2014 Breeding Bird Surveys on the Idaho National Laboratory Site

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EXECUTIVE SUMMARY

Breeding bird surveys (BBSs) have been conducted annually since 1985 (no surveys were conducted in 1992 and 1993) to monitor bird populations on the Idaho National Laboratory (INL) Site. In 2014, we conducted surveys from May 29 to June 27 along 13 established routes, five of which are part of a nationwide survey administered by the U.S. Geological Survey (USGS) and eight of which boarder INL Site facilities. We documented 2,677 birds from 38 species during those surveys. Bird abundance was less than the 1985-2013 average of 4,824 birds, and the number of species (i.e., species richness) was lower than the 27-year average of 57.

Compared with past surveys, we observed similar patterns of bird abundance among those species that are typically the most numerous. In 2014, the five species that were documented in greatest abundance were horned lark (*Eremophila alpestris*, *n* = 771), western meadowlark (*Sturnella neglecta*, *n* = 674), sage thrasher (*Oreoscoptes montanus*, *n* = 460), sage sparrow (*Amphispiza belli*, *n* = 208), and Brewer's sparrow (*Spizella breweri*, *n* = 125). During 28 years of breeding bird surveys on the INL Site these species have been the five most abundant 21 times, and in the remaining seven years they were among the six most abundant species. Considering reported declines in populations of sagebrush-obligate species throughout the intermountain west, this trend indicates that the quality of sagebrush-steppe habitat on the INL Site remains stable.

Although three new species were added in the past four years to the list of birds that have been observed at least once during BBS on the INL Site, no observations of new species were made in 2014.

Species observed during the 2014 BBS that are considered species of conservation concern in Idaho included the Franklin's gull (*Larus pipixcan*, *n* = 2), ferruginous hawk (*Buteo regalis*, *n* = 8), long-billed curlew (*Numenius americanus*, *n* = 2), burrowing owl (*Athene cunicularia*, *n* = 2), and grasshopper sparrow (*Ammodramus savannarum*, *n* = 5).

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ACRONYMS

ATRC	Advanced Test Reactor Complex
BBS	Breeding Bird Survey
CFA	Central Facilities Area
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
MFC	Materials and Fuels Complex
NRF	Naval Reactor Facility
PBF	Power Burst Facility
RWMC	Radioactive Waste Management Complex
TAN	Test Area North
USGS	United States Geological Survey

1.0 INTRODUCTION

The North American Breeding Bird Survey (BBS) was developed by the U.S. Fish and Wildlife Service along with the Canadian Wildlife Service to document trends in bird populations. Pilot surveys began in 1965 and immediately expanded to cover the U.S. east of the Mississippi and Canada, and by 1968 included all of North America (Sauer and Link 2011). The BBS program in North America is managed by the U.S. Geological Survey (USGS) and currently consists of over 5,100 routes, with approximately 2,500 of these being sampled each year (Sauer and Link 2011).

BBS data provide long-term species abundance and distribution trends for > 420 species of birds across a broad-geographic scale (Sauer and Link 2011). These data have been used to estimate population changes for hundreds of bird species, and they are the primary source for regional conservation programs and modeling efforts for birds (Sauer and Link 2011). The BBS provides a wealth of information about population trends of birds in North America, and is the foundation for broad conservation assessments extending beyond local jurisdictional boundaries (Sauer and Link 2011).

The Idaho National Laboratory (INL) Site has five permanent, official BBS routes originally established in 1985 (hereafter referred to as remote routes) and eight additional survey routes near INL Site facilities (hereafter referred to as facility routes) (Figure 1). Facility routes were developed to monitor avifauna in proximity to anthropogenic activities and disturbances. The annual BBS provides land managers with information regarding trends in abundance of breeding birds relative to activities conducted on the INL Site. This report summarizes the results from the 2014 BBS and compares species abundance across survey routes with long-term averages.

1.1 STUDY AREA

The INL Site encompasses almost 900 mi^2 (2,330 km^2) on the Upper Snake River Plain in southeast Idaho (Figure 1) and is administered by the U. S. Department of Energy. The INL Site was designated a National Environmental Research Park in 1975 to facilitate research assessing environmental impacts from the development of nuclear energy technologies. This area is located within portions of Bingham, Bonneville, Butte, Clark, and Jefferson counties. The INL Site has been designated as an Important Bird Area by the Idaho Comprehensive Wildlife Conservation Strategy (Idaho Department of Fish and Game 2005). This designation recognizes wildlife species that are listed by either state or federal agencies and provides a comprehensive listing of the Idaho species of Greatest Conservation Need (Idaho Department of Fish and Game 2005). The INL Site has also been recognized as a Global Important Bird Area by the National Audubon Society.

Topography across the INL Site is mostly flat with an average elevation of 4,985 ft (1,519 m). Other than minor topographic variation created by basalt outcrops, the only significant geographical relief occurs around East and Middle buttes and the southern portion of the Lemhi Mountains located near the northwest corner of the INL Site.

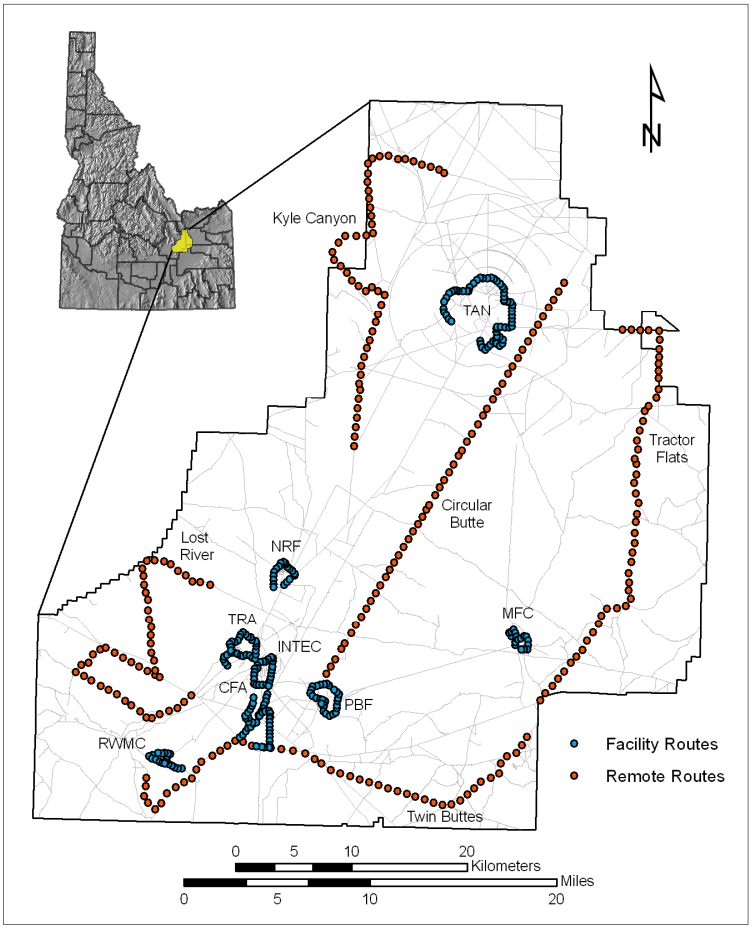

Figure 1. Location of Breeding Bird Survey routes on the Idaho National Laboratory Site. Blue dots represent survey points along facility routes and red dots represent the same for remote routes.

In general, the INL Site is located in a semi-arid desert that experiences hot, dry summers and cold winters. Annual precipitation on the INL Site averages 8 inches (20 cm), with peak precipitation commonly occurring in spring. The geology is dominated by Quaternary basalt lava flows producing outcrops and lava tubes. Aeolian soils consisting primarily of silt loam and sandy loam are the most common soil type on the INL Site, while alluvial soils more commonly occur along the flood plain of the Big Lost River. The INL Site is a shrub-steppe ecosystem dominated by a woody shrub over-story and perennial bunchgrass and forb understory. Big sagebrush (*Artemisia tridentata* ssp.) is the most dominant shrub community on the INL Site, while other common species include green rabbitbrush (*Chrysothamnus viscidiflorus*), spiny hopsage (*Grayia spinosa*), shadscale (*Atriplex confertifolia*), winterfat (*Krascheninnikovia lanata*), and other sagebrush species (*A.* spp.). The most common native grasses are streambank wheatgrass (*Elymus lanceolatus*), bottlebrush squirreltail (*E. elymoides*), Indian ricegrass (*Achnatherum hymenoides*), and needle-and-thread grass (*Hesperostipa comata*). More information regarding the climate, geology, and vegetation communities on the INL Site is described in Shive et al. (2011).

Very little surface water exists during spring and summer on the INL Site. The Big Lost River and Birch Creek are both diverted upstream for agricultural purposes and consequently little, if any, water from these streams reaches the INL Site. During years of high flow, however, water from the Big Lost River can reach the INL Site where it drains into an ephemeral wetland known as the Big Lost River Sinks. This ephemeral wetland provides the only substantial water source for waterfowl and shorebirds on the INL Site, although a number of man-made waste treatment ponds near facilities also provide aquatic habitat for migrating birds.

1.2 METHODS

Data Collection

The BBS is a roadside count of all birds seen or heard along predefined routes. Thirteen BBS routes were surveyed from May 29 to June 27, 2014, consisting of five official USGS BBS routes and eight facility routes that were developed specifically for the INL Site (Figure 1). Each remote survey route is 24.5 miles (39.2 km) with 50 sampling points systematically spaced every 0.5 mile (0.8 km). Facility routes vary in length between 3.6 miles (5.8 km) and 11.9 miles (19.2 km), depending on the size of the facility. Sampling points along facility routes are separated by approximately 0.2 mile (0.32 km).

During surveys, observers followed the North American BBS protocols provided by the USGS Patuxent Wildlife Research Center (Sauer and Link 2011). At each sampling location (i.e., stop), a trained observer recorded every bird species observed or heard (song) within a quarter-mile radius during a 3-minute interval. Any bird that was suspected of being counted on the previous stop was not recorded again (Sauer and Link 2011). Additional data such as temperature, wind speed, and sky condition were recorded after every five stops along remote routes, and at the beginning and end of each facility route. Each route was only surveyed when weather conditions were appropriate (e.g., no heavy rain or strong wind). These surveys began one-half hour before sunrise and continued for up to 6 hours until the route was completed. The number of vehicles that passed observers during the 3-minute sampling period was recorded on all remote routes. Also, observers noted whether background noise interfered with audible detection of birds.

Correlation of Bird Abundance and Environmental Factors

In previous reports of BBSs on the INL Site, environmental factors have been investigated to explain variation in observed bird abundance. Between 1985 and 1991, significantly more birds were detected along facility routes in June when the weather was cool and wet than when it was hot and dry (Belthoff et al. 1998). In another report spanning a greater number of years, Belthoff and Ellsworth (1999) reported that high bird abundance in June was significantly correlated with low temperatures and that a non-significant trend existed between high bird abundance and high June precipitation. Interestingly, the removal of one outlier from the 1995 data would have resulted in a statistically significant relationship between abundance and precipitation (Belthoff and Ellsworth 1999). Those authors used Spearman rank correlation coefficients to identify whether there was a relationship between bird abundance and June temperature and precipitation (Belthoff and Ellsworth 1999).

The Spearman rank correlation coefficient is a non-parametric test used to investigate the relationship between variables (Zar 1984). Instead of using the raw abundance data, both variables are ranked in increasing order and the assigned ranks are used in the statistical analysis.

Spearman rank correlation coefficient (r_s) is calculated using the following equation, where (d) is the difference between the ranks and (n) is the sample size.

$$r_s = 1 - \frac{6\sum d_i^2}{n^3 - n}$$

It is most appropriate to use a different set of equations when there are tied ranks, although there is no appreciable difference in the outcome unless there are numerous tied values (Zar 1984). The first equation (see below) is calculated for both variables (x and y) where (t_i) is the number of tied values, and the second equation calculates the Spearman rank correlation coefficient corrected to rank ties $(r_s)_c$.

$$\sum t_{(xy)} = \frac{\sum \left(t_i^3 - t_i\right)}{12}$$

$$(r_s)_c = \frac{\left(n^3 - n\right)/6 - \sum d_i^2 - \sum t_x - \sum t_y}{\sqrt{\left[\left(n^3 - n\right)/6 - 2\sum t_x\right]\left[\left(n^3 - n\right)/6 - 2\sum t_y\right]}}$$

We used Spearman rank correlation coefficient to investigate relationships between bird abundance and both mean temperature and total precipitation in June since 1985. Weather data were recorded at the Central Facilities Area (CFA) and are available at http://niwc.noaa.inel.gov/climate.htm. Statistical significance was calculated using a two-tailed test with $\alpha = 0.05$.

Community Diversity Indices

An ecological community is comprised of all interacting species within a given environment. A community with low species diversity may indicate that an ecosystem is unhealthy or improperly functioning, whereas high species diversity is often used as an indicator of a healthy and stable ecosystem. Consequently, increasing diversity is the goal of many management activities.

Species diversity indices are mathematical methods used to quantify community composition. Many diversity indices are commonly used in ecology and each has particular strengths depending on the data to be analyzed and the questions asked. The simplest estimate of community diversity is species richness, which represents the total number of unique species present. Although species richness is a useful measure of diversity, it does not account for differences in abundance between communities. For example, if there are many species for which one individual is observed, richness will be high but may not be comparable to another community with the same number of species and high abundances of those species. Diversity indices that consider both species richness and species abundance may provide a more useful measure of community diversity.

Shannon's diversity index (H) is a method for quantifying diversity of species in an area. This index accounts for both species richness (S) and relative abundance of each species in a community. Shannon's diversity index is derived by first calculating the proportion of species (i) relative to the total number of species (p_i), and then multiplying this proportion by the natural logarithm ($\ln p_i$). Shannon's H can range from 0 to about 4.6, where higher values represent increasing diversity.

$$H = -\sum_{j=1}^{S} p_i \ln p_i$$

Another useful measure is Shannon's equitability (E_H). Shannon's equitability represents a measure of evenness, which is how similar species abundance is within a community. E_H ranges from 0 to 1, with 1 representing a completely even community where all species abundances are equal.

$$E_H = H / \ln S$$

Shannon's H and E_H were calculated for all BBS routes, and compared with standard species richness information documented in past reports. We assumed that data obtained from each survey route was an accurate representation of the local bird community.

1.3 RESULTS AND DISCUSSION

Summary Statistics

We documented 2,677 birds during the 2014 surveys (Appendix A), which was lower than the average from 1985 to 2013 of 4,824 birds (Figure 2). Species richness of all BBS routes consisted of 38 species, which was lower than the historic average of 57 species (Table 1).

The Tractor Flats Route had the highest species richness and the highest bird abundance of all routes (Table 1). Among remote routes, Tractor Flats consistently has had the highest abundance since 1999, excluding 2010. The mean bird abundance of this route since 1985 is 687 individuals, which is higher than other remote routes. For facility routes TAN had the highest abundance and ATRC had highest species richness. The TAN Route has had the highest mean abundance at a facility since 1985 with 489 birds and NRF, CFA, and MFC have had the highest mean richness since 1985 with 21 species.

Horned lark (*Eremophila alpestris*) was the most abundant species counted during the 2014 survey with 771 individuals representing 28.8% of all observations (Table 2). This species was observed at 67.27% (333) of the total stops made during the survey (Table 2). The horned lark is the most abundant species recorded during historic BBSs on the INL Site, and has been the most abundant species annually since 1998 until 2013.

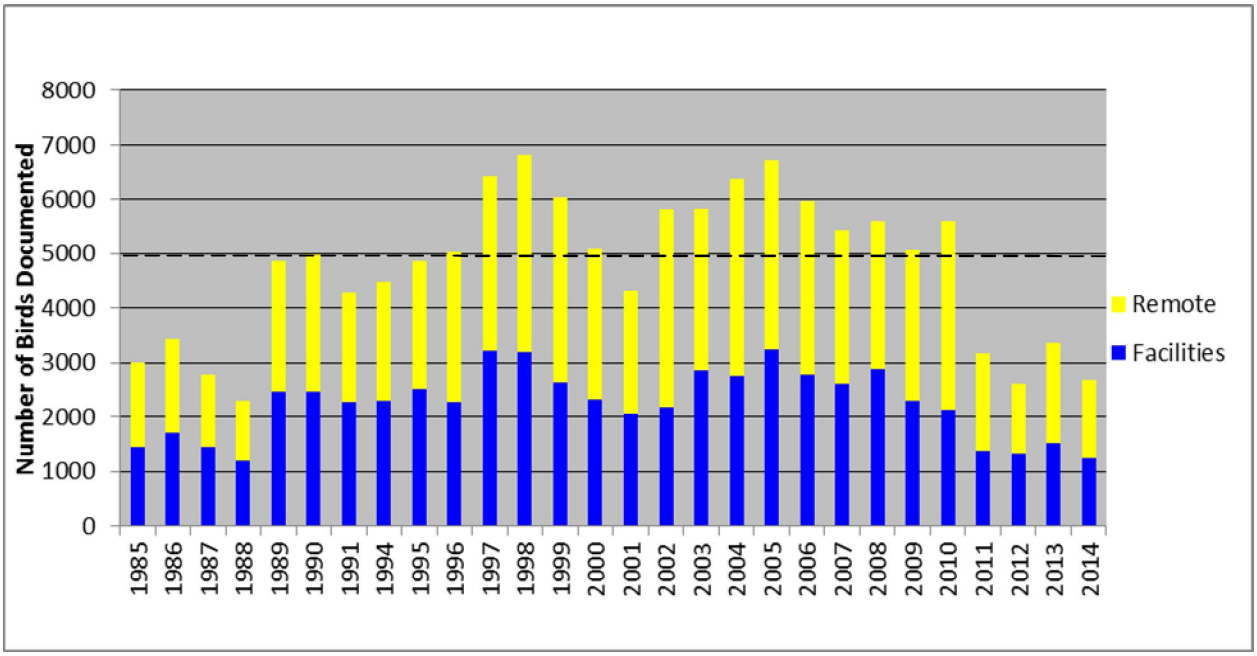

Figure 2. Number of birds observed during the Breeding Bird Survey on the Idaho National Laboratory Site. The dashed black line indicates the mean number of birds observed from 1985 to 2013. No BBSs were conducted on the INL Site in 1992 or 1993.

The five most abundant birds we observed were horned lark (*n* = 771), western meadowlark (*Sturnella neglecta*, *n* = 674), sage thrasher (*Oreoscoptes montanus*, *n* = 460), sage sparrow (*Amphispiza belli*, *n* = 208, and Brewer's sparrow (*Spizella breweri*, *n* = 125). These five species consisted of > 83% of all observations made in 2014 and they were observed on every remote route (Table 2, Appendix A). In the 28 years of INL Site BBS, these five species have been the most abundant 21 times, in five of the remaining seven years they were among the six most abundant species, during the other two years there were eastern meadowlarks observed instead of western meadowlarks. Surveys in the western U.S. indicate that populations of horned larks, western meadowlarks, Brewer's sparrows, and sage sparrows have all declined across their range (Knick et al. 2003; Sauer and Link 2011). As sagebrush obligates are experiencing population declines from habitat loss and disturbance (Knick et al. 2003), it is encouraging to see the relatively high abundance of these species each year on the INL Site. Recent fires on the INL Site, however, have reduced the amount of sagebrush habitat. Such reduction in habitat most likely has affected the total abundance of birds, including sagebrush obligates in this area.

Table 1. Number of stops surveyed, species richness, and bird abundance in 2014 for Breeding Bird Survey routes on the Idaho National Laboratory Site.

Route	Stops	# Species	Abundance
Remote Routes			
Lost River	50	15	267
Circular Butte	50	14	301
Kyle Canyon	50	14	256
Tractor Flats	50	23	408
Twin Buttes	50	14	217
Subtotal	**250**	**30***	**1449**
Facility Routes			
CFA	42	16	127
INTEC	25	9	104
MFC	18	15	123
NRF	20	9	88
PBF	28	14	217
ATRC	32	17	198
RWMC	20	15	144
TAN	60	12	227
Subtotal	**245**	**29***	**1228**
Total	**495**	**38**	**2677**

*This value represents the combined number of unique species documented within each route subgroup (i.e., remote and facility).

Rare Observations and Species of Special Concern

Five species were observed during the 2014 BBS that are considered species of conservation concern in Idaho by the Idaho Department of Fish and Game (2005). These included the burrowing owl (*Athene cunicularia*, $n = 2$), Franklin's gull (*Larus pipixcan*, $n = 2$), long-billed curlew (*Numenius americanus*, $n = 2$), grasshopper sparrow (*Ammodramus savannarum*, $n = 5$), and ferruginous hawk (*Buteo regalis*, $n = 8$).

Species Assemblage Summary

Assemblages of bird species in particular habitats within a region provide useful insight about general ecological health of such habitats. For example, if a study area contains large shrubland and grassland habitat patches and the corresponding observations of bird assemblages are low in those areas, this may indicate that the local population is experiencing declines.

Table 2. Summary of species from 13 routes, sorted by abundance, that were observed during the 2014 Breeding Bird Survey on the Idaho National Laboratory Site.

Common Name	Scientific Name	n	%	Routes[1]	Stops[2]	%[3]
Horned Lark	*Eremophila alpestris*	771	28.80	5,8	333	67.27
Western Meadowlark	*Sturnella neglecta*	674	25.18	5,6	298	60.20
Sage Thrasher	*Oreoscoptes montanus*	460	17.18	5,8	268	54.14
Sage Sparrow	*Amphispiza belli*	208	7.77	5,7	137	27.68
Brewer's Sparrow	*Spizella breweri*	125	4.67	5,8	81	16.36
Common Raven	*Corvus corax*	80	2.99	5,8	61	12.32
Mourning Dove	*Zenaida macroura*	57	2.13	5,7	42	8.48
Vesper Sparrow	*Pooecetes gramineus*	53	1.98	5,5	35	7.07
Brewer's Blackbird	*Euphagus cyanocelphalus*	31	1.16	3,6	15	3.03
European Starling	*Sturnus vulgaris*	29	1.08	1,2	9	1.82
Barn Swallow	*Hirundo rustica*	27	1.01	2,4	13	2.63
Rock Wren	*Salpinctes obsoletus*	17	0.64	4,4	16	3.23
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	16	0.60	0,1	4	0.81
Brown-headed Cowbird	*Molothrus ater*	15	0.56	2,2	9	1.82
Red-tailed Hawk	*Buteo jamaicensis*	14	0.52	5,1	12	2.42
Bank Swallow	*Riparia riparia*	9	0.34	1,4	6	1.21
Say's Phoebe	*Sayornis saya*	9	0.34	0,5	9	1.82
Ferruginous Hawk	*Buteo regalis*	8	0.30	2,2	7	1.41
Gadwall	*Anas strepera*	8	0.30	0,1	2	0.40
Common Nighthawk	*Chordeiles minor*	7	0.26	1,3	7	1.41
Black-billed Magpie	*Pica pica*	6	0.22	3,0	5	1.01
Swainson's Hawk	*Buteo swainsoni*	6	0.22	2,0	5	1.01
American Robin	*Turdus migratorius*	6	0.22	1,2	4	0.81
American Crow	*Corvus brachyrhynchos*	5	0.19	1,0	2	0.40
Grasshopper Sparrow	*Ammodramus savannarum*	5	0.19	2,0	5	1.01
House Finch	*Carpodacus mexicanus*	5	0.19	0,2	3	0.61
Killdeer	*Charadrius vociferous*	5	0.19	0,3	3	0.61
Loggerhead Shrike	*Lanius ludovicianus*	5	0.19	2,2	5	1.01
Red-winged Blackbird	*Agelaius phoeniceus*	2	0.07	0,2	2	0.40
Burrowing Owl	*Athene cunicularia*	2	0.07	1,1	2	0.40
Franklin's Gull	*Larus pipixcan*	2	0.07	1,0	1	0.20
Long-billed Curlew	*Numenius americanus*	2	0.07	1,0	1	0.20
Northern Harrier	*Circus cyaneus*	2	0.07	2,0	2	0.40
Savannah Sparrow	*Passerculus sandwichensis*	2	0.07	1,1	2	0.40
Eastern Kingbird	*Tyrannus tyrannus*	1	0.04	0,1	1	0.20
Great Horned Owl	*Bubo virginianus*	1	0.04	0,1	1	0.20
Rock Pigeon	*Columba livia*	1	0.04	1,0	1	0.20
Western Kingbird	*Tyrannus verticalis*	1	0.04	1,0	1	0.20

[1]The first value represents the number of remote routes at which a species was recorded, and the second value represents the number of facility routes at which a species was recorded.
[2]Number of stops at which a species was documented.
[3]Percent of stops (from a total of 495) at which a species was recorded.

The most dominant species assemblage on the INL Site was the shrub-steppe/grassland category, representing nearly 61.7% of all BBS observations (Figure 3). The shrub-steppe/grassland bird assemblage consistently has the highest bird abundance because the majority of the INL Site consists of shrub-steppe and grassland habitats. The second most abundant species assemblage was sagebrush obligates representing 29.6% of all observations (Figure 3). Given the regional concern for sagebrush-obligate species (Knick et al. 2003), it is encouraging that these species are doing well on the INL Site. In the past six years the abundance of species in this category has averaged 30% (range = 26% to 35%). As indicated earlier, recent fires on the INL Site have reduced the amount of sagebrush habitat. Such reduction in sagebrush most likely has affected the abundance of sagebrush-obligate species. Further analyses needs to be conducted to verify this relationship.

Shrub-steppe/Grassland

Species representing the shrub-steppe/grassland assemblage have always been observed in the greatest number in past BBSs, and they dominated observations in 2014 with 1,652 individuals (61.7%). Common shrub-steppe/grassland species include horned lark, western meadowlark, brown-headed cowbird (*Molothrus ater*), and vesper sparrow (*Pooecetes gramineus*). Western meadowlark (n = 674) and horned lark (n = 771) and were the most abundant species in this assemblage, and were ranked as the top two most abundant species for the entire survey (Table 2). Annual horned lark observations between 2002 and 2014 have averaged 1,401 birds, whereas the average number observed between 1985 and 2001 was 699 birds. We suspect that the high abundance of horned lark in recent years is a response to wildfires that have converted shrub-dominated habitat into grassland communities. Further investigation of this hypothesis may provide useful insight into the effects of wildfire on bird communities.

Sagebrush Obligates

The sagebrush obligate assemblage had the second highest species abundance with 793 individuals (29.6% of total). This assemblage includes Brewer's sparrow, sage sparrow, sage thrasher, and greater sage-grouse. Sage thrasher was the most abundant sagebrush obligate with 460 individuals. These data indicate that populations of sagebrush obligates are stable on the INL Site. In many other western states, sagebrush obligates are facing significant habitat loss, and consequently sagebrush-obligate species are experiencing population declines (Knick 1999; Knick et al. 2003). The population trends across the INL Site show a high abundance of sagebrush obligates, which is likely because the INL Site is comprised of a large area of relatively undisturbed sagebrush-steppe habitat compared with other areas in the Intermountain West.

Raptors and Corvids

The raptor and corvid assemblage consisted of 129 observations representing 4.8% of the total count. Among these were six species of raptors (eagles, hawks, falcons, and owls), red-tailed hawk (*Buteo jamaicensis*) was the most abundant raptor with 14 individuals observed. Observations that were notable in 2014 included the 5 loggerhead shrikes (*Lanius ludovicianus*) that were observed. This is significantly lower than the average of 32 loggerhead shrikes per year between 1985 and 2013.

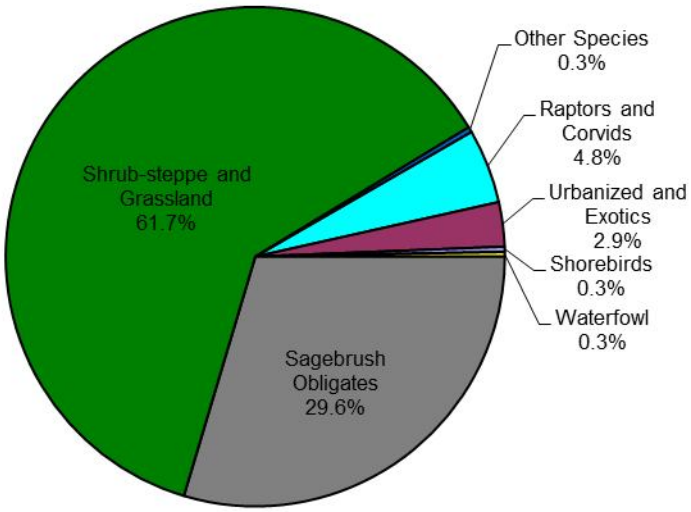

Figure 3. Summary of species assemblage for Breeding Bird Surveys of remote and facility routes on the Idaho National Laboratory Site in 2014.

The corvids include ravens (*Corvus* spp.), crows (*C.* spp.), and magpies (*Pica* spp.). The common raven (*C. corax*) was the most abundant species within this assemblage with 80 individuals observed. The number observed in 2014 was the highest abundance since 2010. Since egg predation by ravens can negatively impact sage-grouse nest success, it will be important to continue to closely monitor raven abundance, especially if sage-grouse populations continue to decline across the western U.S.

Urbanized and Exotics

The urbanized and exotics assemblage represents birds associated with urban or human-altered environments, which are most commonly found around INL Site facilities. Examples of these species include European starling (*Sturnus vulgaris*), rock dove (*Columba livia*), and American robin (*Turdus migratorius*). This assemblage constituted 2.9% (n = 77) of the total observations in 2014. The European starling was the most abundant species observed in this assemblage (29 individuals), followed by barn swallow (*Hirundo rustica*) (27 individuals).

Waterfowl

Waterfowl are commonly observed during the BBS even though little standing water exists on the INL Site. With the exception of the ephemeral Big Lost River and the Big Lost River Sinks Wetland, the only standing water bodies on the INL Site are wastewater treatment ponds near facilities. These man-made ponds serve as stopover locations for migrating birds and a number of different species have been observed using these areas since 1985.

We documented 8 individuals from one waterfowl species, gadwall (*Anas strepera*), representing 0.3% of total observations. As in past years the gadwall were observed along the facility routes.

Shorebirds

We observed 9 individuals representing three species from the shorebird assemblage, which accounted for 0.3% of the total BBS observations. Because standing water is rare on the INL Site, most observations of shorebirds occurred in proximity to waste ponds near facility routes. Franklin's gull (n = 2), killdeer (*Charadrius vociferous*, n = 5), and long-billed curlew (*Numenius americanus*, n = 2) comprised all observations. The Franklin's gulls were recorded along the Tractor Flats Route.

Other Birds

One bird species that was not assigned to any species assemblage were observed in 2014. This species was the bank swallow (*Riparia riparia*, n = 9).

Bird Abundance Correlation

Bird abundance was marginally negatively correlated (r_s = -0.32, n = 28, P = 0.10) with mean June temperature (Figure 4). This result supports previous findings from BBSs on the INL Site (Belthoff et al. 1998, Belthoff and Ellsworth 1999), indicating that June temperature should be a consideration when interpreting BBS results. In years where June temperatures are above average, the number of bird observations during the BBS tends to be lower compared with cooler years. The correlation with June temperature and bird abundance thus allows for interpretation of changes in bird abundance across the INL Site, and may help explain annual variability in BBS results. Although, a relationship exists with temperature and abundance, we recognize that

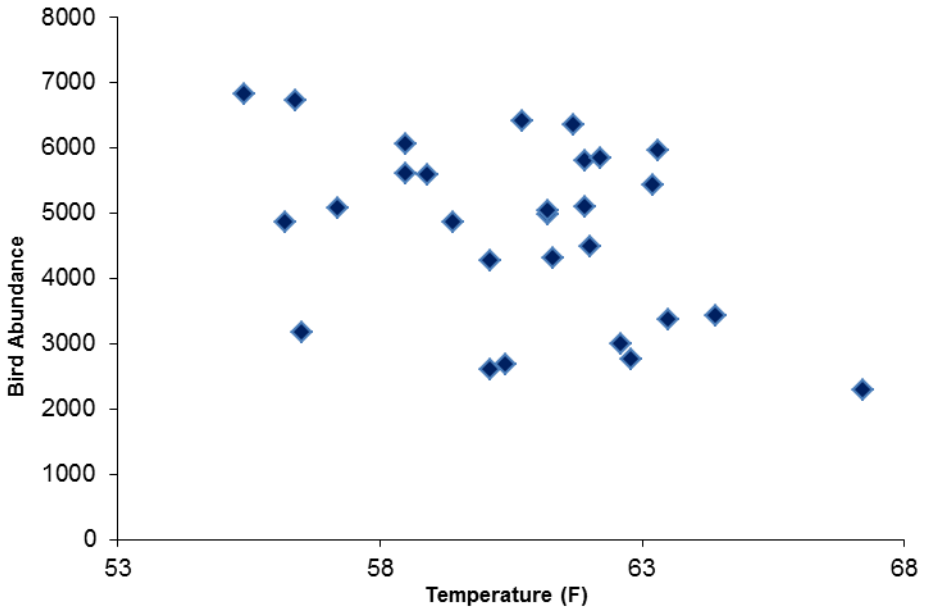

Figure 4. Relationship between bird abundance at the Idaho National Laboratory Site and the average June temperature recorded at the Central Facilities Area from 1985 to 2014.

other factors (i.e., observer) could influence assessment of bird abundance. Therefore, we recommend that future data analyses use multivariate techniques to test for strength of each independent variable (i.e., temperature, date of survey, or observer) that could influence bird abundance.

Total precipitation in June was significantly correlated with bird abundance (r_{sc} = 0.44, n = 28, P = 0.02; Figure 5). These results also support previous analyses (Betlhoff and Ellsworth 1999). Therefore, precipitation is an important variable to be considered when interpreting changes in annual BBS abundance.

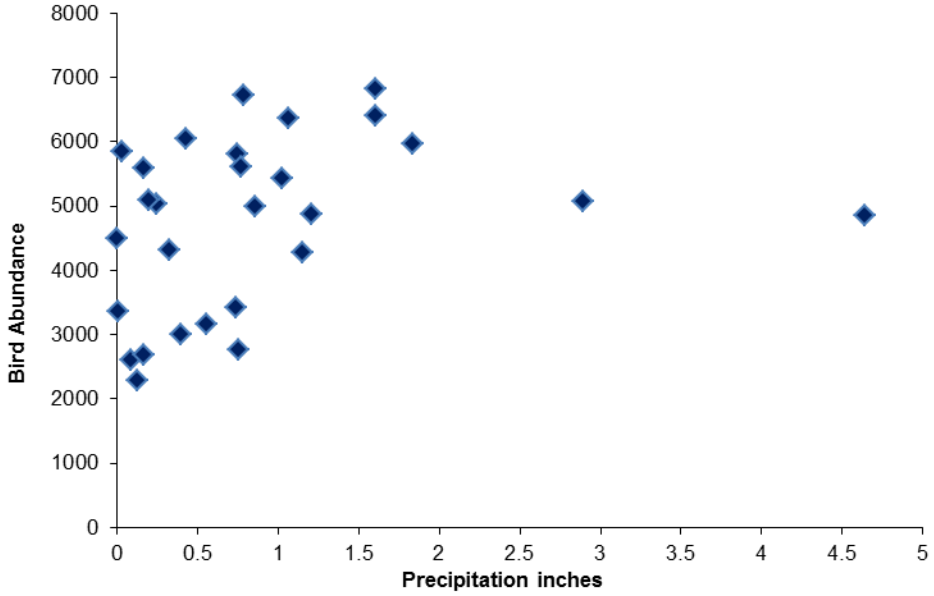

Figure 5. Relationship between bird abundance at the Idaho National Laboratory Site and total June precipitation recorded at the Central Facilities Area from 1985 to 2014.

Community Diversity Index

Based on both of Shannon's measures of diversity, the CFA Route had the most diverse bird community of all 13 routes (H = 2.28, E_H = 0.82; Table 3), followed by the MFC Route (H = 2.12, E_H = 0.78). Tractor Flats had the highest species richness (n = 23). Kyle Canyon had the most diverse bird community among remote routes based on both of Shannon's indicators (H = 1.96, E_H = 0.74). The TAN Route had the lowest diversity among facility routes based on Shannon's measures of diversity (H = 1.52; E_H = 0.61), and Twin Buttes was the least diverse among remote routes based on richness and H (n = 14; H = 1.62). Overall, TAN was the least diverse of all routes.

Over the past six years, CFA is the only route that has been among the top three in regards to diversity each year. RWMC has been among the three most diverse during five of the past seven years. During the same time, Tractor Flats has had the highest or second highest species richness. This information indicates that the area surrounding CFA and RWMC (building, trees, and waste-water ponds) may provide unique habitat for several species of birds. Additionally,

the northern stops on the Tractor Flats Route occur in the agricultural areas near State Highway 33, which likely influences the total number of unique birds that are detected in that area.

Table 3. Values for species richness, Shannon Diversity (*H*), and Equitability (E_H) indices for the 2014 Idaho National Laboratory Site Breeding Bird Surveys.

Route	Species Richness	Shannon's *H*	Shannon's E_H
Remote Routes			
Circular Butte	14	1.82	0.69
Kyle Canyon	14	1.96	0.74
Lost River	15	1.83	0.68
Tractor Flats	23	2.01	0.64
Twin Buttes	14	1.62	0.61
Facility Routes			
CFA	16	2.28	0.82
INTEC	9	1.60	0.73
MFC	15	2.12	0.78
NRF	9	1.52	0.69
PBF	14	1.91	0.72
ATRC	17	1.72	0.61
RWMC	15	2.11	0.78
TAN	12	1.52	0.61

2.0 SUMMARY

As in most previous years, birds belonging to shrub-steppe and grassland community assemblages dominated observations during the 2014 BBS on the INL Site. The total number of birds observed (n = 2,677) and species richness (n = 38) from all routes was lower than the INL Site averages ($\bar{x}$ = 4,824; $\bar{x}$ = 57) since 1985. Following patterns of abundance from previous BBSs on the INL Site, horned larks were the most abundant species, followed by western meadowlark, sage thrasher, sage sparrow, and Brewer's sparrow. These species have been consistently among the most abundant species each year of the BBS. This is encouraging for those concerned about the conservation of sage-steppe ecosystems, because these species are in decline over much of their range. Thus, the habitat quality on the INL Site appears to remain stable.

Species observed during the 2014 BBS that are considered species of conservation concern in Idaho included the burrowing owl (n = 2), Franklin's gull (n = 2), long-billed curlew (n = 2), grasshopper sparrow (n = 5), and ferruginous hawk (n = 8).

2.1 FUTURE DATA ANALYSES

With over two decades of BBS data collected, we are well positioned to conduct a long-term analysis of bird population trends for species occupying the INL Site. Past reports have provided details regarding particular species, but no effort has been made to consider a comprehensive analysis of all BBS data from the INL Site. In the near future, we plan to analyze all data from past BBSs, and to investigate long-term trends in bird abundance and species richness using new methods to do such (Sauer and Link 2011).

Landscape Change and Habitat Variation

The habitat and vegetation communities across the INL Site are a mosaic of sagebrush-steppe habitat. The INL Site has experienced some large, natural disturbances (e.g., wildfire), which have caused changes in vegetation community composition and distribution across the INL Site. Little is known, however, concerning responses of bird populations to alterations of habitat composition and distribution across the landscape (Knick eta al. 2003) and how habitat fragmentation can influence local populations. Local bird populations and community assemblages can respond to these habitat changes, and the long-term BBS data should reflect these changes. We will investigate the patterns of habitat modification in conjunction with changes in observed bird abundance and richness along routes.

Long-term Community Diversity Trend

Diversity indices have not been calculated each year, and a useful comparison would be to calculate Shannon's H and E_H for all BBS routes for all years to assess which routes have experienced significant change in bird community abundance. The initial community diversity results reported here consider community differences between different routes in the same year. It is unknown how diversity on the same route has changed over time. A number of community similarity indices; can be calculated to address this question. We anticipate coupling the results from the spatial analysis described above with the results from community diversity change over time to present a comprehensive description of how bird communities have changed on the INL Site since 1985.

The INL Site has five permanent, official BBS routes originally established in 1985 and eight additional survey routes near INL Site facilities. The annual BBS provides DOE-ID with historical information regarding population trends of breeding birds relative to activities conducted in remote areas and near facilities on the INL Site. These data can be useful when addressing issues regarding the National Environmental Policy Act and the Migratory Bird Treaty Act. Additionally, BBSs comply with the direction to promote monitoring of migratory birds as described in the Memorandum of Understanding between the Department of Energy and the United States Fish and Wildlife Service for responsibilities of federal agencies to protect migratory birds (2006).

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Appendix A

SUMMARY OF SPECIES BY ROUTE
2014

Survey Route: **RWMC**
Survey Date: **May 29, 2014**

Species	Abundance	Percentage
Western Meadowlark	43	29.86
Horned Lark	25	17.36
Sage Thrasher	22	15.28
Barn Swallow	13	9.03
Sage Sparrow	11	7.64
Gadwall	8	5.56
Brewer's Sparrow	7	4.86
Common Raven	3	2.08
Mourning Dove	3	2.08
Rock Wren	3	2.08
Say's Phoebe	2	1.39
Brewer's Blackbird	1	0.69
Killdeer	1	0.69
Red-winged Blackbird	1	0.69
Vesper Sparrow	1	0.69
Total Individuals	***144***	
Total Species	***15***	

Survey Route: **Lost River**
Survey Date: **May 30, 2014**

Species	Abundance	Percentage
Western Meadowlark	85	31.84
Horned Lark	82	30.71
Sage Thrasher	28	10.49
Brewer's Sparrow	20	7.49
Common Raven	19	7.12
Sage Sparrow	15	5.62
Red-tailed Hawk	4	1.50
Brewer's Blackbird	3	1.12
Mourning Dove	3	1.12
American Robin	2	0.75
Rock Wren	2	0.75
Barn Swallow	1	0.37
Ferruginous Hawk	1	0.37
Savannah Sparrow	1	0.37
Vesper Sparrow	1	0.37
Total Individuals	***267***	
Total Species	***15***	

Survey Route: **ARTC**
Survey Date: **June 2, 2014**

Species	Abundance	Percentage
Horned Lark	74	37.37
Western Meadowlark	61	30.81
Brewer's Sparrow	23	11.62
Sage Thrasher	16	8.08
Vesper Sparrow	7	3.54
Common Raven	2	1.01
European Starling	2	1.01
House Finch	2	1.01
Rock Wren	2	1.01
Sage Sparrow	2	1.01
American Robin	1	0.51
Bank Swallow	1	0.51
Loggerhead Shrike	1	0.51
Mourning Dove	1	0.51
Red-winged Blackbird	1	0.51
Savannah Sparrow	1	0.51
Say's Phobe	1	0.51
Total Individuals	***198***	
Total Species	***17***	

Survey Route: **Tractor Flats**
Survey Date: **June 3, 2014**

Species	Abundance	Percentage
Western Meadowlark	131	32.11
Horned Lark	118	28.92
Sage Thrasher	43	10.54
Sage Sparrow	27	6.62
Mourning Dove	19	4.66
Brewer's Sparrow	17	4.17
Common Raven	13	3.19
Vesper Sparrow	7	1.72
American Crow	5	1.23
European Starling	4	0.98
Barn Swallow	3	0.74
Grasshopper Sparrow	3	0.74
Red-tailed Hawk	3	0.74
Black-billed Magpie	2	0.49
Brown-headed Cowbird	2	0.49
Bank Swallow	2	0.49
Franklin's Gull	2	0.49
Long-billed Curlew	2	0.49
Burrowing Owl	1	0.25
Northern Harrier	1	0.25
Rock Pigeon	1	0.25
Swainson's Hawk	1	0.25
Western Kingbird	1	0.25
Total Individuals	***408***	
Total Species	***23***	

Survey Route: **Circular Butte**
Survey Date: **June 4, 2014**

Species	Abundance	Percentage
Horned Lark	103	34.22
Western Meadowlark	76	25.25
Sage Thrasher	42	13.95
Brewer's Sparrow	25	8.31
Sage Sparrow	24	7.97
Common Raven	9	2.99
Mourning Dove	8	2.66
Brown-headed Cowbird	4	1.33
Vesper Sparrow	3	1.00
Common Nighthawk	3	1.00
Brewer's Blackbird	1	0.33
Northern Harrier	1	0.33
Rock Wren	1	0.33
Red-tailed Hawk	1	0.33
Total Individuals	***301***	
Total Species	***14***	

Survey Route: **MFC**
Survey Date: **June 10, 2014**

Species	Abundance	Percentage
Western Meadowlark	34	27.64
Horned Lark	28	22.76
Yellow-headed Blackbird	16	13.01
Sage Thrasher	14	11.38
Rock Wren	6	4.88
Brewer's Blackbird	5	4.07
Brewer's Sparrow	4	3.25
Killdeer	3	2.44
Barn Swallow	3	2.44
Say's Phoebe	3	2.44
Bank Swallow	2	1.63
Common Raven	2	1.63
Common Nighthawk	1	0.81
Ferruginous Hawk	1	0.81
Mourning Dove	1	0.81
Total Individuals	***123***	
Total Species	***15***	

Survey Route: **INTEC**
Survey Date: **June 11, 2014**

Species	Abundance	Percentage
Sage Thrasher	36	34.62
Western Meadowlark	27	25.96
Horned Lark	25	24.04
Brewer's Blackbird	4	3.85
Brewer's Sparrow	4	3.85
Sage Sparrow	4	3.85
Common Nighthawk	2	1.92
Common Raven	1	0.96
Mourning Dove	1	0.96
Total Individuals	***104***	
Total Species	***9***	

Survey Route: **Kyle Canyon**
Survey Date: **June 16, 2014**

Species	Abundance	Percentage
Sage Thrasher	60	23.44
Western Meadowlark	54	21.09
Horned Lark	52	20.31
Sage Sparrow	45	17.58
Common Raven	11	4.30
Mourning Dove	8	3.13
Vesper Sparrow	8	3.13
Ferruginous Hawk	5	1.95
Red-tailed Hawk	4	1.56
Black-billed Magpie	3	1.17
Brewer's Blackbird	3	1.17
Brewer's Sparrow	1	0.39
Loggerhead Shrike	1	0.39
Rock Wren	1	0.39
Total Individuals	***256***	
Total Species	***14***	

Survey Route: **Twin Buttes**
Survey Date: **June 17, 2014**

Species	Abundance	Percentage
Western Meadowlark	83	32.42
Horned Lark	74	28.91
Sage Thrasher	25	9.77
Sage Sparrow	10	3.91
Swainson's Hawk	5	1.95
Common Raven	4	1.56
Vesper Sparrow	4	1.56
Brewer's Sparrow	3	1.17
Grasshopper Sparrow	2	0.78
Loggerhead Shrike	2	0.78
Mourning Dove	2	0.78
Black-billed Magpie	1	0.39
Red-tailed Hawk	1	0.39
Rock Wren	1	0.39
Total Individuals	***217***	
Total Species	***14***	

Survey Route: **CFA**
Survey Date: **June 18, 2014**

Species	Abundance	Percentage
Sage Thrasher	24	18.90
European Starling	23	18.11
Horned Lark	23	18.11
Western Meadowlark	15	11.81
Brewer's Blackbird	12	9.45
Brewer's Sparrow	5	3.94
Brown-headed Cowbird	5	3.94
Sage Sparrow	5	3.94
Barn Swallow	4	3.15
Common Raven	3	2.36
House Finch	3	2.36
Bank Swallow	1	0.79
Eastern Kingbird	1	0.79
Killdeer	1	0.79
Loggerhead Shrike	1	0.79
Mourning Dove	1	0.79
Total Individuals	***127***	
Total Species	***16***	

Survey Route: **TAN**
Survey Date: **June 23, 2014**

Species	Abundance	Percentage
Horned Lark	90	39.65
Sage Thrasher	66	29.07
Sage Sparrow	42	18.50
Vesper Sparrow	13	5.73
Mourning Dove	4	1.76
Brewer's Sparrow	3	1.32
Barn Swallow	3	1.32
Common Raven	2	0.88
Burrowing Owl	1	0.44
Common Nighthawk	1	0.44
Red-tailed Hawk	1	0.44
Rock Wren	1	0.44
Total Individuals	***227***	
Total Species	***12***	

Survey Route: **NRF**
Survey Date: **June 25, 2014**

Species	Abundance	Percentage
Sage Thrasher	36	40.91
Horned Lark	29	32.95
Sage Sparrow	8	9.09
Common Raven	6	6.82
Bank Swallow	3	3.41
Brewer's Sparrow	2	2.27
Vesper Sparrow	2	2.27
Brewer's Blackbird	1	1.14
Say's Phobe	1	1.14
Total Individuals	***88***	
Total Species	***9***	

Survey Route: **PBF**
Survey Date: **June 27, 2014**

Species	Abundance	Percentage
Western Meadowlark	65	29.95
Horned Lark	48	22.12
Sage Thrasher	48	22.12
Sage Sparrow	15	6.91
Brewer's Sparrow	11	5.07
Vesper Sparrow	7	3.23
Mourning Dove	6	2.76
Common Raven	5	2.30
Brown-headed Cowbird	4	1.84
American Robin	3	1.38
Say's Phoebe	2	0.92
Brewer's Blackbird	1	0.46
Ferruginous Hawk	1	0.46
Great Horned Owl	1	0.46
Total Individuals	***217***	
Total Species	***14***	