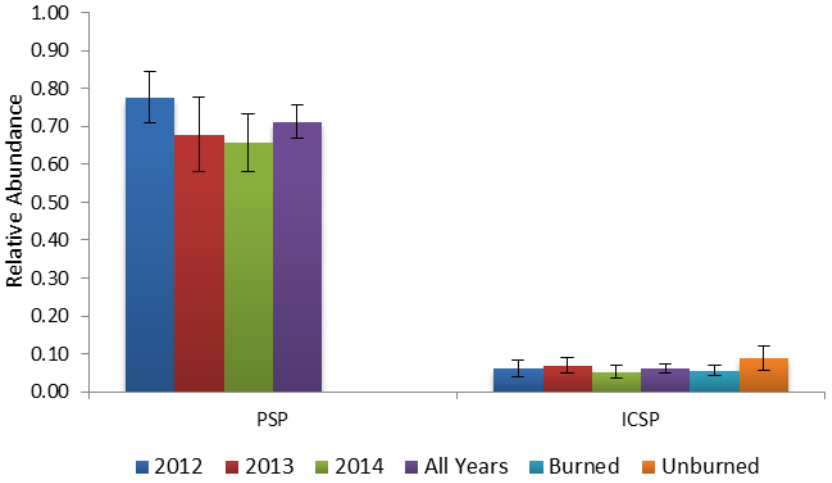
T) White-breasted Nuthatch



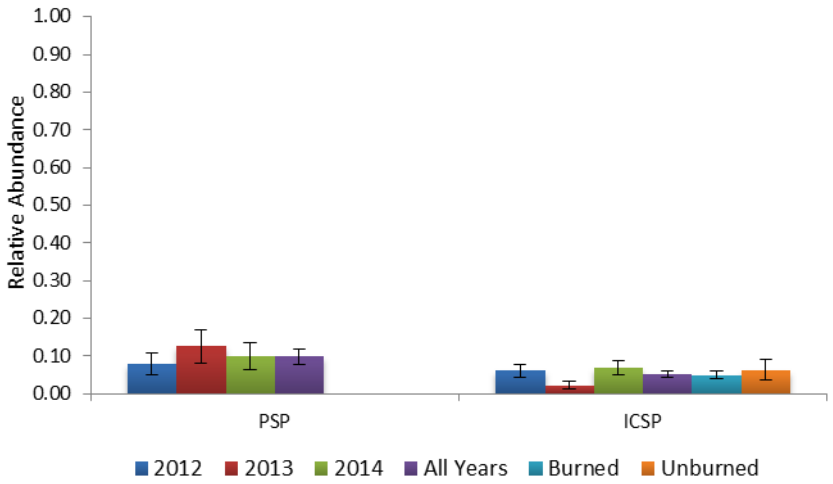
U) Carolina Wren



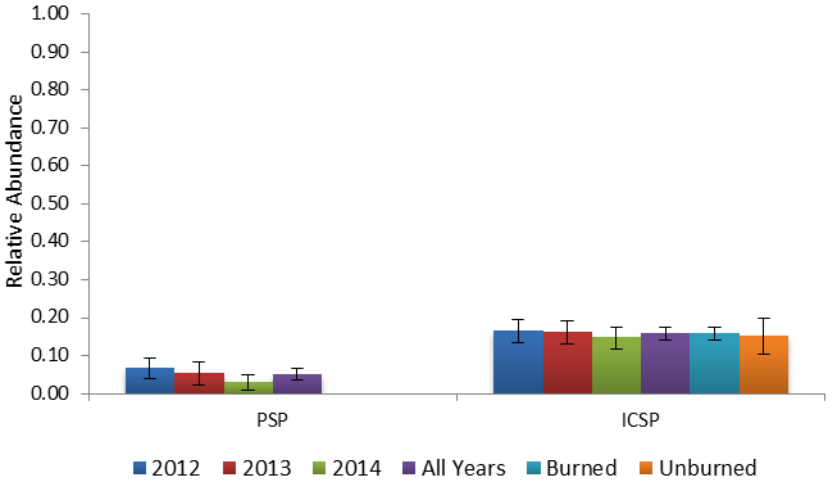
V) House Wren



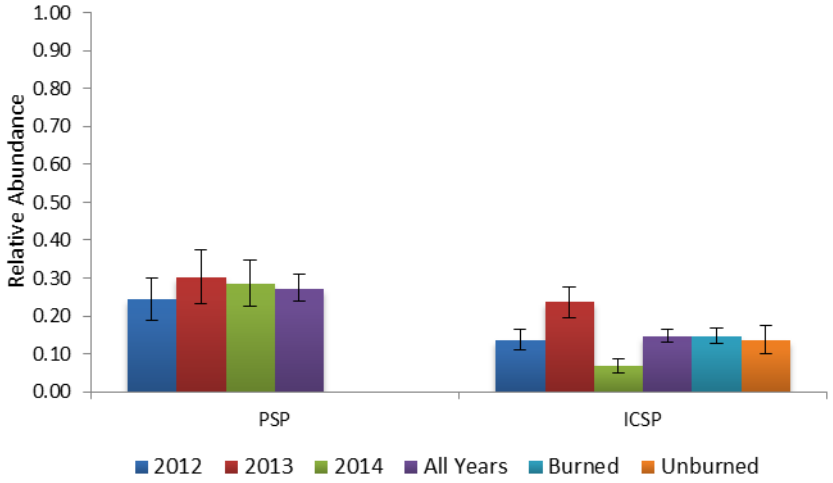
W) Blue-gray Gnatcatcher



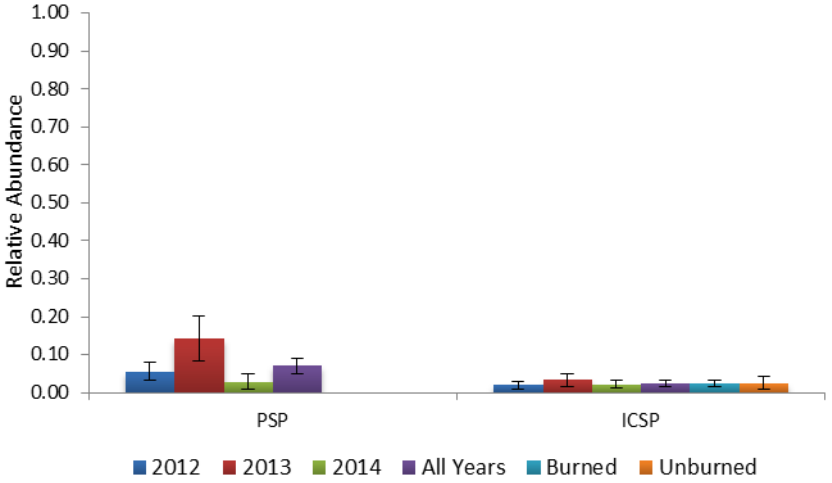
X) Wood Thrush



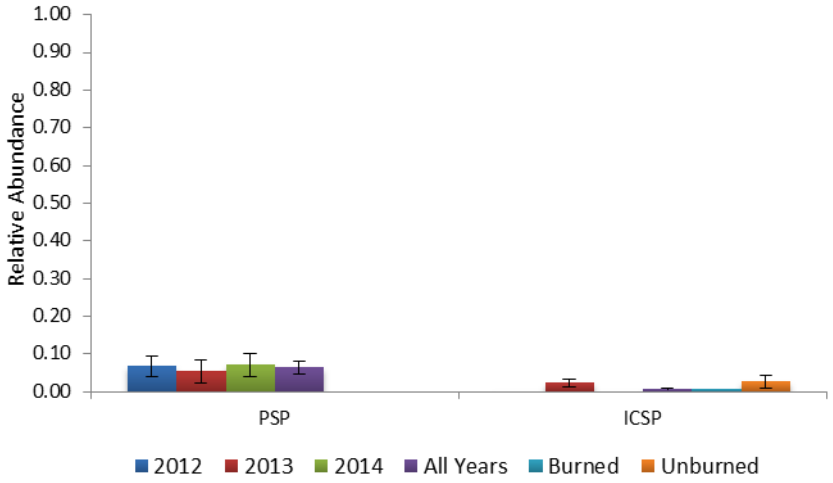
Y) American Robin



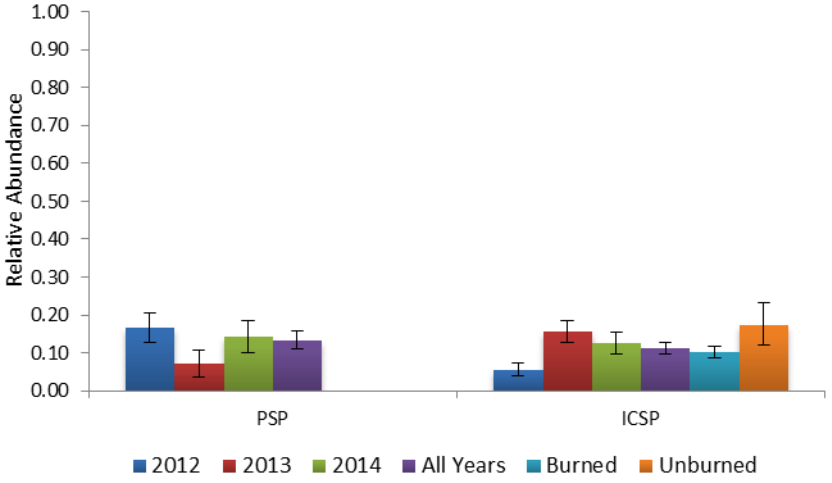
Z) Gray Catbird



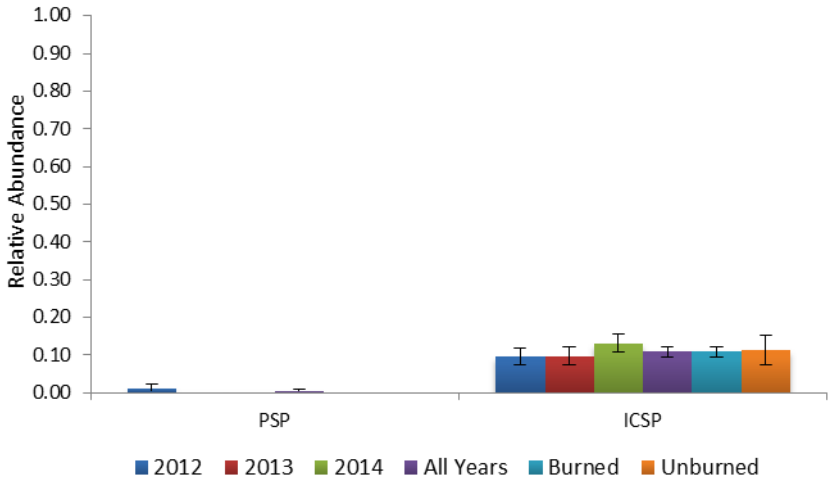
AA) Cedar Waxwing



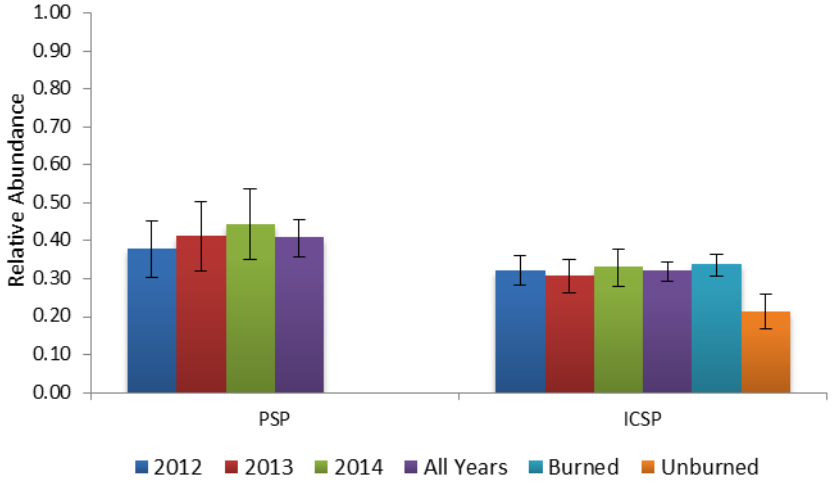
AB) Ovenbird



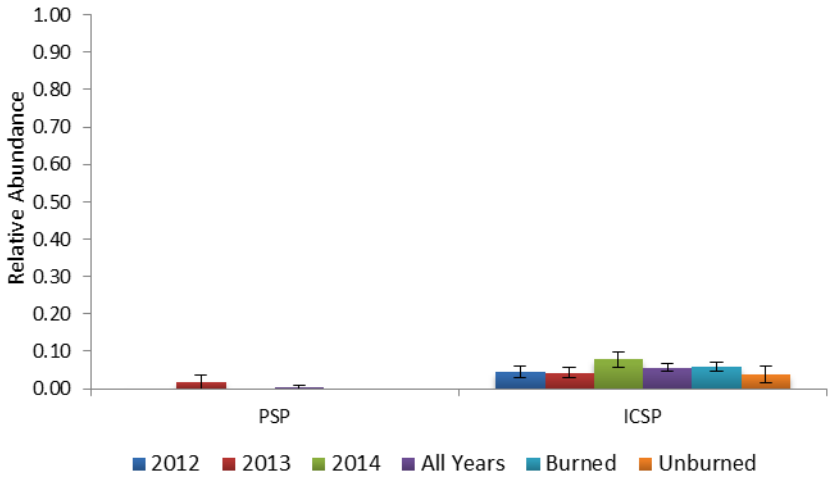
AC) Kentucky Warbler



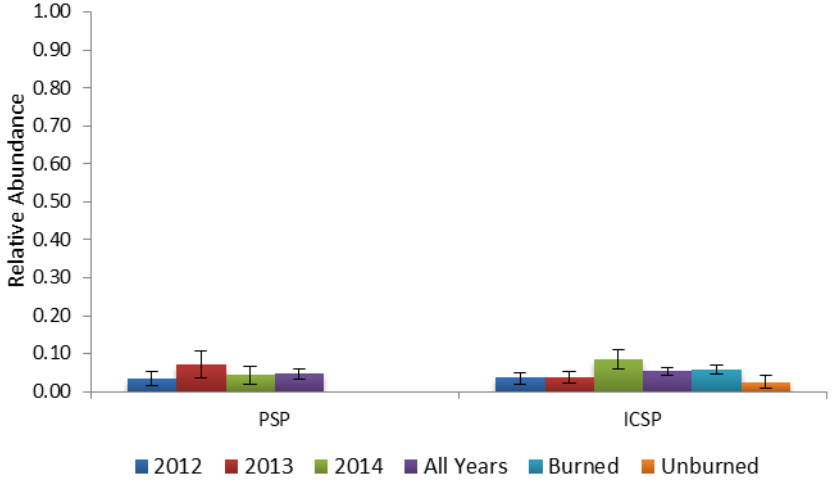
AD) American Redstart



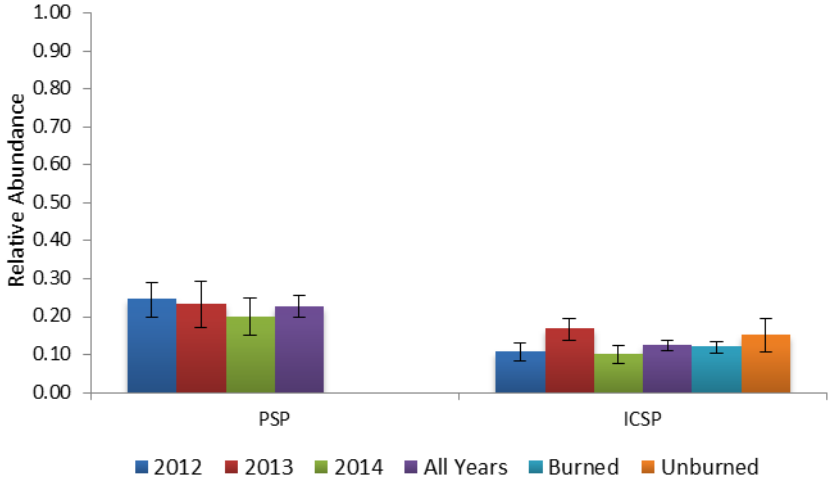
AE) Northern Parula



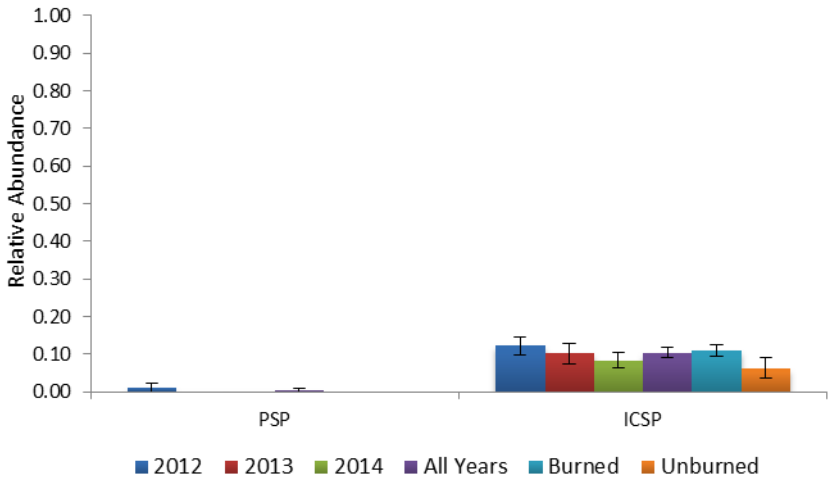
AF) Yellow Warbler



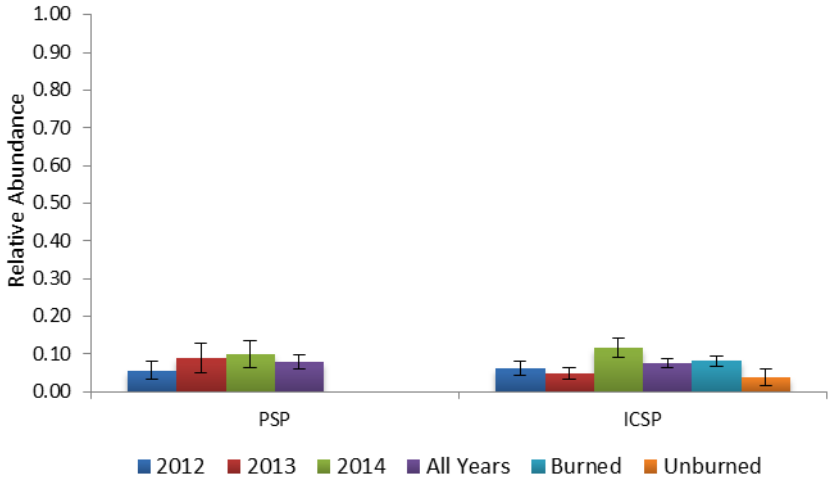
AG) Eastern Towhee



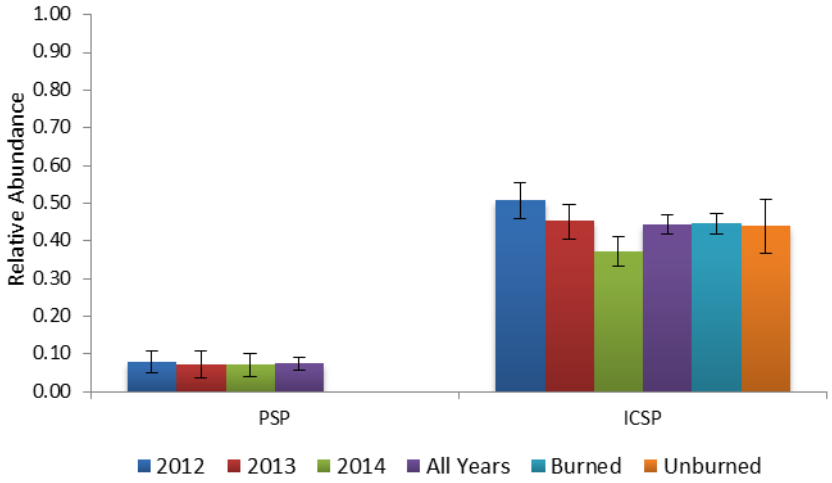
AH) Summer Tanager



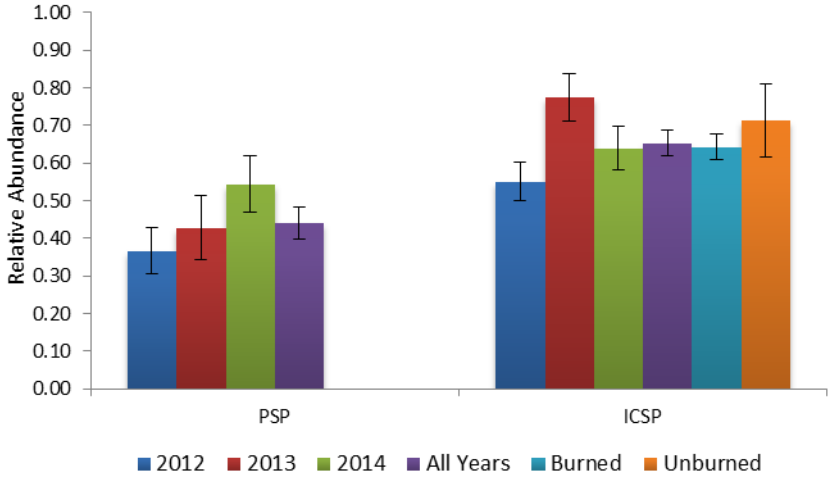
AI) Scarlet Tanager



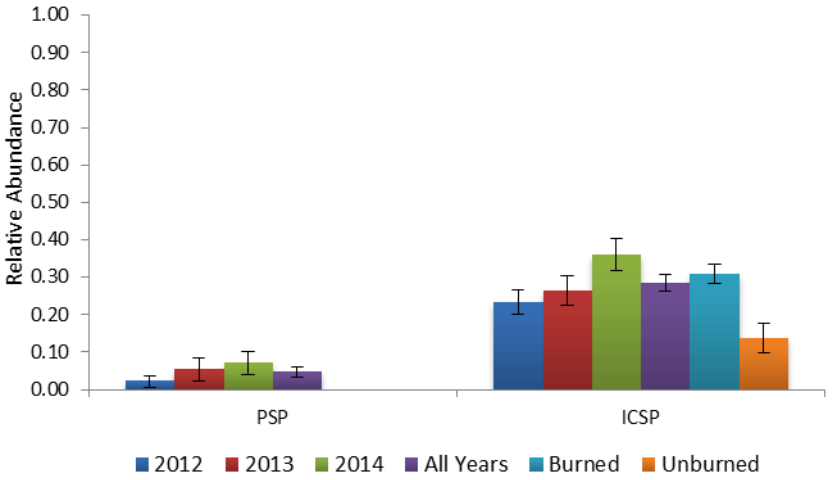
AJ) Northern Cardinal



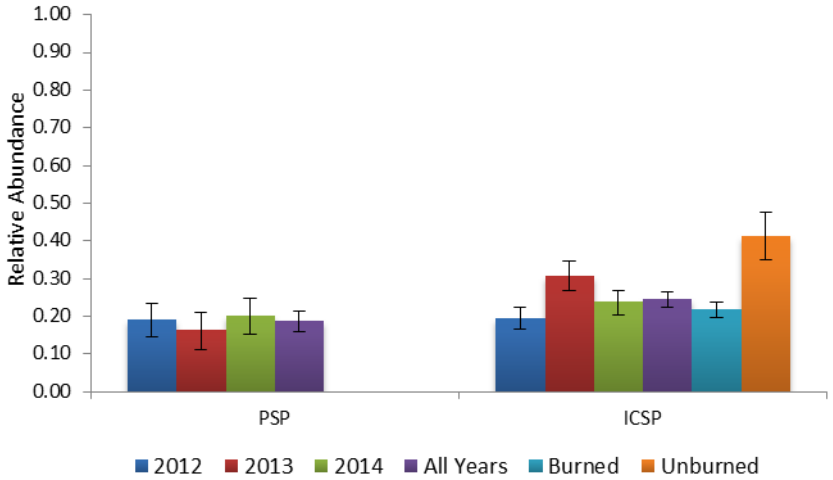
AK) Rose-breasted Grosbeak



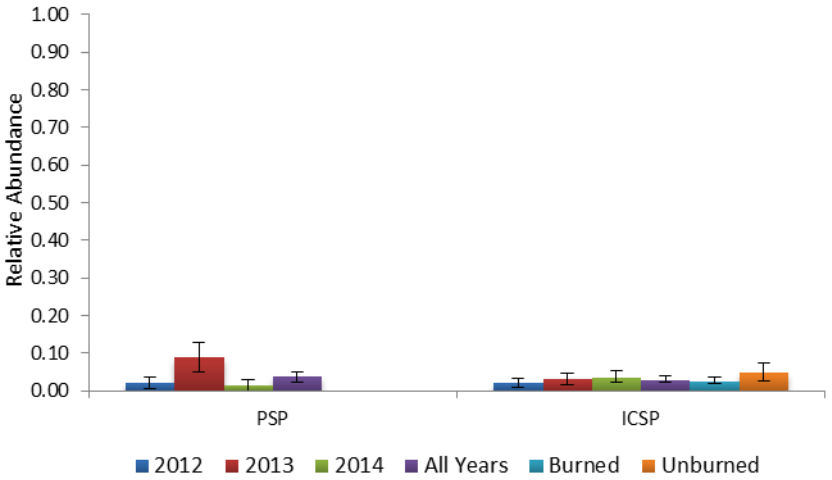
AL) Indigo Bunting



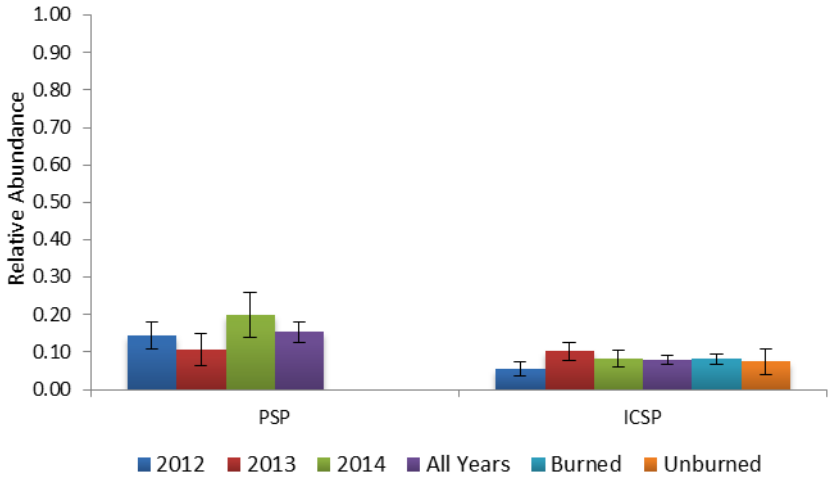
AM) Brown-headed Cowbird



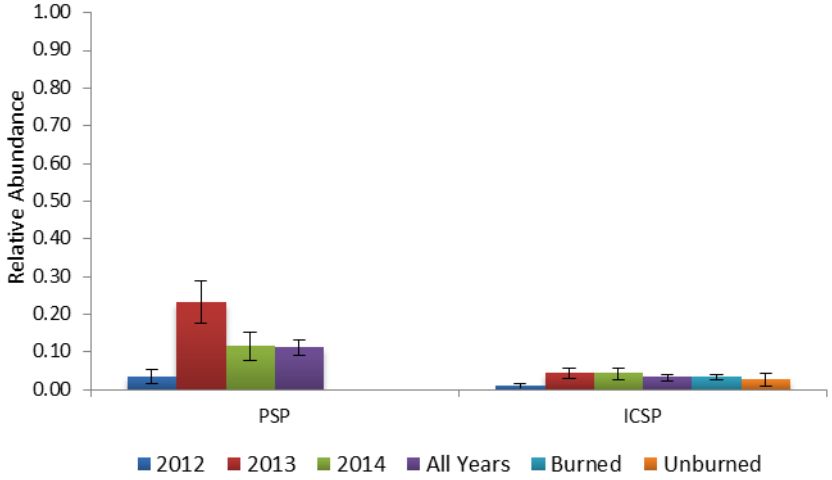
AN) Orchard Oriole



AO) Baltimore Oriole



AP) American Goldfinch



Appendix C. Species relative abundance at ICSP and PSP (A) and ICSP burned and unburned management units (B). Only includes regular woodland breeding species.

A. Species' relative abundance at ICSP and PSP by year.

	Indian Cave State Park				Ponca State Park			
Species	**2012**	**2013**	**2014**	**Total**	**2012**	**2013**	**2014**	**Total**
Mourning Dove	0.06 ± 0.02	0.27 ± 0.03	0.10 ± 0.02	0.14 ± 0.02	0.03 ± 0.02	0.07 ± 0.04	0.07 ± 0.03	0.06 ± 0.02
Yellow-billed Cuckoo	0.11 ± 0.02	0.08 ± 0.02	0.30 ± 0.04	0.17 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.03 ± 0.02	0.01 ± 0.01
Ruby-throated Hummingbird	0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.01 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.09 ± 0.03	0.03 ± 0.01
Red-headed Woodpecker	0.15 ± 0.03	0.12 ± 0.02	0.08 ± 0.02	0.12 ± 0.01	0.00 ± 0.00	0.04 ± 0.03	0.00 ± 0.00	0.01 ± 0.01
Red-bellied Woodpecker	0.27 ± 0.03	0.27 ± 0.03	0.28 ± 0.04	0.27 ± 0.02	0.09 ± 0.03	0.09 ± 0.04	0.07 ± 0.03	0.08 ± 0.02
Downy Woodpecker	0.06 ± 0.02	0.08 ± 0.02	0.10 ± 0.02	0.08 ± 0.01	0.24 ± 0.05	0.16 ± 0.05	0.09 ± 0.04	0.17 ± 0.03
Hairy Woodpecker	0.03 ± 0.01	0.02 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.06 ± 0.02	0.07 ± 0.04	0.06 ± 0.03	0.06 ± 0.02
Northern Flicker	0.03 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	0.03 ± 0.01	0.03 ± 0.02	0.00 ± 0.00	0.01 ± 0.01	0.02 ± 0.01
Pileated Woodpecker	0.02 ± 0.01	0.09 ± 0.02	0.03 ± 0.01	0.04 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Eastern Wood-Pewee	0.18 ± 0.03	0.41 ± 0.04	0.45 ± 0.04	0.35 ± 0.02	0.23 ± 0.05	0.32 ± 0.06	0.16 ± 0.04	0.23 ± 0.03
Acadian Flycatcher	0.21 ± 0.04	0.19 ± 0.03	0.17 ± 0.03	0.19 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Great-crested Flycatcher	0.33 ± 0.04	0.29 ± 0.04	0.38 ± 0.04	0.34 ± 0.02	0.07 ± 0.03	0.13 ± 0.04	0.16 ± 0.04	0.11 ± 0.02
Yellow-throated Vireo	0.03 ± 0.01	0.06 ± 0.02	0.08 ± 0.02	0.05 ± 0.01	0.03 ± 0.02	0.05 ± 0.03	0.03 ± 0.02	0.04 ± 0.01
Warbling Vireo	0.04 ± 0.02	0.06 ± 0.02	0.02 ± 0.01	0.04 ± 0.01	0.08 ± 0.04	0.04 ± 0.03	0.03 ± 0.02	0.05 ± 0.02
Red-eyed Vireo	0.28 ± 0.04	0.35 ± 0.04	0.42 ± 0.04	0.35 ± 0.02	0.23 ± 0.05	0.32 ± 0.07	0.23 ± 0.05	0.25 ± 0.03
Blue Jay	0.19 ± 0.03	0.32 ± 0.04	0.18 ± 0.03	0.23 ± 0.02	0.21 ± 0.05	0.16 ± 0.05	0.11 ± 0.05	0.17 ± 0.03
American Crow	0.02 ± 0.01	0.09 ± 0.02	0.04 ± 0.01	0.05 ± 0.01	0.01 ± 0.01	0.02 ± 0.02	0.01 ± 0.01	0.01 ± 0.01
Black-capped Chickadee	0.16 ± 0.03	0.07 ± 0.02	0.05 ± 0.02	0.10 ± 0.01	0.46 ± 0.06	0.25 ± 0.06	0.19 ± 0.05	0.31 ± 0.03
Tufted Titmouse	0.18 ± 0.03	0.47 ± 0.04	0.47 ± 0.04	0.37 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
White-breasted Nuthatch	0.37 ± 0.04	0.18 ± 0.03	0.15 ± 0.03	0.23 ± 0.02	0.34 ± 0.06	0.25 ± 0.07	0.20 ± 0.05	0.27 ± 0.03
Carolina Wren	0.02 ± 0.01	0.07 ± 0.02	0.07 ± 0.02	0.05 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
House Wren	0.06 ± 0.02	0.07 ± 0.02	0.05 ± 0.02	0.06 ± 0.01	0.78 ± 0.07	0.68 ± 0.10	0.66 ± 0.08	0.71 ± 0.05
Blue-gray Gnatcatcher	0.06 ± 0.02	0.02 ± 0.01	0.07 ± 0.02	0.05 ± 0.01	0.08 ± 0.03	0.13 ± 0.04	0.10 ± 0.04	0.10 ± 0.02
Wood Thrush	0.16 ± 0.03	0.16 ± 0.03	0.15 ± 0.03	0.16 ± 0.02	0.07 ± 0.03	0.05 ± 0.03	0.03 ± 0.02	0.05 ± 0.01
American Robin	0.14 ± 0.03	0.24 ± 0.04	0.07 ± 0.02	0.15 ± 0.02	0.24 ± 0.06	0.30 ± 0.07	0.29 ± 0.06	0.27 ± 0.04
Gray Catbird	0.02 ± 0.01	0.03 ± 0.02	0.02 ± 0.01	0.02 ± 0.01	0.06 ± 0.02	0.14 ± 0.06	0.03 ± 0.02	0.07 ± 0.02
Cedar Waxwing	0.00 ± 0.00	0.02 ± 0.01	0.00 ± 0.00	0.01 ± 0.00	0.07 ± 0.03	0.05 ± 0.03	0.07 ± 0.03	0.06 ± 0.02
Ovenbird	0.06 ± 0.02	0.16 ± 0.03	0.13 ± 0.03	0.11 ± 0.01	0.17 ± 0.04	0.07 ± 0.03	0.14 ± 0.04	0.13 ± 0.02

A. Continued

	Indian Cave State Park				Ponca State Park			
Species	**2012**	**2013**	**2014**	**Total**	**2012**	**2013**	**2014**	**Total**
Kentucky Warbler	0.10 ± 0.02	0.10 ± 0.02	0.13 ± 0.02	0.11 ± 0.01	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
American Redstart	0.32 ± 0.04	0.31 ± 0.04	0.33 ± 0.05	0.32 ± 0.03	0.38 ± 0.07	0.41 ± 0.09	0.44 ± 0.09	0.41 ± 0.05
Northern Parula	0.05 ± 0.01	0.04 ± 0.01	0.08 ± 0.02	0.06 ± 0.01	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.00 ± 0.00
Yellow Warbler	0.04 ± 0.02	0.04 ± 0.01	0.08 ± 0.02	0.05 ± 0.01	0.03 ± 0.02	0.07 ± 0.03	0.04 ± 0.02	0.05 ± 0.01
Eastern Towhee	0.11 ± 0.02	0.17 ± 0.03	0.10 ± 0.02	0.12 ± 0.01	0.24 ± 0.05	0.23 ± 0.06	0.20 ± 0.05	0.23 ± 0.03
Summer Tanager	0.12 ± 0.02	0.10 ± 0.03	0.08 ± 0.02	0.10 ± 0.01	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Scarlet Tanager	0.06 ± 0.02	0.05 ± 0.02	0.12 ± 0.03	0.08 ± 0.01	0.06 ± 0.02	0.09 ± 0.04	0.10 ± 0.04	0.08 ± 0.02
Northern Cardinal	0.51 ± 0.05	0.45 ± 0.05	0.37 ± 0.04	0.44 ± 0.03	0.08 ± 0.03	0.07 ± 0.03	0.07 ± 0.03	0.07 ± 0.02
Rose-breasted Grosbeak	0.55 ± 0.05	0.77 ± 0.06	0.64 ± 0.06	0.65 ± 0.03	0.37 ± 0.06	0.43 ± 0.08	0.54 ± 0.08	0.44 ± 0.04
Indigo Bunting	0.23 ± 0.03	0.26 ± 0.04	0.36 ± 0.04	0.29 ± 0.02	0.02 ± 0.02	0.05 ± 0.03	0.07 ± 0.03	0.05 ± 0.01
Brown-headed Cowbird	0.19 ± 0.03	0.31 ± 0.04	0.24 ± 0.03	0.24 ± 0.02	0.19 ± 0.04	0.16 ± 0.05	0.20 ± 0.05	0.19 ± 0.03
Orchard Oriole	0.02 ± 0.01	0.03 ± 0.02	0.04 ± 0.02	0.03 ± 0.01	0.02 ± 0.02	0.09 ± 0.04	0.01 ± 0.01	0.04 ± 0.01
Baltimore Oriole	0.06 ± 0.02	0.10 ± 0.02	0.08 ± 0.02	0.08 ± 0.01	0.14 ± 0.04	0.11 ± 0.04	0.20 ± 0.06	0.15 ± 0.03
American Goldfinch	0.01 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.02	0.23 ± 0.06	0.11 ± 0.04	0.11 ± 0.02

B. Relative abundance of species in ICSP burned and unburned management units.

	Burned				Unburned			
Species	**2012**	**2013**	**2014**	**Total**	**2012**	**2013**	**2014**	**Total**
Mourning Dove	0.07 ± 0.02	0.25 ± 0.04	0.08 ± 0.02	0.13 ± 0.02	0.03 ± 0.03	0.48 ± 0.11	0.19 ± 0.10	0.21 ± 0.05
Yellow-billed Cuckoo	0.13 ± 0.03	0.08 ± 0.02	0.32 ± 0.04	0.18 ± 0.02	0.00 ± 0.00	0.09 ± 0.06	0.19 ± 0.08	0.09 ± 0.03
Ruby-throated Hummingbird	0.01 ± 0.01	0.00 ± 0.00	0.02 ± 0.01	0.01 ± 0.00	0.00 ± 0.00	0.04 ± 0.04	0.00 ± 0.00	0.01 ± 0.01
Red-headed Woodpecker	0.18 ± 0.03	0.13 ± 0.03	0.09 ± 0.02	0.13 ± 0.02	0.00 ± 0.00	0.04 ± 0.04	0.04 ± 0.04	0.03 ± 0.02
Red-bellied Woodpecker	0.31 ± 0.04	0.26 ± 0.04	0.27 ± 0.04	0.28 ± 0.02	0.06 ± 0.04	0.35 ± 0.10	0.38 ± 0.12	0.25 ± 0.05
Downy Woodpecker	0.05 ± 0.02	0.08 ± 0.02	0.11 ± 0.03	0.08 ± 0.01	0.13 ± 0.06	0.04 ± 0.04	0.04 ± 0.04	0.08 ± 0.03
Hairy Woodpecker	0.04 ± 0.01	0.02 ± 0.01	0.04 ± 0.02	0.03 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.04 ± 0.04	0.01 ± 0.01
Northern Flicker	0.04 ± 0.01	0.04 ± 0.02	0.02 ± 0.01	0.03 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.04 ± 0.04	0.01 ± 0.01
Pileated Woodpecker	0.02 ± 0.01	0.08 ± 0.02	0.03 ± 0.01	0.04 ± 0.01	0.00 ± 0.00	0.13 ± 0.07	0.00 ± 0.00	0.04 ± 0.02
Eastern Wood-Pewee	0.19 ± 0.03	0.36 ± 0.04	0.50 ± 0.05	0.35 ± 0.02	0.16 ± 0.07	0.78 ± 0.13	0.15 ± 0.07	0.34 ± 0.06
Acadian Flycatcher	0.24 ± 0.04	0.20 ± 0.03	0.19 ± 0.03	0.21 ± 0.02	0.10 ± 0.05	0.13 ± 0.07	0.04 ± 0.04	0.09 ± 0.03
Great-crested Flycatcher	0.36 ± 0.05	0.28 ± 0.04	0.36 ± 0.04	0.33 ± 0.03	0.19 ± 0.07	0.35 ± 0.13	0.54 ± 0.14	0.35 ± 0.07
Yellow-throated Vireo	0.03 ± 0.01	0.04 ± 0.02	0.08 ± 0.02	0.05 ± 0.01	0.00 ± 0.00	0.17 ± 0.10	0.08 ± 0.05	0.08 ± 0.03
Warbling Vireo	0.04 ± 0.02	0.07 ± 0.02	0.02 ± 0.01	0.04 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Red-eyed Vireo	0.31 ± 0.04	0.34 ± 0.04	0.43 ± 0.05	0.36 ± 0.03	0.13 ± 0.06	0.43 ± 0.12	0.35 ± 0.11	0.29 ± 0.06
Blue Jay	0.21 ± 0.03	0.29 ± 0.04	0.18 ± 0.04	0.22 ± 0.02	0.10 ± 0.05	0.52 ± 0.12	0.23 ± 0.08	0.26 ± 0.05
American Crow	0.02 ± 0.01	0.07 ± 0.02	0.04 ± 0.01	0.04 ± 0.01	0.03 ± 0.03	0.17 ± 0.08	0.04 ± 0.04	0.08 ± 0.03
Black-capped Chickadee	0.12 ± 0.03	0.08 ± 0.02	0.06 ± 0.02	0.09 ± 0.01	0.39 ± 0.10	0.00 ± 0.00	0.00 ± 0.00	0.15 ± 0.04
Tufted Titmouse	0.21 ± 0.03	0.47 ± 0.05	0.47 ± 0.05	0.38 ± 0.03	0.03 ± 0.03	0.48 ± 0.12	0.46 ± 0.13	0.30 ± 0.06
White-breasted Nuthatch	0.37 ± 0.04	0.16 ± 0.03	0.16 ± 0.03	0.23 ± 0.02	0.39 ± 0.09	0.30 ± 0.10	0.04 ± 0.04	0.25 ± 0.05
Carolina Wren	0.02 ± 0.01	0.08 ± 0.02	0.07 ± 0.02	0.06 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.04 ± 0.04	0.01 ± 0.01
House Wren	0.06 ± 0.03	0.06 ± 0.02	0.05 ± 0.02	0.06 ± 0.01	0.06 ± 0.04	0.17 ± 0.08	0.04 ± 0.04	0.09 ± 0.03
Blue-gray Gnatcatcher	0.04 ± 0.02	0.02 ± 0.01	0.08 ± 0.02	0.05 ± 0.01	0.16 ± 0.07	0.00 ± 0.00	0.00 ± 0.00	0.06 ± 0.03
Wood Thrush	0.18 ± 0.03	0.15 ± 0.03	0.15 ± 0.03	0.16 ± 0.02	0.10 ± 0.05	0.22 ± 0.11	0.15 ± 0.09	0.15 ± 0.05
American Robin	0.15 ± 0.03	0.24 ± 0.04	0.06 ± 0.02	0.15 ± 0.02	0.10 ± 0.05	0.22 ± 0.09	0.12 ± 0.06	0.14 ± 0.04
Gray Catbird	0.02 ± 0.01	0.02 ± 0.02	0.02 ± 0.01	0.02 ± 0.01	0.00 ± 0.00	0.09 ± 0.06	0.00 ± 0.00	0.03 ± 0.02
Cedar Waxwing	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.09 ± 0.06	0.00 ± 0.00	0.03 ± 0.02
Ovenbird	0.06 ± 0.02	0.12 ± 0.03	0.12 ± 0.03	0.10 ± 0.01	0.03 ± 0.03	0.39 ± 0.15	0.15 ± 0.09	0.18 ± 0.06
Louisiana Waterthrush	0.01 ± 0.01	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Kentucky Warbler	0.10 ± 0.03	0.09 ± 0.02	0.13 ± 0.03	0.11 ± 0.01	0.06 ± 0.04	0.17 ± 0.10	0.12 ± 0.06	0.11 ± 0.04
Common Yellowthroat	0.02 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.03 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01
American Redstart	0.33 ± 0.04	0.31 ± 0.05	0.37 ± 0.06	0.34 ± 0.03	0.26 ± 0.08	0.30 ± 0.10	0.08 ± 0.05	0.21 ± 0.05

B. Continued

	Burned				Unburned			
Species	**2012**	**2013**	**2014**	**Total**	**2012**	**2013**	**2014**	**Total**
Northern Parula	0.04 ± 0.02	0.05 ± 0.02	0.08 ± 0.02	0.06 ± 0.01	0.06 ± 0.04	0.00 ± 0.00	0.04 ± 0.04	0.04 ± 0.02
Yellow Warbler	0.04 ± 0.02	0.04 ± 0.01	0.09 ± 0.03	0.06 ± 0.01	0.00 ± 0.00	0.04 ± 0.04	0.04 ± 0.04	0.03 ± 0.02
Eastern Towhee	0.10 ± 0.02	0.16 ± 0.03	0.10 ± 0.02	0.12 ± 0.02	0.16 ± 0.07	0.22 ± 0.09	0.08 ± 0.08	0.15 ± 0.04
Summer Tanager	0.13 ± 0.03	0.11 ± 0.03	0.09 ± 0.02	0.11 ± 0.02	0.10 ± 0.05	0.04 ± 0.04	0.04 ± 0.04	0.06 ± 0.03
Scarlet Tanager	0.07 ± 0.02	0.06 ± 0.02	0.12 ± 0.03	0.08 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.12 ± 0.06	0.04 ± 0.02
Northern Cardinal	0.56 ± 0.05	0.42 ± 0.05	0.35 ± 0.04	0.44 ± 0.03	0.19 ± 0.07	0.70 ± 0.17	0.50 ± 0.11	0.44 ± 0.07
Rose-breasted Grosbeak	0.59 ± 0.06	0.69 ± 0.06	0.64 ± 0.06	0.64 ± 0.04	0.32 ± 0.10	1.35 ± 0.19	0.62 ± 0.17	0.71 ± 0.10
Indigo Bunting	0.24 ± 0.04	0.27 ± 0.04	0.42 ± 0.05	0.31 ± 0.03	0.19 ± 0.07	0.22 ± 0.09	0.00 ± 0.00	0.14 ± 0.04
Brown-headed Cowbird	0.16 ± 0.03	0.25 ± 0.04	0.24 ± 0.03	0.22 ± 0.02	0.35 ± 0.09	0.70 ± 0.15	0.23 ± 0.08	0.41 ± 0.06
Orchard Oriole	0.02 ± 0.01	0.02 ± 0.01	0.03 ± 0.02	0.03 ± 0.01	0.00 ± 0.00	0.09 ± 0.06	0.08 ± 0.05	0.05 ± 0.02
Baltimore Oriole	0.06 ± 0.02	0.09 ± 0.02	0.10 ± 0.03	0.08 ± 0.01	0.03 ± 0.03	0.22 ± 0.11	0.00 ± 0.00	0.08 ± 0.03
American Goldfinch	0.01 ± 0.01	0.04 ± 0.01	0.05 ± 0.02	0.03 ± 0.01	0.00 ± 0.00	0.09 ± 0.06	0.00 ± 0.00	0.03 ± 0.02

Appendix D

Notable observations during the study

During this study in 2012, a recently-hatched Chuck-will's-Widow chick was photographed at ICSP by Brogie, representing only the second known record for nesting of this species in Nebraska. Chuck-will's-Widow is a species whose contemporary distribution in Nebraska is along or near ridge tops of oak-hickory woodlands in the extreme southeastern counties of the state (Sharpe et al. 2001). There are no Chuck-will's-Widow records for PSP, although in recent years they have been found in summer in counties bordering the Missouri River to the west of this locale. Krista Lang observed a Whip-poor-will with a nest that contained an egg and newly hatched chick 3 July 2014. Her photographs of the observation are provided, below.

Appendix E. Survey Points at ICSP (A) and at PSP (B).

A. ICSP survey points

Point	Latitude	Longitude	Point	Latitude	Longitude	Point	Latitude	Longitude	Point	Latitude	Longitude
IC001	40.24862	-95.54047	IC051	40.26509	-95.57700	IC101	40.24933	-95.54410	IC151	40.26933	-95.57575
IC002	40.26833	-95.56696	IC052	40.26362	-95.56962	IC102	40.25168	-95.56436	IC152	40.26955	-95.57308
IC003	40.27733	-95.57712	IC053	40.25305	-95.55730	IC103	40.25998	-95.55705	IC153	40.27971	-95.57869
IC004	40.25551	-95.55000	IC054	40.24495	-95.53556	IC104	40.24496	-95.53757	IC154	40.24758	-95.55867
IC005	40.25004	-95.56397	IC055	40.25656	-95.56063	IC105	40.25682	-95.54533	IC155	40.24861	-95.55208
IC006	40.24291	-95.53022	IC056	40.24865	-95.53794	IC106	40.27107	-95.57028	IC156	40.26017	-95.55506
IC007	40.24887	-95.56004	IC057	40.24742	-95.52064	IC107	40.24614	-95.55564	IC157	40.24698	-95.52106
IC008	40.25133	-95.56516	IC058	40.25846	-95.55353	IC108	40.25399	-95.56107	IC158	40.24790	-95.55324
IC009	40.26366	-95.56489	IC059	40.25563	-95.54123	IC109	40.27424	-95.56911	IC159	40.26940	-95.56780
IC010	40.24826	-95.54495	IC060	40.25013	-95.54522	IC110	40.24355	-95.53978	IC160	40.27984	-95.57386
IC011	40.26526	-95.56774	IC061	40.27473	-95.57786	IC111	40.24141	-95.55708	IC161	40.26603	-95.57679
IC012	40.26141	-95.56833	IC062	40.24691	-95.52529	IC112	40.26222	-95.55758	IC162	40.27141	-95.57276
IC013	40.25768	-95.56036	IC063	40.25903	-95.55960	IC113	40.24476	-95.53936	IC163	40.25621	-95.55694
IC014	40.26709	-95.58322	IC064	40.26470	-95.58091	IC114	40.24418	-95.54206	IC164	40.27089	-95.56361
IC015	40.25766	-95.55816	IC065	40.25497	-95.55099	IC115	40.24695	-95.51865	IC165	40.25583	-95.56649
IC016	40.25372	-95.54593	IC066	40.24370	-95.54651	IC116	40.25984	-95.55295	IC166	40.26228	-95.55886
IC017	40.25337	-95.54998	IC067	40.26852	-95.57173	IC117	40.24620	-95.54791	IC167	40.24705	-95.54523
IC018	40.25545	-95.56338	IC068	40.25141	-95.55536	IC118	40.25688	-95.55757	IC168	40.24389	-95.53235
IC019	40.27613	-95.57027	IC069	40.25057	-95.55236	IC119	40.26942	-95.56531	IC169	40.26977	-95.57053
IC020	40.28156	-95.57065	IC070	40.25022	-95.54949	IC120	40.27285	-95.57206	IC170	40.26963	-95.57659
IC021	40.25461	-95.56331	IC071	40.25226	-95.55746	IC121	40.26843	-95.57804	IC171	40.26030	-95.55400
IC022	40.26011	-95.56166	IC072	40.27289	-95.57338	IC122	40.27495	-95.57428	IC172	40.25054	-95.54722
IC023	40.26603	-95.58189	IC073	40.25421	-95.55733	IC123	40.26133	-95.57103	IC173	40.24284	-95.54098
IC024	40.24909	-95.55067	IC074	40.24948	-95.53562	IC124	40.27806	-95.56876	IC174	40.26753	-95.56695
IC025	40.24626	-95.53696	IC075	40.24326	-95.54992	IC125	40.26998	-95.57580	IC175	40.27804	-95.57243
IC026	40.25262	-95.53853	IC076	40.28059	-95.57873	IC126	40.24492	-95.53414	IC176	40.26875	-95.56115
IC027	40.24114	-95.55756	IC077	40.27675	-95.57674	IC127	40.27938	-95.56887	IC177	40.24299	-95.52596
IC028	40.24521	-95.54132	IC078	40.24645	-95.53204	IC128	40.25831	-95.56430	IC178	40.24308	-95.54336
IC029	40.24279	-95.52213	IC079	40.25285	-95.55190	IC129	40.26715	-95.58069	IC179	40.28087	-95.57121
IC030	40.26293	-95.56209	IC080	40.25595	-95.55528	IC130	40.24205	-95.54549	IC180	40.24934	-95.55431
IC031	40.26131	-95.56978	IC081	40.26745	-95.55924	IC131	40.27233	-95.57217	IC181	40.24663	-95.51811
IC032	40.27777	-95.56975	IC082	40.25019	-95.55533	IC132	40.25592	-95.54855	IC182	40.27067	-95.57589
IC033	40.24109	-95.55569	IC083	40.25550	-95.55680	IC133	40.24735	-95.54915	IC183	40.24214	-95.54020
IC034	40.24775	-95.52478	IC084	40.26861	-95.56255	IC134	40.24979	-95.55197	IC184	40.24636	-95.55301
IC035	40.25260	-95.56634	IC085	40.26756	-95.56087	IC135	40.24258	-95.54843	IC185	40.24914	-95.54778
IC036	40.24997	-95.53696	IC086	40.26573	-95.57756	IC136	40.28060	-95.57603	IC186	40.25547	-95.55608
IC037	40.24319	-95.53160	IC087	40.25568	-95.56451	IC137	40.27220	-95.56913	IC187	40.25069	-95.55810
IC038	40.24142	-95.55324	IC088	40.24449	-95.54159	IC138	40.24589	-95.53981	IC188	40.25421	-95.55658
IC039	40.25780	-95.55019	IC089	40.26491	-95.56192	IC139	40.26078	-95.56703	IC189	40.24726	-95.55678
IC040	40.24591	-95.53527	IC090	40.28245	-95.57449	IC140	40.26595	-95.56762	IC190	40.25250	-95.55410
IC041	40.26789	-95.56935	IC091	40.26725	-95.56464	IC141	40.25600	-95.56276	IC191	40.25102	-95.56164
IC042	40.27967	-95.57504	IC092	40.25289	-95.53925	IC142	40.25710	-95.54931	IC192	40.27260	-95.57624
IC043	40.27202	-95.57811	IC093	40.26610	-95.57531	IC143	40.24317	-95.54826	IC193	40.25507	-95.54657
IC044	40.24358	-95.52752	IC094	40.27912	-95.57225	IC144	40.24813	-95.52279	IC194	40.26153	-95.56630
IC045	40.26934	-95.56241	IC095	40.24695	-95.55001	IC145	40.25703	-95.55688	IC195	40.24614	-95.54613
IC046	40.27070	-95.56002	IC096	40.25682	-95.56535	IC146	40.27862	-95.57651	IC196	40.25065	-95.53979
IC047	40.26965	-95.56722	IC097	40.27985	-95.57153	IC147	40.24450	-95.54794	IC197	40.25203	-95.55976
IC048	40.25324	-95.55624	IC098	40.24778	-95.54481	IC148	40.26209	-95.56849	IC198	40.24919	-95.53476
IC049	40.26363	-95.55647	IC099	40.25907	-95.56320	IC149	40.26723	-95.56267	IC199	40.25511	-95.55193
IC050	40.24518	-95.53299	IC100	40.24362	-95.55051	IC150	40.24252	-95.55686	IC200	40.24943	-95.56255

B. PSP survey points

Point	Latitude	Longitude	Point	Latitude	Longitude	Point	Latitude	Longitude	Point	Latitude	Longitude
PO001	42.59843	-96.72060	PO024	42.60265	-96.72056	PO047	42.59229	-96.71413	PO070	42.60181	-96.72077
PO002	42.60390	-96.71402	PO025	42.59713	-96.70940	PO048	42.59666	-96.72093	PO071	42.61346	-96.72722
PO003	42.59102	-96.70849	PO026	42.60246	-96.72348	PO049	42.60768	-96.73181	PO072	42.60137	-96.71627
PO004	42.61270	-96.73517	PO027	42.61334	-96.73519	PO050	42.60251	-96.71740	PO073	42.60601	-96.71901
PO005	42.61458	-96.72805	PO028	42.59634	-96.70955	PO051	42.61486	-96.73134	PO074	42.60871	-96.73078
PO006	42.60941	-96.72716	PO029	42.61498	-96.73391	PO052	42.59348	-96.70691	PO075	42.59915	-96.71640
PO007	42.59503	-96.70845	PO030	42.59731	-96.71623	PO053	42.61340	-96.73128	PO076	42.59942	-96.72320
PO008	42.61072	-96.72536	PO031	42.59691	-96.71442	PO054	42.59951	-96.71890	PO077	42.60310	-96.72077
PO009	42.59292	-96.71321	PO032	42.59279	-96.71887	PO055	42.60937	-96.72382	PO078	42.60169	-96.71905
PO010	42.60109	-96.72568	PO033	42.60074	-96.72431	PO056	42.60397	-96.71939	PO079	42.59969	-96.72397
PO011	42.60026	-96.72319	PO034	42.60142	-96.71157	PO057	42.60908	-96.72643	PO080	42.58970	-96.70463
PO012	42.60543	-96.71539	PO035	42.59101	-96.70995	PO058	42.59850	-96.71283	PO081	42.60565	-96.72940
PO013	42.59165	-96.71834	PO036	42.59217	-96.70771	PO059	42.59810	-96.71404	PO082	42.59778	-96.71254
PO014	42.59902	-96.72485	PO037	42.59160	-96.71012	PO060	42.59649	-96.71696	PO083	42.61060	-96.72290
PO015	42.60567	-96.72369	PO038	42.59862	-96.71651	PO061	42.60957	-96.72204	PO084	42.61227	-96.73588
PO016	42.60678	-96.72349	PO039	42.60866	-96.72571	PO062	42.60854	-96.72647	PO085	42.60125	-96.71318
PO017	42.59799	-96.71728	PO040	42.59772	-96.71533	PO063	42.60662	-96.72880	PO086	42.60684	-96.73018
PO018	42.61148	-96.72935	PO041	42.60657	-96.72100	PO064	42.59016	-96.70025	PO087	42.60056	-96.72532
PO019	42.59107	-96.70281	PO042	42.59708	-96.72397	PO065	42.61069	-96.72974	PO088	42.60608	-96.71764
PO020	42.59092	-96.70918	PO043	42.59857	-96.72455	PO066	42.59405	-96.70287	PO089	42.60930	-96.72016
PO021	42.60761	-96.72751	PO044	42.59375	-96.71312	PO067	42.60246	-96.72205	PO090	42.60300	-96.72443
PO022	42.60990	-96.72941	PO045	42.61464	-96.73039	PO068	42.61169	-96.72550			
PO023	42.60729	-96.72919	PO046	42.60376	-96.71624	PO069	42.59928	-96.70961