

2009 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 2009, we conducted surveys from June 3 to 30 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 circumscribe INL Site facilities. We documented 5,072 birds from 55 species during these surveys. Bird abundance was greater than the 1985-2008 average of 5,018 birds, but the number of species observed (i.e., species richness) was lower than the 22-year average of 59.

Compared with past surveys, we observed similar patterns of bird abundance among those species that are typically most numerous. In 2009, the five species that were surveyed in greatest abundance were horned lark (*Eremophila alpestris*, $n = 1,466$), western meadowlark (*Sturnella neglecta*, $n = 1,071$), Brewer's sparrow (*Spizella breweri*, $n = 743$), sage thrasher (*Oreoscoptes montanus*, $n = 516$), and sage sparrow (*Amphispiza belli*, $n = 367$). During 23 years of breeding bird surveys on the INL Site, these species have been the five most abundant 18 times, and in the remaining five years they were among the six most abundant species. Considering declines reported 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 two years to the list of birds that have been observed at least once during BBSs on the INL Site, no new observations were made in 2009. Four species were observed, however, that had been recorded in ≤ 6 of the past 22 years. These include American goldfinch (*Carduelis tristis*), western tanager (*Piranga ludoviciana*), northern mockingbird (*Mimus polyglottos*), and northern pintail (*Anas acuta*).

Species observed during the 2009 BBSs that are considered imperiled or critically imperiled in Idaho include the long-billed curlew (*Numenius americanus*, $n = 2$), Franklin's gull (*Larus pipixcan*, $n = 26$), and grasshopper sparrow (*Ammodramus savannarum*, $n = 4$).

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ACRONYMS

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 Reactors Facility
PBF	Power Burst Facility
ATR	Advanced Test Reactor Complex
RWMC	Radioactive Waste Management Complex
TAN	Test Area North
USFWS	United States Fish and Wildlife Service
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. and Canada east of the Mississippi, and by 1968 included all of North America (Bystrak 1981, Robbins et al. 1986). The BBS program in North America is managed by the U.S. Geological Survey (USGS) and currently consists of over 4,100 routes, with approximately 3,000 of these being sampled each year.

BBS data provide long-term species abundance and distribution trends across a broad-geographic scale. 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 (Sauer et al. 2003). Numerous statistical procedures for exploring and analyzing BBS data have been proposed and discussed (James et al. 1996, Link and Sauer 1997, McCulloch et al. 1997, Bart et al. 2004, Sauer et al. 2005). Regardless of differences in opinion concerning the most appropriate analysis techniques, 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.

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). Facility routes were developed to monitor avifauna populations in proximity to anthropogenic activities and disturbances. The annual BBS provides land managers with information regarding the population trends of breeding birds relative to activities conducted on the INL Site. This report summarizes the results from the 2009 BBSs and compares species abundance across survey routes with long-term averages.

1.1 STUDY AREA

The INL Site encompasses almost 900 mi² (2,315 km²) 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).

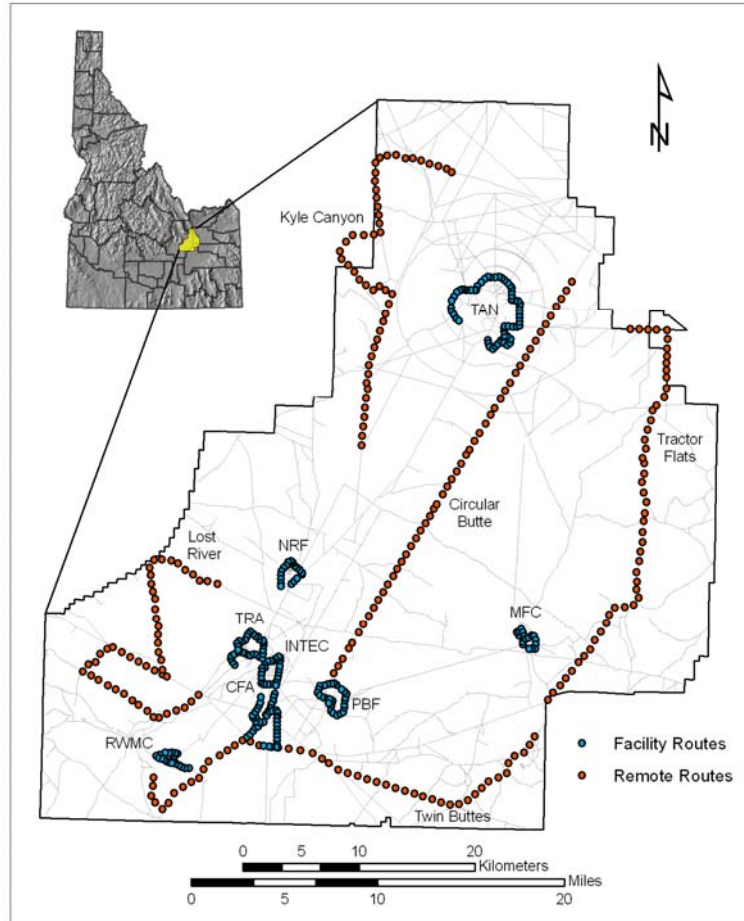


Figure 1. Location of Breeding Bird Survey routes on the Idaho National Laboratory Site. Blue dots represent survey points along facility routes and red dots represent the same for remote routes.

Topography across the INL Site is mostly flat with an average elevation of 4,985 ft (1,520 m). Other than minor topographic variation created by basalt outcrops, the only significant relief occurs around East and Middle Buttes and the southern portion of the Lemhi Mountains located near the northwest corner of the INL Site.

A description of the climate, geology, and vegetation communities on the INL Site is described in Anderson et al. (1996). 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 the 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 found throughout the INL Site, while alluvial soils are more commonly found along the flood plain of the Big Lost River. The INL Site is a shrub-steppe ecosystem dominated by a woody shrub overstory and perennial bunchgrass and forb understory. Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) is the most dominant shrub on the INL Site, while other common species include green rabbitbrush (*Chrysothamnus viscidiflorous*), spiny hopsage (*Grayia spinosa*) shadscale (*Atriplex confertifolia*), winterfat (*Krascheninnikovia lanata*), and other

sagebrush species (*Artemisia*. spp.). The most common native grasses are thickspike wheatgrass (*Elymus laceolatus*), bottlebrush squirreltail (*Elymus elymoides*), Indian ricegrass (*Achnatherum hymenoides*), and needle-and-thread grass (*Hesperostipa comata*).

Very little surface water exists during spring and summer on the INL Site. The Big Lost River and Birch Creek drainages 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 June 3 to 30, 2009, 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 (0.4 km).

During surveys, observers followed the North American BBS protocols provided by the USGS Patuxent Wildlife Research Center. 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. 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 complete. The number of automobiles 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) showed 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 an outlier from the 1995 data would have resulted in a statistically significant relationship between abundance and precipitation (Belthoff and Ellsworth 1999). These authors used Spearman rank correlation coefficients to identify whether there was a relationship between bird abundance and both 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 (Spearman 1904). 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 (Thomas 1989), 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.

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

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

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 from <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 functioning improperly, 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 popular method for quantifying diversity of species in an area (Shannon 1948). 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 ($\ln p_i$). The resulting product is then summed across species and multiplied by -1. Shannon's H can range from zero 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 to 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 5,072 birds during the 2009 survey (Appendix A), which was slightly greater than the average from 1985 to 2008 of 5,018 birds (Figure 2). Species richness of all BBS routes consisted of 55 species, which was lower than the historic average of 59 species (Table 1).

The Tractor Flats route had both the highest bird abundance and species richness of all routes (Table 1). Among remote routes, Tractor Flats consistently has had the highest abundance since 1999. The mean bird abundance of this route since 1985 is 711 individuals, which is higher than other remote routes.

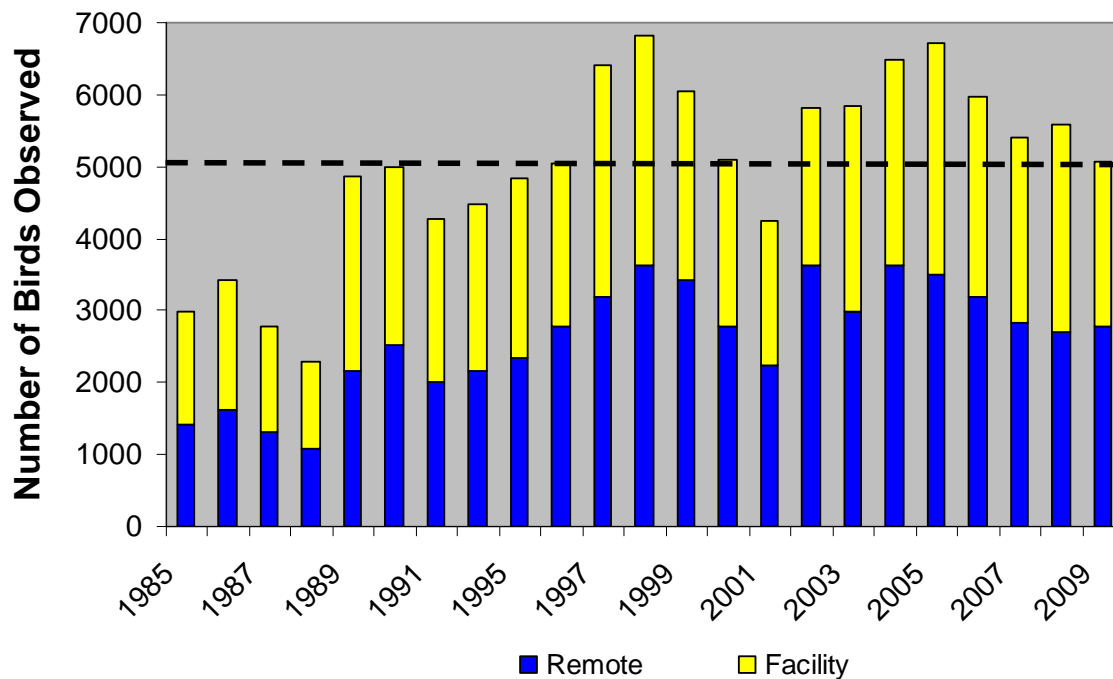


Figure 2. Number of birds observed during Breeding Bird Surveys on the Idaho National Laboratory Site. The dashed black line indicates the mean number of birds observed from 1985 to 2009. No BBSs were conducted on the INL Site in 1992 or 1993.

Horned lark (*Eremophila alpestris*) was the most abundant species counted during the 2009 survey with 1,466 individuals representing 29% of all observations (Table 2). This species was observed at 76% (378) 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.

The five most abundant birds we observed were horned lark ($n = 1,466$), western meadowlark (*Sturnella neglecta*, $n = 1,071$), Brewer's sparrow (*Spizella breweri*, $n = 743$), sage thrasher (*Oreoscoptes montanus*, $n = 516$), and sage sparrow (*Amphispiza belli*, $n = 367$). These five species consisted of > 82% of all observations made in 2009 and they were observed on every remote and facility route (Table 2, Appendix A). In the 23 years of INL Site breeding bird surveys, these five species have been the most abundant 18 times, and in the remaining five years they were among the six most abundant species. Breeding Bird 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 (Peterjohn and Sauer 1999). As sagebrush obligates are experiencing population declines from habitat loss and disturbance (Knick et al. 2003), it is encouraging to see a consistently high abundance of these species on the INL Site.

Table 1. Number of stops surveyed, species richness, and bird abundance in 2009 for Breeding Bird Survey routes on the Idaho National Laboratory Site.

Route	Stops	# Species	Abundance
<i>Remote Routes</i>			
Lost River	50	17	514
Circular Butte	50	13	601
Kyle Canyon	50	23	405
Tractor Flats	50	27	728
Twin Buttes	50	23	530
Subtotal	250	41*	2778
<i>Facility Routes</i>			
CFA	42	23	346
INTEC	25	18	176
MFC	18	23	206
NRF	20	16	238
PBF	28	16	269
ATR	32	20	316
RWMC	20	21	209
TAN	60	12	534
Subtotal	245	40*	2294
Total	495	55	5072

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

Rare Observations and Species of Special Concern

Three species were observed during the 2009 BBSs that are considered imperiled or critically imperiled in Idaho by the Idaho Department of Fish and Game (2005). These include the long-billed curlew (*Numenius americanus*, $n = 2$), Franklin's gull (*Larus pipixcan*, $n = 26$), and grasshopper sparrow (*Ammodramus savannarum*, $n = 4$).

Interestingly, the number of observations for each of these species was lower this year than in the recent past. Long-billed curlew abundance was at the lowest level since 2004, Franklin's gull numbers were the lowest recorded since 2000, and grasshopper sparrow abundance is at the lowest level since 1996 when no birds were observed. Over the long-term, however, these species have been observed more consistently during the past 10-15 years than they were during the first decade in which BBS data were collected.

Table 2. Summary of species from 13 routes, sorted by abundance, that were observed during the 2009 Breeding Bird Surveys on the Idaho National Laboratory Site.

Common Name	Scientific Name	n	%	Routes ¹	Stops ²	%
Horned Lark	<i>Eremophila alpestris</i>	1,466	28.90	5, 8	378	76.36
Western Meadowlark	<i>Sturnella neglecta</i>	1,071	21.12	5, 8	337	68.08
Brewer's Sparrow	<i>Spizella breweri</i>	743	14.65	5, 8	357	72.12
Sage Thrasher	<i>Oreoscoptes montanus</i>	516	10.17	5, 8	320	64.65
Sage Sparrow	<i>Amphispiza belli</i>	367	7.24	5, 8	203	41.01
Vesper Sparrow	<i>Pooecetes gramineus</i>	107	2.11	4, 4	57	11.52
Mourning Dove	<i>Zenaidura macroura</i>	106	2.09	5, 7	61	12.32
Barn Swallow	<i>Hirundo rustica</i>	82	1.62	2, 8	22	4.44
Common Raven	<i>Corvus corax</i>	69	1.36	5, 8	51	10.30
European Starling	<i>Sturnus vulgaris</i>	64	1.26	0, 3	14	2.83
Brown-headed Cowbird	<i>Molothrus ater</i>	50	0.99	4, 5	32	6.46
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	42	0.83	2, 4	17	3.43
Cliff Swallow	<i>Hirundo pyrrhonota</i>	38	0.75	0, 1	2	0.40
Red-tailed Hawk	<i>Buteo jamaicensis</i>	29	0.57	5, 6	25	5.05
Franklin's Gull	<i>Larus pipixcan</i>	26	0.51	1, 0	2	0.40
Common Nighthawk	<i>Chordeiles minor</i>	24	0.47	3, 4	20	4.04
Rock Wren	<i>Salpinctes obsoletus</i>	20	0.39	4, 4	15	3.03
Say's Phoebe	<i>Sayornis saya</i>	18	0.35	1, 8	15	3.03
Ferruginous Hawk	<i>Buteo regalis</i>	15	0.30	3, 0	11	2.22
Loggerhead Shrike	<i>Lanius ludovicianus</i>	15	0.30	4, 4	14	2.83
American Robin	<i>Turdus migratorius</i>	14	0.28	1, 3	12	2.42
Black-billed Magpie	<i>Pica pica</i>	14	0.28	2, 0	6	1.21
Mallard	<i>Anas platyrhynchos</i>	14	0.28	0, 5	7	1.41
Killdeer	<i>Charadrius vociferus</i>	13	0.26	1, 5	12	2.42
N. Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	12	0.24	0, 1	1	0.20
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	11	0.22	1, 3	6	1.21
American Kestrel	<i>Falco sparverius</i>	10	0.20	0, 3	6	1.21
Northern Harrier	<i>Circus cyaneus</i>	10	0.20	4, 1	10	2.02
House Finch	<i>Carpodacus mexicanus</i>	9	0.18	0, 2	5	1.01
Violet-green Swallow	<i>Tachycineta thalassina</i>	9	0.18	2, 0	4	0.81
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	9	0.18	1, 2	5	1.01
Gadwall	<i>Anas strepera</i>	8	0.16	0, 2	3	0.61
Bank Swallow	<i>Riparia riparia</i>	7	0.14	1, 0	2	0.40
Swainson's Hawk	<i>Buteo swainsoni</i>	7	0.14	3, 2	5	1.01
Gray Flycatcher	<i>Empidonax wrightii</i>	6	0.12	2, 0	5	1.01
Golden Eagle	<i>Aquila chrysaetos</i>	5	0.10	3, 0	3	0.61
House Sparrow	<i>Passer domesticus</i>	5	0.10	0, 2	2	0.40
Short-eared Owl	<i>Asio flammeus</i>	5	0.10	2, 1	5	1.01
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	4	0.08	1, 2	4	0.81

Common Name	Scientific Name	n	%	Routes ¹	Stops ²	% ³
Western Tanager	<i>Piranga ludoviciana</i>	4	0.08	0, 1	1	0.20
Chipping Sparrow	<i>Spizella passerina</i>	3	0.06	2, 0	3	0.61
Northern Shoveler	<i>Anas clypeata</i>	3	0.06	0, 1	1	0.20
Prairie Falcon	<i>Falco mexicanus</i>	3	0.06	2, 0	3	0.61
Rock Dove	<i>Columba livia</i>	3	0.06	1, 1	3	0.61
American Goldfinch	<i>Carduelis tristis</i>	2	0.04	0, 1	1	0.20
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	2	0.04	1, 0	2	0.40
Long-billed Curlew	<i>Numenius americanus</i>	2	0.04	0, 1	1	0.20
Mountain Bluebird	<i>Sialia currucoides</i>	2	0.04	1, 1	2	0.40
Northern Pintail	<i>Anas acuta</i>	2	0.04	0, 1	1	0.20
Blue-winged Teal	<i>Anas discors</i>	1	0.02	0, 1	1	0.20
Great-horned Owl	<i>Bubo virginianus</i>	1	0.02	1, 0	1	0.20
Northern Mockingbird	<i>Mimus polyglottos</i>	1	0.02	1, 0	1	0.20
Western Kingbird	<i>Tyrannus verticalis</i>	1	0.02	1, 0	1	0.20
Willet	<i>Catoptrophorus semipalmatus</i>	1	0.02	1, 0	1	0.20
Wilson's Phalarope	<i>Phalaropus tricolor</i>	1	0.02	0, 1	1	0.20

¹The 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.

²Number of stops at which a species was documented.

³Percent of stops (from a total of 495) at which a species was recorded.

Observations of non-imperiled species in 2009 that have rarely been observed during BBSs on the INL Site include American goldfinch (*Carduelis tristis*), western tanager (*Piranga ludoviciana*), northern mockingbird (*Mimus polyglottos*), and northern pintail (*Anas acuta*). These four species had been observed in ≤ 6 previous BBSs.

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.

The most dominant species assemblage on the INL Site was the shrub-steppe/grassland category, representing nearly 59% 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 32% of all observations (Figure 3). Given the regional concern for sagebrush-obligate species (Knick et al. 2003), it is encouraging that they are doing well on the INL Site.

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 2009 with 2,976 individuals (58.6%). Common shrub-steppe/grassland species include horned lark, western meadowlark,

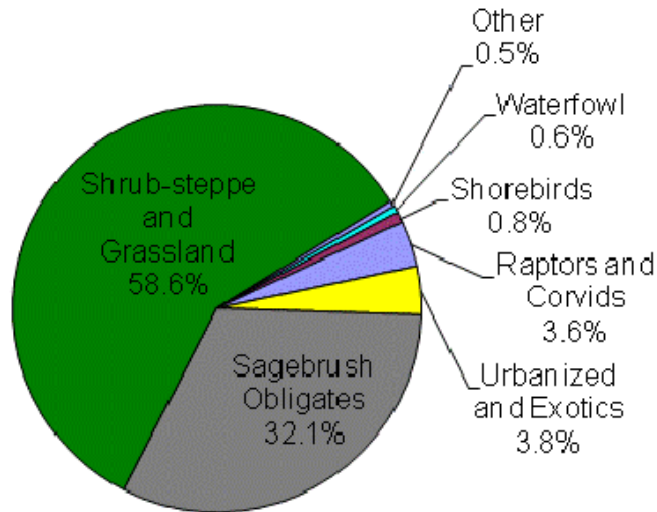


Figure 3. Summary of species assemblage for Breeding Bird Surveys of remote and facility routes on the Idaho National Laboratory Site in 2009.

brown-headed cowbird (*Molothrus ater*), and vesper sparrow (*Pooecetes gramineus*). Horned lark ($n = 1,466$) and western meadowlark ($n = 1,071$) 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 2009 have averaged 1,676 birds, whereas the average number observed between 1985 and 2001 was 717 per year. 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 1,626 individuals (32.1% 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 516 individuals. These data indicate that populations of sagebrush obligates are thriving 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 et al. 2003; Sauer et al. 2008). The population trends across the INL Site show a consistently high abundance of sagebrush obligates (Vilord 2007), 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 183 observations representing 3.6% of the total count. Among these were nine species of raptors (eagles, hawks, falcons, and owls). Red-tailed hawk (*Buteo jamaicensis*) was the most abundant raptor with 29 individuals observed. Two observations were notable in 2009. First, a great-horned owl (*Bubo virginianus*) was observed, which is only the fourth observation of that species since 1994. Second, only 15 loggerhead

shrikes (*Lanius ludovicianus*) were observed in 2009. As only 6 loggerhead shrikes were observed in 2008, the past two years have been substantially lower than the average of 33 loggerhead shrikes per year between 1985 and 2007.

The corvids include ravens and crows (*Corvus* spp.) and magpies (*Pica* spp.). The common raven (*C. corax*) was the most abundant species within this assemblage with 69 individuals observed. Although the number of raven observations has been higher in recent years than prior to 2002, the number observed in 2009 was the lowest abundance since 2004. Since egg predation by ravens can negatively impact sage-grouse nest success, it will be important to continue to monitor closely 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 3.8% ($n = 195$) of the total observations in 2009. The barn swallow (*Hirundo rustica*) was the most abundant species observed in this assemblage (82 individuals), followed by European starlings (64 individuals).

Waterfowl

Waterfowl are commonly observed during the BBSs, even though little standing water exists on the INL Site. With the exception of the ephemeral Big Lost River and 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 28 individuals from five waterfowl species, representing 0.6% of total observations. As in 2008, the number of waterfowl recorded was primarily driven by observations of mallards (*Anas platyrhynchos*, $n = 14$) from five facility routes.

Shorebirds

We observed 43 individuals representing five species from the shorebird assemblage, which accounted for 0.8% 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 (*Larus pipixcan*, $n = 26$) and killdeer (*Charadrius vociferous*, $n = 13$) comprised nearly all observations. As in 2008, all Franklin's gulls were recorded on the Tractor Flats route. The close proximity of the Tractor Flats route to agricultural areas near Mud Lake is probably why so many gulls were observed.

Other Birds

Five bird species that were not assigned to any species assemblage were observed in 2009. These include the bank swallow (*Riparia riparia*), violet-green swallow (*Tachycineta thalassina*), northern mockingbird (*Mimus polyglottos*), western tanager (*Piranga ludoviciana*), and American goldfinch (*Carduelis tristis*). Most of these species have been rarely observed during past BBSs; however, from 1985 to 2003, bank swallows were consistently observed each

year (mean = 13). During the past 7 years, bank swallows have been observed during two surveys (in 2004 and 2009). Thus, the low number of bank swallow observations in recent years may indicate that the population is in decline on INL Site survey routes.

Bird Abundance Correlation

Bird abundance was negatively correlated ($r_s = -0.44$, $n = 23$, $P < 0.05$) with mean June temperature (Figure 4). This result supports previous finding 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.

Total precipitation in June was not significantly correlated with bird abundance ($r_{sc} = 0.29$, $n = 23$, $P > 0.10$; Figure 5). These results also support previous analyses (Belthoff and Ellsworth 1999). It is interesting that the relationship with June precipitation is not stronger since temperature and precipitation are environmental variables that are inversely related (i.e., in years

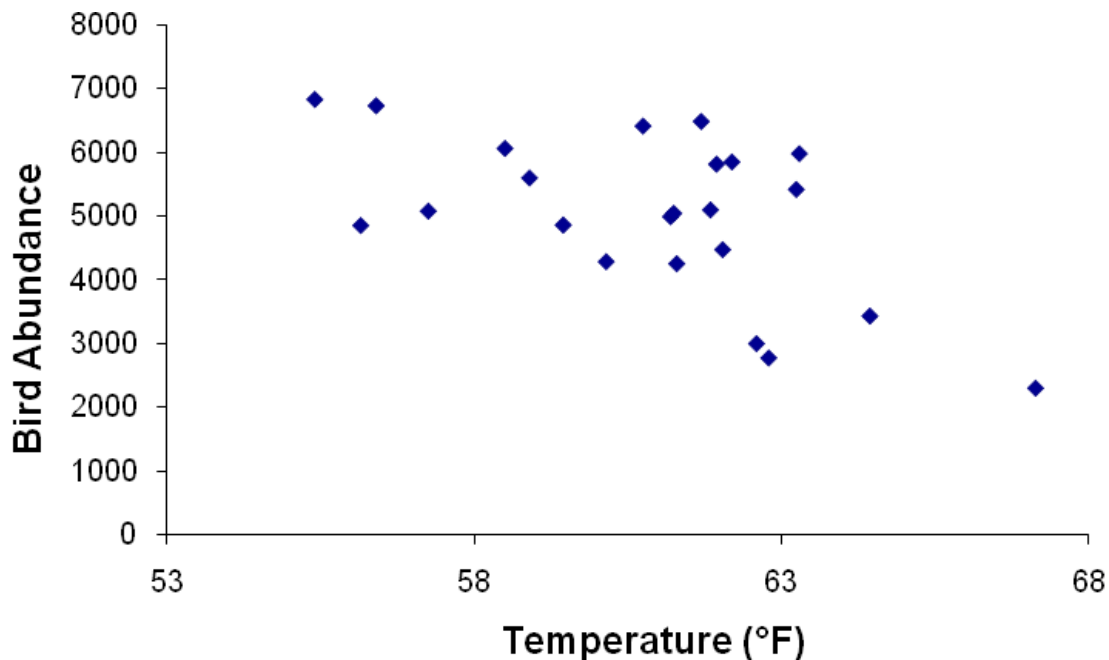


Figure 4. Relationship between bird abundance at the Idaho National Laboratory Site and the average June temperature recorded at the Central Facilities Area from 1985 to 2009.

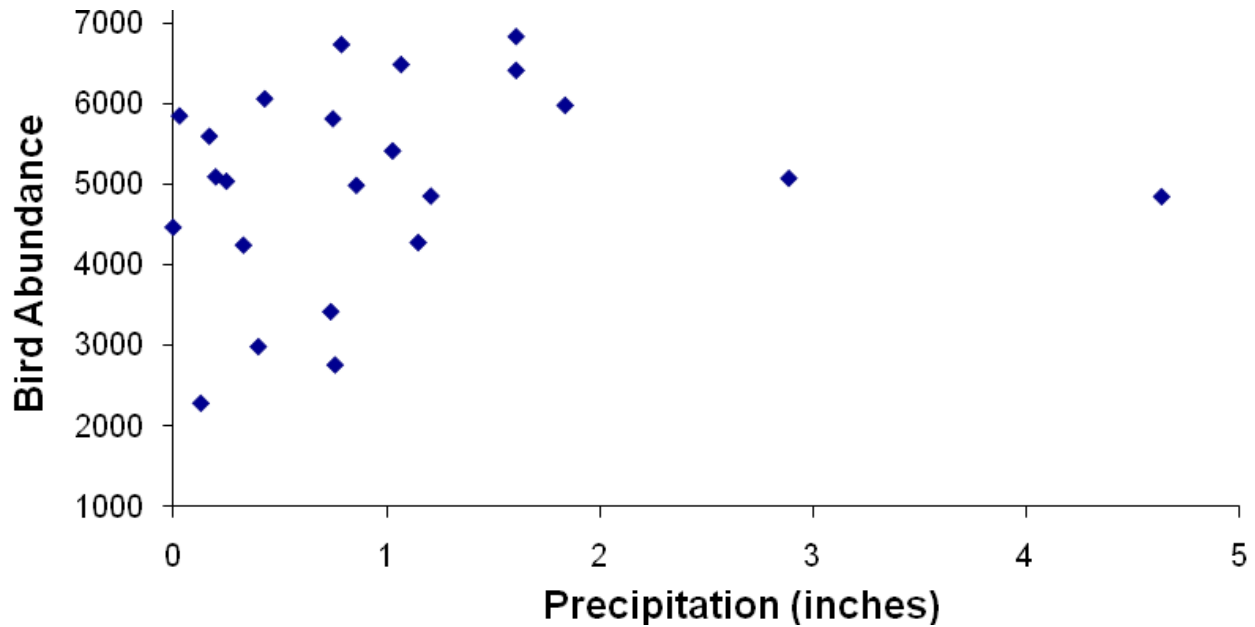


Figure 5. Relationship between bird abundance at the Idaho National Laboratory Site and total June precipitation recorded at the Central Facilities Area from 1985 to 2009.

where there is a lot of rainfall, temperatures are typically lower due to evaporative cooling). Although not statistically significant, there is a clear trend towards increased bird abundance as total June precipitation increases. Therefore, precipitation is an important variable to be considered when interpreting changes in annual BBS abundance.

Community Diversity Index

Based on both of Shannon's measures of diversity, the CFA facility route had the most diverse bird community of all 13 routes ($H = 2.52$, $E_H = 0.81$; Table 3), followed closely by RWMC ($H = 2.41$, $E_H = 0.79$). Tractor Flats had the highest species richness ($n = 27$), but tied for the lowest equitability score ($E_H = 0.60$) because not only did 63% of species have an abundance <10 , the two most abundant species also had over 200 observations each (Appendix A). Kyle Canyon had the most diverse bird community among remote routes based on both of Shannon's indicators ($H = 2.21$, $E_H = 0.70$). The TAN route had the lowest diversity among facility routes by all three measures (richness = 12; $H = 1.57$; $E_H = 0.63$) and Circular Butte was the least diverse among remote routes based on richness and H . Overall, TAN was the least diverse of all routes, although two routes have slightly lower equitability scores.

Over the past three years, CFA is the only route that has been among the top three in regards to diversity each year. RWMC, INTEC, and NRF have been among the three most diverse during two of the past three years. During the same time, Tractor Flats has had the highest or second highest species richness.

Table 3. Values for species richness, Shannon Diversity (H) and Equitability (E_H) indices for the 2009 Idaho National Laboratory Site Breeding Bird Surveys.

Route	Species Richness	Shannon's H	Shannon's E_H
Circular Butte	13	1.68	0.65
Kyle Canyon	23	2.21	0.70
Lost River	17	1.69	0.60
Tractor Flats	27	1.99	0.60
Twin Buttes	23	1.98	0.63
CFA	23	2.52	0.81
INTEC	18	2.04	0.71
MFC	23	2.22	0.71
NRF	16	2.06	0.74
PBF	16	1.84	0.66
ATR	20	1.91	0.64
RWMC	21	2.41	0.79
TAN	12	1.57	0.63

2.0 SUMMARY

As in most previous years, birds belonging to shrub-steppe and grassland community assemblages dominated observations during the 2009 BBSs on the INL Site. The total number of birds observed ($n = 5,072$) and species richness ($n = 55$) from all routes was similar to INL Site averages since 1985. Following patterns of abundance from previous BBSs on the INL Site, horned larks were the most abundant species, followed by western meadowlark, Brewer's sparrow, sage thrasher, and sage sparrow. These five species have been consistently among the most abundant species each year of the BBSs. This is good news 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 high.

Species considered imperiled or critically imperiled in Idaho that were seen during 2009 include: the long-billed curlew, Franklin's gull, and grasshopper sparrow. Other observations of non-imperiled, yet rarely seen birds on the INL Site included American goldfinch, western tanager, northern mockingbird, and northern pintail.

2.1 FUTURE DATA ANALYSIS

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. The results of such an analysis will be submitted to a peer-reviewed journal for publication and will be included in an annual report to the U.S. Department of Energy.

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 site. Little is known, however, concerning responses of bird populations to alterations of habitat composition and distribution across the landscape (Knick and Rotenberry 2002) 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 change 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, such as Morisita's index (Morisita 1959), 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.

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Appendix A

SUMMARY OF SPECIES BY ROUTE 2009

Survey Route: **RWMC**
 Survey Date: **June 18, 2009**

Species	Abundance	Percentage
Barn Swallow	43	20.6
Cliff Swallow	38	18.2
Western Meadowlark	24	11.5
Brewer's Sparrow	18	8.6
Horned Lark	17	8.1
Sage Thrasher	17	8.1
European Starling	13	6.2
Sage Sparrow	12	5.7
Rock Wren	6	2.9
Common Nighthawk	3	1.4
Mallard	3	1.4
Common Raven	2	1.0
Killdeer	2	1.0
Mourning Dove	2	1.0
Red-winged Blackbird	2	1.0
Yellow-headed blackbird	2	1.0
Blue-winged Teal	1	0.5
Loggerhead Shrike	1	0.5
Mountain Bluebird	1	0.5
Say's Phoebe	1	0.5
Wilson's Phalarope	1	0.5
<i>Total Individuals</i>	<i>209</i>	
<i>Total Species</i>	<i>21</i>	

Survey Route: **PBF**
 Survey Date: **June 9, 2009**

Species	Abundance	Percentage
Western Meadowlark	87	32.3
Brewer's Sparrow	64	23.8
Sage Thrasher	53	19.7
Horned Lark	24	8.9
Brown-headed Cowbird	11	4.1
Sage Sparrow	21	3.3
Mourning Dove	8	3.0
American Kestrel	2	0.7
Common Raven	2	0.7
Grasshopper Sparrow	2	0.7
Rock Wren	2	0.7
American Robin	1	0.4
Barn Swallow	1	0.4
Loggerhead Shrike	1	0.4
Red-tailed Hawk	1	0.4
Say's Phoebe	1	0.4

<i>Total Individuals</i>	<i>269</i>
<i>Total Species</i>	<i>16</i>

Survey Route: **TAN**
Survey Date: **June 29, 2009**

Species	Abundance	Percentage
Horned Lark	250	46.8
Sage Sparrow	87	16.3
Brewer's Sparrow	73	13.7
Sage Thrasher	61	11.4
Vesper Sparrow	41	7.7
Barn Swallow	9	1.7
Western Meadowlark	4	0.7
Mourning Dove	3	0.6
Northern harrier	2	0.4
Red-tailed Hawk	2	0.4
Common Raven	1	0.2
Say's Phoebe	1	0.2

<i>Total Individuals</i>	<i>534</i>
<i>Total Species</i>	<i>12</i>

Survey Route: **ATR**
 Survey Date: **June 19, 2009**

Species	Abundance	Percentage
Horned Lark	123	38.9
Western Meadowlark	64	20.3
Brewer's Sparrow	45	14.2
Sage Thrasher	31	9.8
Northern Rough-winged Swallow	12	3.8
Brewer's Blackbird	7	2.2
Vesper Sparrow	6	1.9
Common Raven	4	1.3
Mourning Dove	4	1.3
Sage Sparrow	3	0.9
American Goldfinch	2	0.6
Barn Swallow	2	0.6
Gadwall	2	0.6
Killdeer	2	0.6
Mallard	2	0.6
Red-tailed Hawk	2	0.6
Red-winged blackbird	2	0.6
Common Nighthawk	1	0.3
House Finch	1	0.3
Say's Phoebe	1	0.3
<i>Total Individuals</i>	<i>316</i>	
<i>Total Species</i>	<i>20</i>	

 Survey Route: **Circular Butte**

 Survey Date: **June 4, 2009**

Species	Abundance	Percentage
Western Meadowlark	204	33.9
Horned Lark	168	28.0
Brewer's Sparrow	110	18.3
Sage Thrasher	46	7.7
Sage Sparrow	31	5.2
Mourning Dove	23	3.8
Common Raven	5	0.8
Brown-headed Cowbird	4	0.7
Loggerhead Shrike	4	0.5
Common Nighthawk	2	0.3
Golden Eagle	2	0.3
Red-tailed Hawk	2	0.3
Rock Wren	1	0.2

Total Individuals *601*

Total Species *13*

Survey Route: **Lost River**
 Survey Date: **June 25, 2009**

Species	Abundance	Percentage
Horned Lark	238	46.3
Brewer's Sparrow	98	19.1
Western Meadowlark	61	11.9
Sage Thrasher	40	7.8
Sage Sparrow	34	6.6
Common Nighthawk	8	1.6
Mourning Dove	8	1.6
Vesper Sparrow	8	1.6
Rock Wren	5	1.0
Red-tailed Hawk	4	0.8
Common Raven	3	0.6
Loggerhead Shrike	2	0.4
Brewer's Blackbird	1	0.2
Ferruginous Hawk	1	0.2
Great-horned Owl	1	0.2
Northern Harrier	1	0.2
Swainson's Hawk	1	0.2
<i>Total Individuals</i>	<i>514</i>	
<i>Total Species</i>	<i>17</i>	

 Survey Route: **Tractor Flats**

 Survey Date: **June 3, 2009**

Species	Abundance	Percentage
Horned Lark	255	35.0
Western Meadowlark	209	28.7
Brewer's Sparrow	70	9.6
Sage Thrasher	35	4.8
Mourning Dove	30	4.1
Franklin's Gull	26	3.6
Brown-headed Cowbird	16	2.2
Common Raven	16	2.2
Sage Sparrow	15	2.1
Black-billed Magpie	11	1.5
Bank Swallow	7	1.0
Red-tailed Hawk	7	1.0
Red-winged Blackbird	6	0.8
Northern Harrier	5	0.7
Short-eared Owl	3	0.4
Violet-green Swallow	3	0.4
Barn Swallow	2	0.3
Long-billed Curlew	2	0.3
Rock Dove	2	0.3
Chipping Sparrow	1	0.1
Grasshopper Sparrow	1	0.1
Killdeer	1	0.1
Prairie Falcon	1	0.1
Vesper Sparrow	1	0.1
Western Kingbird	1	0.1
Willet	1	0.1
Yellow-headed blackbird	1	0.1
<hr/>		
<i>Total Individuals</i>	<i>728</i>	
<i>Total Species</i>	<i>27</i>	

Survey Route: **Twin Buttes**
 Survey Date: **June 10, 2009**

Species	Abundance	Percentage
Western Meadowlark	169	31.9
Horned Lark	124	23.4
Brewer's Sparrow	72	13.6
Sage Thrasher	69	13.0
Sage Sparrow	32	6.0
Common Raven	12	2.3
Mourning Dove	9	1.7
Red-tailed Hawk	6	1.1
Violet-green Swallow	6	1.1
Brown-headed Cowbird	4	0.8
Ferruginous Hawk	4	0.8
Loggerhead Shrike	4	0.8
Gray Flycatcher	3	0.6
Rock Wren	3	0.6
Vesper Sparrow	3	0.6
Common Nighthawk	2	0.4
Swainson's Hawk	2	0.4
American Robin	1	0.2
Barn Swallow	1	0.2
Brewer's Blackbird	1	0.2
Golden Eagle	1	0.2
Northern Harrier	1	0.2
Short-eared Owl	1	0.2
<i>Total Individuals</i>	<i>530</i>	
<i>Total Species</i>	<i>23</i>	

Survey Route: CFA
 Survey Date: June 24, 2009

Species	Abundance	Percentage
Horned Lark	52	15.0
Sage Thrasher	47	13.6
Brewer's Sparrow	46	13.3
Western Meadowlark	46	13.3
European Starling	45	13.0
Sage Sparrow	21	6.1
Barn Swallow	14	4.0
Brewer's Blackbird	12	3.5
Common Raven	11	3.2
American Robin	8	2.3
House Finch	8	2.3
Say's Phoebe	7	2.0
American Kestrel	6	1.7
Mallard	6	1.7
Common Nighthawk	4	1.2
House Sparrow	4	1.2
Brown-headed Cowbird	2	0.6
Mourning Dove	2	0.6
Killdeer	1	0.3
Loggerhead Shrike	1	0.3
Red-tailed Hawk	1	0.3
Rock Wren	1	0.3
Swainson's Hawk	1	0.3
<i>Total Individuals</i>	<i>346</i>	
<i>Total Species</i>	<i>23</i>	

Survey Route: **INTEC**
 Survey Date: **June 26, 2009**

Species	Abundance	Percentage
Brewer's Sparrow	61	34.7
Horned Lark	28	15.9
Sage Thrasher	24	13.6
Western Meadowlark	22	12.5
Sage Sparrow	13	7.4
Brewer's Blackbird	7	4.0
Common Nighthawk	4	2.3
Common Raven	4	2.3
Barn Swallow	3	1.7
American Kestrel	2	1.1
Brown-headed Cowbird	1	0.6
House Sparrow	1	0.6
Killdeer	1	0.6
Mallard	1	0.6
Rock Wren	1	0.6
Say's Phoebe	1	0.6
Swainson's Hawk	1	0.6
Vesper Sparrow	1	0.6
<i>Total Individuals</i>	<i>176</i>	
<i>Total Species</i>	<i>18</i>	

Survey Route: Kyle Canyon
 Survey Date: June 30, 2009

Species	Abundance	Percentage
Sage Sparrow	87	21.5
Horned Lark	78	19.3
Western Meadowlark	58	14.3
Brewer's Sparrow	53	13.1
Sage Thrasher	44	10.9
Vesper Sparrow	35	8.6
Mourning Dove	12	3.0
Ferruginous Hawk	10	2.5
Black-billed Magpie	3	0.7
Gray Flycatcher	3	0.7
Blue-gray Gnatcatcher	2	0.5
Chipping Sparrow	2	0.5
Common Raven	2	0.5
Golden Eagle	2	0.5
Loggerhead Shrike	2	0.5
Prairie Falcon	2	0.5
Red-tailed Hawk	2	0.5
Say's Phoebe	2	0.5
Swainson's Hawk	2	0.5
Brown-headed Cowbird	1	0.2
Mountain Bluebird	1	0.2
Northern Mockingbird	1	0.2
Rock Wren	1	0.2
<i>Total Individuals</i>	<i>405</i>	
<i>Total Species</i>	<i>23</i>	

Survey Route: **NRF**
 Survey Date: **June 23, 2009**

Species	Abundance	Percentage
Horned Lark	66	27.7
Western Meadowlark	47	19.7
Sage Thrasher	39	16.4
Brewer's Sparrow	23	9.7
Sage Sparrow	22	9.2
Vesper Sparrow	12	5.0
Brown-headed Cowbird	7	2.9
Common Raven	6	2.5
Yellow-headed Blackbird	6	2.5
Barn Swallow	4	1.7
Grasshopper Sparrow	1	0.4
Mourning Dove	1	0.4
Red-tailed Hawk	1	0.4
Rock Dove	1	0.4
Say's Phoebe	1	0.4
Short-eared Owl	1	0.4
<hr/>		
<i>Total Individuals</i>	<i>238</i>	
<i>Total Species</i>	<i>16</i>	

Survey Route: **MFC**
 Survey Date: **June 8, 2009**

Species	Abundance	Percentage
Western Meadowlark	76	36.9
Horned Lark	43	20.9
Brewer's Blackbird	14	6.8
Brewer's Sparrow	10	4.9
Sage Thrasher	10	4.9
European Starling	6	2.9
Gadwall	6	2.9
Killdeer	6	2.9
American Robin	4	1.9
Brown-headed Cowbird	4	1.9
Mourning Dove	4	1.9
Western Tanager	4	1.9
Barn Swallow	3	1.5
Northern Shoveler	3	1.5
Say's Phoebe	3	1.5
Mallard	2	1.0
Northern Pintail	2	1.0
Common Raven	1	0.5
Loggerhead Shrike	1	0.5
Northern Harrier	1	0.5
Red-tailed Hawk	1	0.5
Red-winged blackbird	1	0.5
Sage Sparrow	1	0.5
<i>Total Individuals</i>	<i>206</i>	
<i>Total Species</i>	<i>23</i>	