2011 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 2011, we conducted surveys from June 9 to June 29 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 3,171 birds from 48 species during these surveys. Bird abundance was less than the 1985-2011 average of 4,970 birds, and the number of species (i.e., species richness) was lower than the 25-year average of 58.

Compared with past surveys, we observed similar patterns of bird abundance among those species that are typically the most numerous. In 2011, the six species that were documented in greatest abundance were horned lark (*Eremophila alpestris*, n = 838), western meadowlark (*Sturnella neglecta*, n = 622), Brewer's sparrow (*Spizella breweri*, n = 449), sage thrasher (*Oreoscoptes montanus*, n = 340), sage sparrow (*Amphispiza belli*, n = 237), and Franklin's gull (*Larus pipixcan*, n = 147). During 25 years of breeding bird surveys on the INL Site, with the exception of the Franklin's gull, these species have been the five most abundant 18 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 three 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 2011. One species was observed during the surveys that had been recorded in ≤ 6 of the past 25 years. This species was the house wren (*Troglodytes aedon*).

Species observed during the 2011 BBS that are considered imperiled or critically imperiled in Idaho included the Franklin's gull (n = 147), burrowing owl (*Athene cunicularia*, n = 3), and greater sage-grouse (*Centrocercus urophasianus,* n = 3).

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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. 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 pathways have been proposed and discussed for exploring and analyzing BBS data (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 2011 BBS and compares species abundance across survey routes with long-term averages.

1.1 STUDY AREA

The INL Site encompasses almost 900 mi^2 (2,315 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 relief occurs around East and Middle Buttes and the southern portion of the Lemhi Mountains located near the northwest corner of the INL Site.

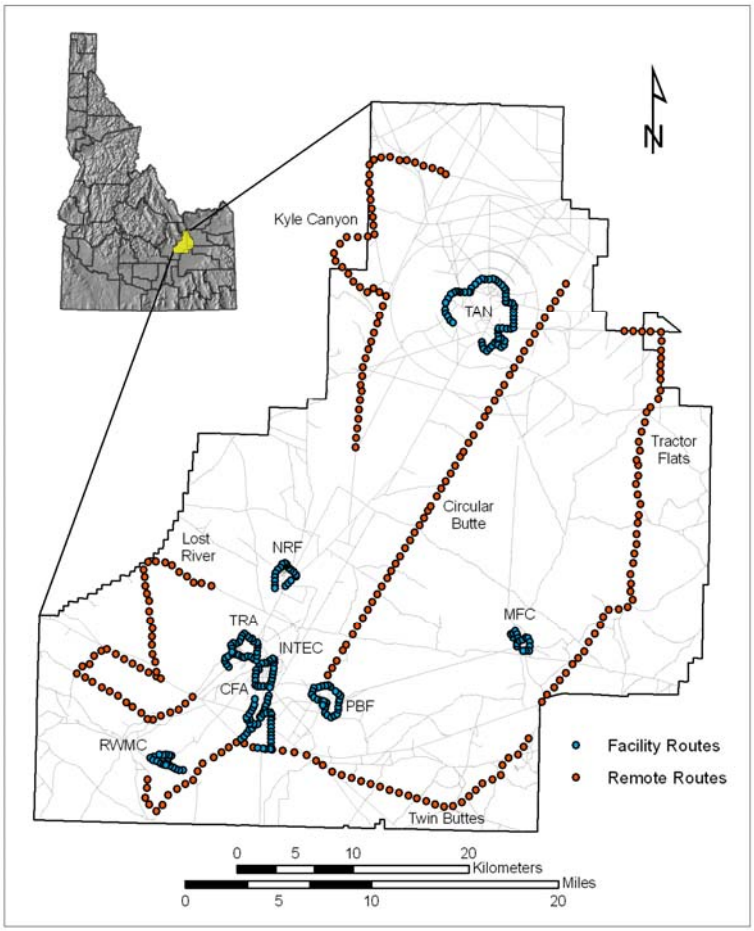

Figure 1. Location of Breeding Bird Survey routes on the Idaho National Laboratory Site. Blue dots represent survey points along facility routes and red dots represent the same for remote routes.

More information regarding the climate, geology, and vegetation communities on the INL Site is described in Shive et al. (2011). 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 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. 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 (*Artemisia* spp.). The most common native grasses are streambank wheatgrass (*Elymus lanceolatus*), 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 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 9 to June 29, 2011, 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 completed. 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 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 (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 $(r_s)_c$.

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

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

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 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 is an accurate representation of the local bird community.

1.3 RESULTS AND DISCUSSION

Summary Statistics

We documented 3,171 birds during the 2011 survey (Appendix A), which was lower than the average from 1985 to 2011 of 4,970 birds (Figure 2). Species richness of all BBS routes consisted of 48 species, which was lower than the historic average of 58 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 707 individuals, which is higher than other remote routes.

Horned lark (*Eremophila alpestris*) was the most abundant species counted during the 2011 survey with 838 individuals representing 26.4% of all observations (Table 2). This species was observed at 69.5% (344) 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.

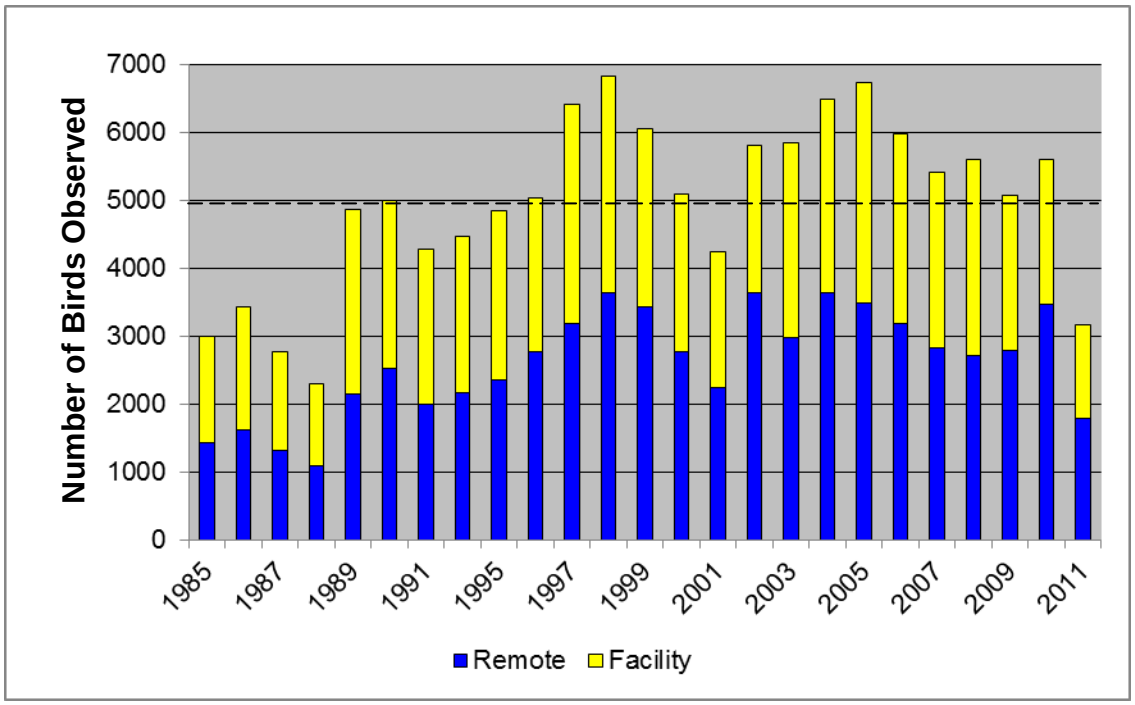

Figure 2. Number of birds observed during the Breeding Bird Survey on the Idaho National Laboratory Site. The dashed black line indicates the mean number of birds observed from 1985 to 2011. No BBSs were conducted on the INL Site in 1992 or 1993.

The six most abundant birds we observed were horned lark (n = 838), western meadowlark (*Sturnella neglecta*, n = 622), Brewer's sparrow (*Spizella breweri*, n = 449), sage thrasher (*Oreoscoptes montanus*, n = 340), sage sparrow (*Amphispiza belli*, n = 237), and Franklin's gull (*Larus pipixcan*, n = 147). These six species consisted of > 82% of all observations made in 2011 and they, with the exception of Franklin's gull and sage sparrow, were observed on every remote and facility route (Table 2, Appendix A). Sage sparrow was observed on every remote route and on seven of the facility routes. In the 25 years of INL Site breeding bird surveys, these five species, with the exception of Franklin's gull, have been the most abundant 18 times, and in the remaining seven 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 2011 for Breeding Bird Survey routes on the Idaho National Laboratory Site.

Route	Stops	# Species	Abundance
Remote Routes			
Lost River	50	12	272
Circular Butte	50	14	366
Kyle Canyon	50	21	339
Tractor Flats	50	27	534
Twin Buttes	50	17	273
Subtotal	**250**	**35***	**1784**
Facility Routes			
CFA	42	19	184
INTEC	25	9	139
MFC	18	13	90
NRF	20	10	150
PBF	28	15	166
ATRC	32	12	229
RWMC	20	21	127
TAN	60	15	302
Subtotal	**245**	**34***	**1387**
Total	**495**	**48**	**3171**

*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 2011 BBS that are considered imperiled or critically imperiled in Idaho by the Idaho Department of Fish and Game (2005). These include the burrowing owl (*Athene cunicularia*, $n = 3$), Franklin's gull ($n = 147$), and greater sage-grouse (*Centrocercus urophasianus, n = 3*).

Last year's survey, Franklin's gull numbers were the highest since 2002, when there were 764 birds observed. This year was the lowest recorded since 2009, when 26 birds were observed. 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 2011 Breeding Bird Survey on the Idaho National Laboratory Site.

Common Name	Scientific Name	n	%	Routes[1]	Stops[2]	%[3]
Horned Lark	*Eremophila alpestris*	838	26.43	5,8	344	69.49
Western Meadowlark	*Sturnella neglecta*	622	19.62	5,8	345	69.70
Brewer's Sparrow	*Spizella breweri*	449	14.16	5,8	257	51.92
Sage Thrasher	*Oreoscoptes montanus*	340	10.72	5,8	260	52.53
Sage Sparrow	*Amphispiza belli*	237	7.47	5,7	175	35.35
Franklin's Gull	*Larus pipixcan*	147	4.64	1,0	4	0.81
Mourning Dove	*Zenaida macroura*	99	3.12	5,6	44	8.89
Common Raven	*Corvus corax*	63	1.99	5,7	44	8.89
Vesper Sparrow	*Pooecetes gramineus*	53	1.67	4,4	36	7.27
Barn Swallow	*Hirundo rustica*	36	1.14	2,5	17	3.43
European Starling	*Sturnus vulgaris*	31	0.98	1,4	12	2.42
Brewer's Blackbird	*Euphagus cyanocelphalus*	32	1.01	4,4	15	3.03
Brown-headed Cowbird	*Molothrus ater*	28	0.88	4,3	28	5.66
Chipping Sparrow	*Spizella passerina*	19	0.60	2,1	11	2.22
Common Nighthawk	*Chordeiles minor*	16	0.50	4,5	15	3.03
Loggerhead Shrike	*Lanius ludovicianus*	15	0.47	4,2	14	2.83
Ferruginous Hawk	*Buteo regalis*	14	0.44	3,0	9	1.82
American Robin	*Turdus migratorius*	13	0.41	0,4	8	1.62
Northern Harrier	*Circus cyaneus*	13	0.41	3,3	10	2.02
Killdeer	*Charadrius vociferus*	10	0.32	1,3	9	1.82
Mallard	*Anas platyrhynchos*	9	0.28	0,1	2	0.40
Black-billed Magpie	*Pica pica*	8	0.25	2,0	6	1.21
Gadwall	*Anas strepera*	8	0.25	0,2	2	0.40
Swainson's Hawk	*Buteo swainsoni*	8	0.25	4,0	7	1.41
Gray Flycatcher	*Empidonax wrightii*	6	0.19	1,0	4	0.81
Red-tailed Hawk	*Buteo jamaicensis*	6	0.19	3,3	6	1.21
Cliff Swallow	*Hirundo pyrrhonota*	5	0.16	0,1	1	0.20
Say's Phoebe	*Sayornis saya*	5	0.16	0,4	4	0.81
Western Kingbird	*Tyrannus verticalis*	5	0.16	2,1	4	0.81
Red-winged Blackbird	*Agelaius phoeniceus*	4	0.13	0,2	3	0.61
Rock Wren	*Salpinctes obsoletus*	4	0.13	0,2	4	0.81
Willet	*Catoptrophorus semipalmatus*	4	0.13	1,0	3	0.61
Burrowing Owl	*Athene cunicularia*	3	0.09	1,1	3	0.61
Greater Sage-Grouse	*Centrocercus urophasianus*	3	0.09	1,0	1	0.20
American Kestrel	*Falco sparverius*	2	0.06	0,1	1	0.20
Golden Eagle	*Aquila chrysaetos*	2	0.06	1,1	2	0.40
House Wren	*Troglodytes aedon*	2	0.06	0,1	1	0.20
Mountain Bluebird	*Sialia currucoides*	2	0.06	1,0	1	0.20
American Crow	*Corvus brachyrhynchos*	1	0.03	1,0	1	0.20

Common Name	Scientific Name	n	%	Routes[1]	Stops[2]	%[3]
Blue-gray Gnatcatcher	*Polioptila caerulea*	1	0.03	1,0	1	0.20
Bullock's Oriole	*Icterus bullockii*	1	0.03	0,1	1	0.20
California Gull	*Larus californicus*	1	0.03	0,1	1	0.20
Lark Sparrow	*Chondestes grammacus*	1	0.03	1,0	1	0.20
Northern Flicker	*Colaptes auratus*	1	0.03	0,1	1	0.20
Prairie Falcon	*Falco mexicanus*	1	0.03	1,0	1	0.20
Rock Pigeon	*Columba livia*	1	0.03	0,1	1	0.20
Savannah Sparrow	*Passerculus sandwichensis*	1	0.03	1,0	1	0.20
Western Tanager	*Piranga ludoviciana*	1	0.03	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.

Observations of non-imperiled species in 2011 that have rarely been observed during BBSs on the INL Site included house wrens (*Troglodytes aedon*). This species was last observed in 2005.

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 55% 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 32.5% 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 2011 with 1,737 individuals (54.8%). Common shrub-steppe/grassland species include horned lark, western meadowlark,

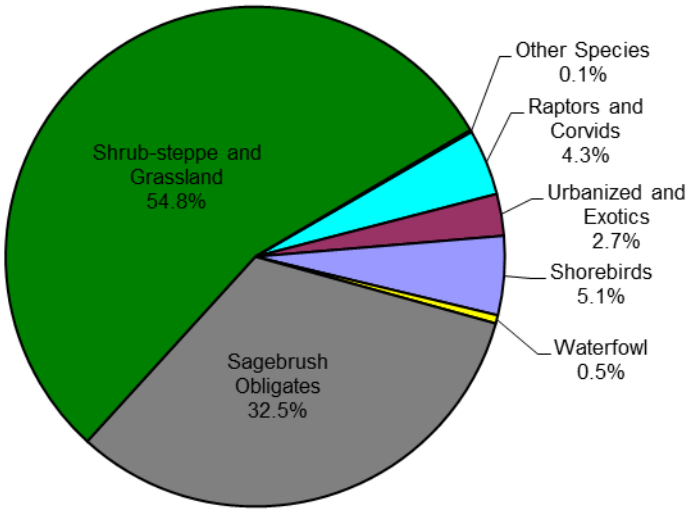

Figure 3. Summary of species assemblage for Breeding Bird Surveys of remote and facility routes on the Idaho National Laboratory Site in 2011.

brown-headed cowbird (*Molothrus ater*), and vesper sparrow (*Pooecetes gramineus*). Horned lark (n = 838) and western meadowlark (n = 622) 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 2011 have averaged 1,570 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 1,029 individuals (32.5% of total). This assemblage includes Brewer's sparrow, sage sparrow, sage thrasher, and greater sage-grouse. Brewer's sparrow was the most abundant sagebrush obligate with 449 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 136 observations representing 4.3% of the total count. Among these were nine species of raptors (eagles, hawks, falcons, and owls). Ferruginous hawk (*Buteo regalis*) was the most abundant raptor with 14 individuals observed. Observations that were notable in 2011 included the 15 loggerhead shrikes (*Lanius ludovicianus*) that were observed. While still lower than the average of 33 loggerhead shrikes per year between

1985 and 2007, it is comparable to the average of 14 loggerhead shrikes per year between 2008 and 2010.

The corvids include ravens (*Corvus* spp.), crows (*Corvus* spp.), and magpies (*Pica* spp.). The common raven (*C. corax*) was the most abundant species within this assemblage with 63 individuals observed. The number observed in 2011 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 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 2.7% (n = 86) of the total observations in 2011. The barn swallow (*Hirundo rustica*) was the most abundant species observed in this assemblage (36 individuals), followed by European starlings (31 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 17 individuals from two waterfowl species, mallards (*Anas platyrynchos*, n = 9) and gadwall (*A. strepera*, n = 8), representing 0.5% of total observations. As in past years the mallards and gadwall were observed along the facility routes.

Shorebirds

We observed 162 individuals representing four species from the shorebird assemblage, which accounted for 5.1% 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 = 147), killdeer (*Charadrius vociferous,* n = 10), and willet (*Catoptrophorus semipalmatus,* n = 4) comprised nearly all observations. The Franklin's gulls were recorded along the Tractor Flats Route. The close proximity of the Tractor Flats Route to agricultural areas near Mud Lake is probably why so many gulls (n = 147) were observed.

Other Birds

Three bird species that were not assigned to any species assemblage were observed in 2011. These include the house wren, western tanager (*Piranga ludoviciana*), and Bullock's oriole (*Icterus bullockii*). Most of these species have been rarely observed during past breeding bird surveys. Bullock's orioles have been observed during 10 of 25 years of surveys. Western tanagers were observed during 8 of the 25 years of surveys. House wrens have been observed during 3 of the 25 years of surveys.

Bird Abundance Correlation

Bird abundance was marginally negatively correlated (r_s = -0.34, n = 25, P = 0.08) 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.

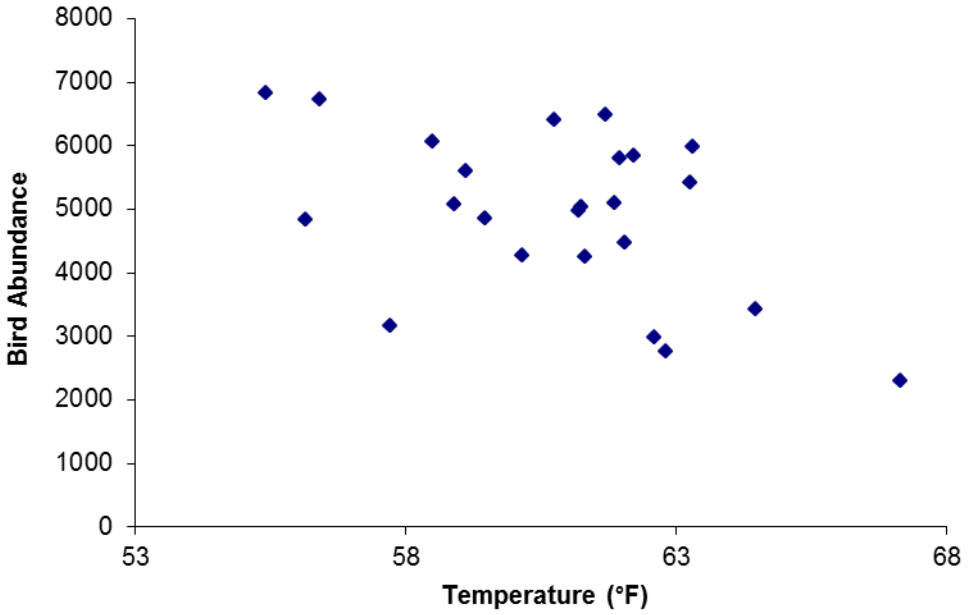

Figure 4. Relationship between bird abundance at the Idaho National Laboratory Site and the average June temperature recorded at the Central Facilities Area from 1985 to 2011.

Total precipitation in June was not significantly correlated with bird abundance (r_{sc} = 0.30, n = 25, P = 0.14; Figure 5). These results also support previous analyses (Betlhoff 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 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.

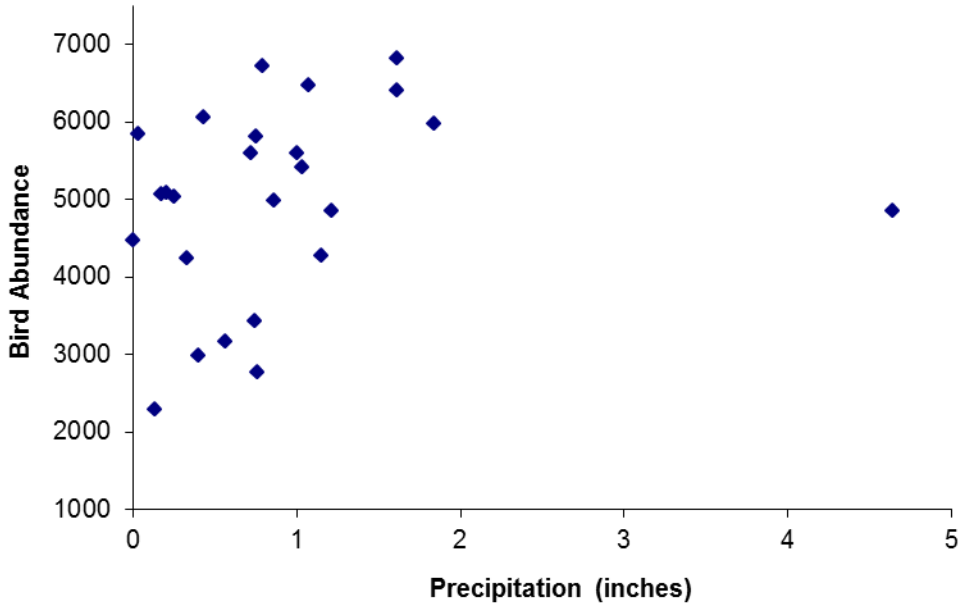

Figure 5. Relationship between bird abundance at the Idaho National Laboratory Site and total June precipitation recorded at the Central Facilities Area from 1985 to 2011.

Community Diversity Index

Based on both of Shannon's measures of diversity, the RWMC facility route had the most diverse bird community of all 13 routes (H = 2.64, E_H = 0.87; Table 3), followed by CFA facility route (H = 2.38, E_H = 0.82). Tractor Flats had the highest species richness (n = 27), but had the third lowest equitability score (E_H = 0.66) because not only did 70% of species have an abundance <10, the two most abundant species also had close to 45% of the individuals observed on the route (Appendix A). Kyle Canyon had the most diverse bird community among remote routes based on both of Shannon's indicators (H = 2.19, E_H = 0.72). The ATRC Route had the lowest diversity among facility routes based on Shannon's measures of diversity (H = 1.61; E_H = 0.65), and Lost River was the least diverse among remote routes based on richness and H (n = 12; H = 1.66). Overall, ATRC was the least diverse of all routes, although one route had slightly lower equitability scores.

Over the past four 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 three of the past five 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 2011 Idaho National Laboratory Site Breeding Bird Surveys.

Route	Species Richness	Shannon's H	Shannon's E_H
Remote Routes			
Circular Butte	14	1.94	0.73
Kyle Canyon	21	2.19	0.72
Lost River	12	1.66	0.67
Tractor Flats	27	2.18	0.66
Twin Buttes	17	2.13	0.75
Facility Routes			
CFA	18	2.38	0.82
INTEC	9	1.76	0.80
MFC	13	2.11	0.82
NRF	10	1.86	0.81
PBF	15	1.94	0.72
ATRC	12	1.61	0.65
RWMC	21	2.64	0.87
TAN	15	1.74	0.64

2.0 SUMMARY

As in most previous years, birds belonging to shrub-steppe and grassland community assemblages dominated observations during the 2011 BBS on the INL Site. The total number of birds observed (n = 3,171) and species richness (n = 48) from all routes was lower than the INL Site averages ($\bar{x}$ = 4,970; $\bar{x}$ = 58) 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, sage sparrow, and Franklin's gull. These species, with the exception of the Franklin's gull, have been consistently among the most abundant species each year of the BBS. 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 good.

Species considered imperiled or critically imperiled in Idaho that were seen during 2011 included the burrowing owl (n = 3), Franklin's gull (n = 147), and greater sage-grouse (n = 3). Other observations of non-imperiled, yet rarely seen birds on the INL Site included the house wren.

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.

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 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, 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 2011

Survey Route: RWMC
Survey Date: June 22, 2011

Species	Abundance	Percentage
Western Meadowlark	21	16.54
Sage Thrasher	17	13.39
Brewer's Sparrow	16	12.60
Barn Swallow	12	9.45
Horned Lark	9	7.09
Mallard	9	7.09
Sage Sparrow	8	6.30
Cliff Swallow	5	3.94
Gadwall	5	3.94
Common Raven	4	3.15
European Starling	4	3.15
Brown-headed Cowbird	3	2.36
Rock Wren	3	2.36
Mourning Dove	2	1.57
Red-winged Blackbird	2	1.57
Western Kingbird	2	1.57
Brewer's Blackbird	1	0.79
California Gull	1	0.79
Common Nighthawk	1	0.79
Red-tailed Hawk	1	0.79
Say's Phoebe	1	0.79
Total Individuals	*127*	
Total Species	*21*	

Survey Route: PBF
Survey Date: June 21, 2011

Species	Abundance	Percentage
Horned Lark	57	34.34
Western Meadowlark	33	19.88
Sage Thrasher	23	13.86
Brewer's Sparrow	17	10.24
Sage Sparrow	14	8.43
Mourning Dove	7	4.22
Chipping Sparrow	4	2.41
American Robin	2	1.20
Brown-headed Cowbird	2	1.20
Common Raven	2	1.20
Common Nighthawk	1	0.60
Loggerhead Shrike	1	0.60
Red-tailed Hawk	1	0.60
Rock Wren	1	0.60
Say's Phoebe	1	0.60
Total Individuals	*166*	
Total Species	*15*	

Survey Route: TAN
Survey Date: June 27, 2011

Species	Abundance	Percentage
Horned Lark	129	42.72
Brewer's Sparrow	49	16.23
Sage Sparrow	41	13.58
Sage Thrasher	35	11.59
Vesper Sparrow	19	6.29
Western Meadowlark	14	4.64
Common Raven	4	1.32
Northern Harrier	4	1.32
Barn Swallow	1	0.33
Burrowing Owl	1	0.33
Golden Eagle	1	0.33
Mourning Dove	1	0.33
Red-tailed Hawk	1	0.33
Rock Dove	1	0.33
Say's Phoebe	1	0.33
Total Individuals	*302*	
Total Species	*15*	

Survey Route: ATRC
Survey Date: June 14, 2011

Species	Abundance	Percentage
Horned Lark	94	41.05
Brewer's Sparrow	41	17.90
Western Meadowlark	57	24.89
Sage Thrasher	14	6.11
European Starling	5	2.18
Vesper Sparrow	5	2.18
Brewer's Blackbird	4	1.75
Common Raven	4	1.75
Red-winged blackbird	2	0.87
Bullock's Oriole	1	0.44
Mourning Dove	1	0.44
Northern Harrier	1	0.44
Total Individuals	*229*	
Total Species	*12*	

Survey Route: Circular Butte
Survey Date: June 15, 2011

Species	Abundance	Percentage
Western Meadowlark	115	31.42
Horned Lark	65	17.76
Brewer's Sparrow	60	16.39
Sage Thrasher	43	11.75
Sage Sparrow	41	11.20
Mourning Dove	12	3.28
Chipping Sparrow	10	2.73
Brown-headed Cowbird	4	1.09
Northern Harrier	4	1.09
Common Nighthawk	3	0.82
Common Raven	3	0.82
Loggerhead Shrike	3	0.82
Swainson's Hawk	2	0.55
Brewer's Blackbird	1	0.27
Total Individuals	*366*	
Total Species	*14*	

Survey Route: Lost River
Survey Date: June 28, 2011

Species	Abundance	Percentage
Horned Lark	130	47.79
Brewer's Sparrow	43	15.81
Western Meadowlark	37	13.60
Sage Thrasher	20	7.35
Sage Sparrow	16	5.88
Vesper Sparrow	8	2.94
Common Raven	7	2.57
Brewer's Blackbird	4	1.47
Ferruginous Hawk	3	1.10
Brown-headed Cowbird	2	0.74
Common Nighthawk	1	0.37
Mourning Dove	1	0.37
Total Individuals	*272*	
Total Species	*12*	

Survey Route: Tractor Flats
Survey Date: June 10, 2011

Species	Abundance	Percentage
Franklin's Gull	147	27.53
Western Meadowlark	91	17.04
Horned Lark	84	15.73
Mourning Dove	55	10.30
Brewer's Sparrow	52	9.74
Sage Thrasher	38	7.12
Sage Sparrow	14	2.62
Common Raven	11	2.06
Brewer's Blackbird	9	1.69
Black-billed Magpie	4	0.75
European Starling	4	0.75
Willet	4	0.75
Greater Sage-Grouse	3	0.56
Vesper Sparrow	3	0.56
Burrowing Owl	2	0.37
Western Kingbird	2	0.37
American Crow	1	0.19
Barn Swallow	1	0.19
Common Nighthawk	1	0.19
Ferruginous Hawk	1	0.19
Golden Eagle	1	0.19
Killdeer	1	0.19
Loggerhead Shrike	1	0.19
Northern Harrier	1	0.19
Red-tailed Hawk	1	0.19
Savannah Sparrow	1	0.19
Swainson's Hawk	1	0.19
Total Individuals	*534*	
Total Species	*27*	

Survey Route: Twin Buttes
Survey Date: June 16, 2011

Species	Abundance	Percentage
Western Meadowlark	71	26.01
Horned Lark	60	21.98
Sage Thrasher	39	14.29
Brewer's Sparrow	29	10.62
Sage Sparrow	18	6.59
Common Raven	16	5.86
Brown-headed Cowbird	12	4.40
Brewer's Blackbird	6	2.20
Mourning Dove	6	2.20
Loggerhead Shrike	4	1.47
Swainson's Hawk	3	1.10
Vesper Sparrow	3	1.10
Barn Swallow	2	0.73
Common Nighthawk	1	0.37
Northern Harrier	1	0.37
Prairie Falcon	1	0.37
Red-tailed Hawk	1	0.37
Total Individuals	*273*	
Total Species	*17*	

Survey Route: CFA
Survey Date: June 24, 2011

Species	Abundance	Percentage
Western Meadowlark	34	18.48
Horned Lark	32	17.39
Sage Thrasher	28	15.22
Brewer's Sparrow	19	10.33
European Starling	14	7.61
Barn Swallow	10	5.43
Sage Sparrow	8	4.35
American Robin	6	3.26
Mourning Dove	6	3.26
Brown-headed Cowbird	4	2.17
Common Nighthawk	4	2.17
Killdeer	4	2.17
Loggerhead Shrike	3	1.63
Vesper Sparrow	3	1.63
American Kestrel	2	1.09
Common Raven	2	1.09
House Wren	2	1.09
Say's Phoebe	2	1.09
Northern Flicker	1	0.54
Total Individuals	*184*	
Total Species	*19*	

Survey Route: INTEC
Survey Date: June 20, 2011

Species	Abundance	Percentage
Horned Lark	39	28.06
Brewer's Sparrow	32	23.02
Western Meadowlark	30	21.58
Sage Thrasher	15	10.79
Sage Sparrow	14	10.07
Brewer's Blackbird	4	2.88
Common Raven	2	1.44
Mourning Dove	2	1.44
Common Nighthawk	1	0.72
Total Individuals	*139*	
Total Species	*9*	

Survey Route: Kyle Canyon
Survey Date: June 13, 2011

Species	Abundance	Percentage
Horned Lark	76	22.42
Sage Sparrow	49	14.45
Sage Thrasher	37	10.91
Brewer's Sparrow	58	17.11
Western Meadowlark	62	18.29
Vesper Sparrow	8	2.36
Mourning Dove	6	1.77
Black-billed Magpie	4	1.18
Ferruginous Hawk	10	2.95
Loggerhead Shrike	3	0.88
Gray Flycatcher	6	1.77
Chipping Sparrow	5	1.47
Common Raven	5	1.47
Mountain Bluebird	2	0.59
Swainson's Hawk	2	0.59
Blue-gray Gnatcatcher	1	0.29
Brown-headed Cowbird	1	0.29
Lark Sparrow	1	0.29
Red-tailed Hawk	1	0.29
Western Kingbird	1	0.29
Western Tanager	1	0.29
Total Individuals	*339*	
Total Species	*21*	

Survey Route: NRF
Survey Date: June 29, 2011

Species	Abundance	Percentage
Horned Lark	43	28.67
Western Meadowlark	29	19.33
Brewer's Sparrow	27	18.00
Sage Thrasher	22	14.67
Sage Sparrow	13	8.67
Barn Swallow	7	4.67
Vesper Sparrow	4	2.67
Common Nighthawk	3	2.00
American Robin	1	0.67
Killdeer	1	0.67
Total Individuals	*150*	
Total Species	*10*	

Survey Route: MFC
Survey Date: June 9, 2011

Species	Abundance	Percentage
Western Meadowlark	28	31.11
Horned Lark	20	22.22
Brewer's Sparrow	6	6.67
Brewer's Blackbird	3	3.33
Sage Thrasher	9	10.00
Killdeer	4	4.44
American Robin	4	4.44
Gadwall	3	3.33
European Starling	4	4.44
Barn Swallow	3	3.33
Common Raven	3	3.33
Northern Harrier	2	2.22
Sage Sparrow	1	1.11
Total Individuals	*90*	
Total Species	*13*	