BIRD POPULATION TRENDS AND HABITAT TREATMENT EFFECTS AT THE LAS VEGAS WASH, 2005-2016

Prepared by:

Great Basin Bird Observatory
1755 E. Plumb Lane #256
Reno, NV 89502

Prepared for:

Las Vegas Wash Coordination Committee
Southern Nevada Water Authority
P.O. Box 99956
Las Vegas, NV 89193-9956

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Table of Contents

Abstract

In 2016, Great Basin Bird Observatory completed the eighth year of bird surveys and vegetation assessments along an 8.7 km stretch of the Las Vegas Wash (hereafter: Wash). This effort, conducted on the behalf of the Las Vegas Wash Coordination Committee (LVWCC), continues work done in the first four years (2005-2009) of the 11-year project by the San Bernardino County Museum. It accompanies the LVWCC's stabilization and enhancement project designed to prevent erosion and reclaim wetland and riparian habitat in the Wash. The project includes in-channel construction and habitat restoration, resulting in 19 weirs and impoundments to date, a major reduction of tamarisk cover and over 450 acres revegetated with native plants.

In this report, we summarize bird species occurrence, trends in richness and abundance, and effects of restoration activities on bird populations. In each of the eight years, bird surveys were completed year-round every two weeks using 29 (later amended to 31) permanently established survey points. Once a year, in the fall, vegetation assessments were conducted at each survey point.

A total of 209 bird species were recorded over the eight years, constituting approximately 43% of the total bird species richness recorded in Nevada. Of these, 50 are conservation priority species according to conservation rankings by regional bird initiatives.

Average species richness and total abundance increased significantly over the project period, particularly in the two most recent years of Wash surveys. Species-specific trends were mixed with seven species showing significant declines and nine showing significant increases over the study period. Several of the declining birds are riparian shrub-associated, and many of the species with increasing trends are marsh or water-dependent. We expect that with further recovery of native vegetation, even the species currently in decline – likely due to short-term treatment effects – will recover at the Wash in the long term.

When comparing bird species metrics among recently cleared/released/flooded sites, immature revegetation sites, and older revegetation sites, we found significant differences in richness ($P=0.085$), but no significant differences in total abundance. Species that were significantly more abundant in revegetated sites were primarily those associated with riparian shrub and woodlands, such as Yellow Warbler and Yellow-breasted Chat. Two species were more abundant in mature revegetation sites than in immature sites, and both were cavity users, indicating that it takes more than ten years to establish sufficient nesting (Lucy's Warbler) and roosting (Northern Flicker) opportunities for these species. Recently cleared/released/flooded areas were dominated by wetland and waterbirds.

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Introduction

The Las Vegas Wash (hereafter: Wash) is the primary drainage of the Las Vegas Valley Hydrographic Basin and is located in the southeastern portion of Las Vegas Valley. The lower Wash extends approximately 20 km, flowing through the Clark County Wetlands Park (Figure 1) and terminating in Las Vegas Bay of Lake Mead. While the Wash was historically ephemeral, it has become a perennial riverine and wetland complex due to drainage of treated wastewater and urban runoff, as well as a shallow groundwater table. From the increasing Las Vegas Valley discharge, the Wash began to degrade through channel down-cutting, which led in 1998 to the formation of the Las Vegas Wash Coordination Committee (LVWCC), a stakeholder group that includes local, state, and federal agencies, citizens, businesses, a university and an environmental group. The LVWCC generated the Las Vegas Wash Comprehensive Adaptive Management Plan that recommended measures to halt the channel degradation, restore riparian and wetland habitats, and to conduct wildlife monitoring (LVWCC 2000). In 2000, implementation of this plan began and continues to the present. Plan activities include installing weirs and bank protection to halt erosion, and extensive vegetation improvements through tamarisk (*Tamarix ramosissima*) control, revegetation with native woodland species, and other plantings. For more details on the history of these efforts, see Braden et al. (2009). The plan also led to the creation and implementation of the Las Vegas Wash Wildlife Management Plan, which contains 31 recommended actions designed to conserve native species, protect and enhance their habitats and increase community awareness of these resources (Shanahan et al. 2008).

In 2005, the San Bernardino County Museum, in conjunction with the Southern Nevada Water Authority (the lead agency of the LVWCC), began point count bird surveys along an 8.7 km reach of the Wash (Braden et al. 2007, 2009). The purpose of these bird surveys was to (1) inventory bird populations and bird habitat parameters to provide a baseline dataset, (2) set up a long-term monitoring program that is designed to document the benefits of project activities, and (3) assist in the adaptive management process by providing valuable insight to which activities are effective and in what time frame. The museum conducted four years of surveys which are summarized in Braden et al. (2009). Our report summarizes eight years of surveys: the four years conducted by the museum, and four years conducted by the Great Basin Bird Observatory

(GBBO; 2009-2011 and 2014-2016, respectively), and we analyzed all data together to summarize bird community structure, early population trends, and habitat conditions. Bird-habitat changes and bird community changes based on the first several survey years were discussed in more detail in GBBO (2011a and b), and changes through the tenth year of the project were reported in GBBO (2016).

Methods

Study Area

The study area encompasses 8.7 km of the Wash between the Upper Diversion and Powerline Crossing weirs (Figure 1). Twenty-nine points were established in 2005, and later additions and a deletion yielded 31 points by the end of 2006. The survey points are arranged along both sides of the Wash (Figure 1) at regular intervals to monitor the bird community and vegetation where channel modification and revegetation has occurred or will occur, as well as in areas where project activities are unlikely to occur (Braden et al. 2007), providing a broad cross-section of the different habitat types found at the Wash. The upland vegetation is dominated by Mojave scrub (dominated by creosote bush, *Larrea tridentata*). Earlier in the project, the riparian area was dominated by the invasive, non-native tamarisk and common reed (*Phragmites australis*); these habitats are no longer the most predominant, however, tamarisk remains the most abundant tree species along the Wash (GBBO 2016). Native vegetation present includes Goodding willow (*Salix gooddingii*), sandbar willow (*S. exigua*), seep willow (*Baccharis salicifolia*), Fremont cottonwood (*Populus fremontii*), honey and screwbean mesquite (*Prosopis glandulosa* and *P. pubescens*), arrowweed (*Pluchea sericea*), cattail (*Typha domingensis*), and bulrush (*Schoenoplectus* spp.). Mesquites are now the most abundant category of tree along the Wash (GBBO 2016).

Active channel stabilization and revegetation activities occurred along the length of the study area throughout the study period. By the end of the first year, nine weirs and 75 acres of revegetation had been installed. Mid-way through the study period (Year 6), 12 weirs and approximately 280 acres of revegetation were in place. By 2016, 19 weirs and over 450 acres of revegetation had been established.

Bird Data and Analyses

Data Collection Methods

Birds were surveyed using standardized 5-minute point counts (Ralph and Scott 1981). Initially, 26 points were established. This increased to 29 within a few months and to 31 by the end of the second year. Subsequently, from Year 3 through Year 11, 31 points were surveyed or attempted to be surveyed each year, with a few survey points having to be skipped in some years due to active construction and some points having to be replaced due to recent construction activities

(Table 1). Replacement points were established in locations as close as was safely possible to the original location, which resulted in replacement points up to 50 m from their original location.

Each survey point was visited approximately every two weeks, with all survey points visited over a two-day period. The order in which points were sampled was rotated among survey visits. Surveys were conducted from sunrise to approximately five hours post-sunrise to capture the period of greatest bird activity and vocalization. Nesting evidence was collected from 2009 on using standard breeding bird atlas methods (e.g., Floyd et al. 2007), which consider breeding to be confirmed if active nests, dependent young, food/nest material/fecal sac carrying, or nest building is observed. For more details on the point count protocol, see Braden et al. (2007).

Twenty-six surveys were generally conducted per year (Table 1), with the survey year typically running from mid-February through January for the first phase of the study. For the two most recent years of surveys, the survey year ran from September through August. The majority of this report covers the first full six years between 12 February 2005 and 31 January 2011, and the final two years between 5 September 2014 and 31 August 2016. The few seventh-year surveys conducted in 2011 (1 February through 24 April) were not included in most of our analyses, but they were used for the comprehensive species list.

Data Analysis

Species List

A comprehensive species list of all birds recorded at the Wash was generated based on all visits between 12 February 2005 and 31 August 2016, including all survey points (the total of which typically varied among years), all detection distances, and all birds detected incidentally outside of formal surveys. The list also includes "fly-over" sightings (e.g., Red-tailed Hawks flying high overhead) of birds that were in the Wash area but may not have been closely tied to the vegetation present at a survey point. This species list was generated to characterize the bird community of the Wash as comprehensively as possible, and because no quantitative comparisons are necessary to do that, all survey results and incidental and fly-over detections were included regardless of survey effort.

Species Richness and Abundance

Unlike our approach for the comprehensive species list, species richness and abundance patterns were analyzed using standardized comparisons that included only bird detections that occurred within a 100 m radius of each survey point. Fly-overs were also excluded even if they occurred directly above a survey point, because these birds were generally not assumed to actively use the surveyed area. Limiting the sample to detections within 100 m of the point allowed us to compare bird abundances among survey points and treatment areas, but it precluded analyses for species with a primarily aerial lifestyle, such as swallows, swifts, and nighthawks. For these species, a separate analysis that includes fly-overs would be necessary, if determining their trends and habitat associations is desired.

We included survey data from all survey points for which data were available, which varied slightly over the first few years of the project. Although species richness (i.e., the number of species detected) can be sensitive to survey effort, we considered the variation to be minor, particularly given that the added and deleted survey points were representative of the rest of the study area in habitat types and species composition present.

To be able to compare the Wash data to other regional and national abundance data, we used the standardized estimate of density of the number of bird detections per 40 ha, converted from the fixed radius of 100 m around each point (3.14 ha). We then plotted the number of bird species and the number of bird detections per 40 ha by survey visit in order to illustrate temporal variation in species richness and abundance. Juvenile birds were excluded from analyses of breeding season data. We also performed simple linear regression analyses on total abundance and total species richness by survey visit; in both cases, the residuals were not normally distributed, so the natural log of abundance and richness was used. For all statistical analysis results in this report, $P < 0.05$ was used as the significance level for one-tailed comparisons and $P < 0.1$ for two-tailed comparisons.

Species richness and abundance were also examined for the breeding and non-breeding seasons. In previous analyses (Braden et al. 2009), the breeding season was defined as the period between 15 March through 31 August to encompass the breeding of the majority of both year-round resident and migrant species. In this report, we used the same definitions to retain consistency with previous analyses. This time period overlaps with spring and early fall migration of several mid and long-distance migrants, so at least some non-breeding birds are included in the breeding season estimates. The non-breeding season was defined as 1 October through 31 January to include overwintering birds, but to exclude nesting of most resident species. Average richness and estimated density per survey were calculated for these seasons. Transitional periods covering the dates not included in either the breeding or non-breeding seasons were also included in the results, where appropriate.

Species-Specific Abundances

For each species, estimated bird density (birds per 40 ha) was calculated for each year overall, and for its breeding and non-breeding seasons. Relative abundance (proportion of total bird abundance contributed by a species) was calculated for the same periods, but only for species representing at least 1% of the total abundance in one or more periods. We also report species frequency, which stands for the percentage of the Wash survey points at which the species was detected. This metric provides a measure of how widespread a species is within the study area.

Breeding season abundances from the Wash surveys were also compared to data collected as a part of GBBO's Nevada Bird Count (NBC) in other Clark County lowland riparian areas. This was done to provide a reference point for the estimated densities at the Wash from regional data collected in similar habitat types. The NBC data were collected on 190 survey visits of 46 transects, generating surveys on approximately 1,900 point-visits (since each transect typically consists of ten points) in roughly the same period (2005-2014) as the Wash surveys (6,279 point-visits). Both datasets included only detections from within 100 m of the survey point for the purpose of comparisons. However, NBC data were collected over a ten-minute survey period per

point, rather than the five-minute period used at the Wash. Further, the breeding season periods differed in that the Wash data were for the period between 15 March through 31 August, with surveys evenly distributed throughout that time period, while the NBC data were collected from mid-April through 30 June, with surveys primarily occurring in May and early June. Regardless of these differences in methods, we consider the regional comparisons of estimates of breeding densities reported here informative for most breeding landbird species.

Finally, we performed linear regression analyses to determine whether population trends over time were significant. In the first analysis run, all species that were detected in ≥ 40 survey visits between February 2005 and August 2016 were included in the trend analyses. The arbitrarily chosen 40-event threshold was necessary because meaningful population trends over the eleven years can only be established for at least moderately common species using linear regression. This criterion resulted in an extremely long species list, so to narrow it further, we followed the recommendation in GBBO (2011b) to focus on select indicator and conservation priority species, particularly those for which the point count method is well-suited for detection. We further ensured that the list included species with different seasonal uses of the Wash, which resulted in a final list of 20 species for which analysis results are reported here. The dataset used was trimmed to exclude periods where the species were not, and were not likely to be, present. To determine this, the full dataset was reviewed for the presence of each species, including all distance categories and incidental records; if the species was present during a survey visit, that survey visit was included in the analyses. Periods with zero detections that consisted of less than six weeks were also included in the analysis. Data were then transformed, as needed.

Restoration Treatment Effects

Wash stabilization and revegetation treatments include clearing of vegetation (typically non-native) in preparation for construction; building of weirs that widens the channel, impounds the stream and increases surface area for passive establishment of marshy vegetation cover; and planting of native wetland, riparian, riparian-transitional (i.e., mesquite and acacia) and upland vegetation covers. Following weir construction, several survey points have been flooded, and early in 2015, the vegetation at, and adjacent to, several points was cleared for a large weir project that was later delayed. In addition to removing most of the remaining tamarisk from the Wash, acres of native woody riparian habitat, both actively planted and passively established, were also cleared.

For our analyses of treatment effects on bird populations, we divided the 31 survey points into five categories based on the 2015-2016 status of project implementation: no treatment (n = 1 survey point), recently cleared/released from construction/flooded (cleared/released/flooded in 2012 or later; n = 13), less recently cleared/released/flooded (2006-2011; n =1); immature revegetation (2006-2011; n = 5), and older revegetation (planted no later than 2005; n = 11). Because there was only one non-treated survey point, it was eliminated from this analysis. The less-recently cleared survey point was included with the recently cleared points. These categories were assigned by dominant vegetation type at the survey point, defined as affecting ≥ 50% of the surface area within a 100 m radius. This dominance criterion resulted in survey points with some revegetation efforts to be classified in the “recently cleared/flooded” category.

To determine bird responses to treatments, we used only the 2014-2016 bird survey data. To compare species richness effects of treatments, we calculated total species richness per survey point. Total abundance and species abundances were calculated as the number of birds per 40 ha. Species abundances were calculated only for the 41 species that were detected at the Wash on more than 15 of the 31 survey points during this period. Differences between treatment classes were determined using Analysis of Variance (ANOVA).

Vegetation Measurements

Vegetation data were collected at each bird survey point along the Wash during each fall in 2005-2010 and in 2014-2015, using a vegetation protocol developed by Braden et al. (2009). Three 100 m vegetation transects were laid out radially, at 120^{o} angles from the point. Data were collected every 2 m along each transect at the distances of 20-40 m and 50-70 m from the survey point. Along each of these six 20 m segments, plant species occurrence, height, and vertical structure were recorded at 2 m intervals, yielding 60 sampling stations per point. Using an 11-15 m survey rod, perennial plant height was measured to within 0.1 m; any vegetation exceeding the height of the survey rod was estimated to within 0.5 m. Perennial plant structure was measured as the number of vegetation contacts at 1 m vertical intervals along the survey rod. These data through 2014 were analyzed in GBBO (2016), and were not repeated in this report. The 2015 data will be summarized in a later report.

Results and Discussion

Species List

Between 12 February 2005 and 31 August 2016, 209 bird species were observed during visits to the Wash (Table 2). In this eleventh year since the start of the project, nine new species were detected for the first time in the Wash, including Canvasback, Long-billed Curlew, Marbled Godwit, Wilson's Phalarope, Franklin's Gull, Forster's Tern, Blackpoll Warbler, Sagebrush Sparrow, and Red Crossbill (all scientific names in Table 2). Fifty-two species that had been recorded at least once during the first seven years of surveys were not found in 2015-2016, including for example, California Gull, Bushtit, Blue-gray Gnatcatcher, Brewer's Blackbird, and Horned Lark.

Of the 209 species observed during the eight years of surveys, 181 were recorded during the breeding season (15 March - 31 August), and 157 were recorded during the non-breeding season (1 October - 31 January). Only a small number of species (7) were detected exclusively during the transitional seasons between the designated breeding and non-breeding seasons, suggesting that most migrants actually passed through during the "breeding" or "non-breeding" seasons.

Fifty species recorded in the Wash are conservation priorities according to the *Nevada Comprehensive Bird Conservation Plan* (GBBO 2010), the Clark County Multiple Species Habitat Conservation Plan (Clark County 2000), the Lower Colorado River Multi-Species Conservation Program (Bureau of Reclamation 2006), and/or the Partners in Flight Landbird

Conservation Plan (Rosenberg et al. 2016; Table 2). Thirty-four of the priority species were recorded during the non-breeding season, and 42 were recorded during the breeding season. Forty priority species were detected during the transitional periods, but only four of these were detected exclusively in the transitional seasons.

Nine of the conservation priority species were confirmed to nest within the Wash, including Gambel's Quail, Costa's Hummingbird, Long-eared Owl, Loggerhead Shrike, Bell's Vireo, Lucy's Warbler, Yellow Warbler, Abert's Towhee, and Blue Grosbeak. Also, four new species were confirmed as breeders in 2015-2016 (Black-chinned Hummingbird, Common Gallinule, Double-crested Cormorant, and Red-shouldered Hawk), resulting in a total of 40 species confirmed to be nesting in the Wash based on breeding evidence gathered in 2009-2016:

Abert's Towhee	House Finch
American Kestrel	Indigo Bunting
Bell's Vireo	Killdeer
Bewick's Wren	Loggerhead Shrike
Black Phoebe	Long-eared Owl
Black-chinned Hummingbird	Lucy's Warbler
Black-crowned Night-Heron	Mallard
Black-tailed Gnatcatcher	Mourning Dove
Blue Grosbeak	Northern Harrier
Brown-headed Cowbird	Northern Mockingbird
Canada Goose	Northern Rough-winged Swallow
Common Gallinule	Red-shouldered Hawk
Common Yellowthroat	Red-tailed Hawk
Cooper's Hawk	Red-winged Blackbird
Costa's Hummingbird	Say's Phoebe
Crissal Thrasher	Song Sparrow
Double-crested Cormorant	Verdin
Gambel's Quail	Yellow Warbler
Greater Roadrunner	Yellow-breasted Chat
Great-tailed Grackle	Yellow-headed Blackbird

Species Richness and Total Abundance

Overall seasonal patterns of species richness were similar among most years, with richness being lowest in January and peaking during September due to migration and juvenile dispersal (Figure 2). However, there appears to be a change in pattern between Years 6 and 10. In the first six years, richness was lowest during the non-breeding season and the winter transition and highest during fall. In the two most recent years, richness was lowest in fall and higher in winter. This apparent change in pattern may be related to increases in richness over time. Species richness remained similar throughout the first six years, showing only a slight increase, but then increased dramatically in Years 10 and 11 (Figure 3; Table 3). Regression analysis results showed that the increase over the 11-year period was significant (Adjusted $R^2 = 0.42$: $P < 0.001$).

Total bird abundance (bird detections per 40 ha) varied seasonally, but the overall pattern shows a small peak observed mid-breeding season (May-June) and a larger increase during late fall migration/early winter (October-December; Figure 4). Seasonal abundance patterns varied by year, with the lowest numbers typically found in either the winter or fall transition. Numbers were most consistently high during the non-breeding season but during the two most recent years of surveys, numbers were highest during the winter transition. Total abundance increased almost every year (Figure 5; Table 4), and showed an overall significant increasing trend (Adjusted R^2 = 0.34; $P < 0.001$). The largest increase in abundance occurred in the winter transition period, which averaged fewer than 100 birds per 40 ha in Year 1 and increased to more than 450 birds per 40 ha in Year 11, an increase of over 475%.

Species-Specific Abundances

Overall Abundance Patterns

For the entire study period, the species with the greatest absolute abundances included American Coot, Abert's Towhee, Red-winged Blackbird, Yellow-rumped Warbler, Song Sparrow, Mallard, Marsh Wren, White-crowned Sparrow, Bewick's Wren, and Gadwall (Table 5). The two most recent survey years show a large change relative to the first six years of the project, as primarily waterbirds have increased, particularly in the non-breeding season (e.g., American Wigeon, which was not recorded during Year 1, was one of the five most abundant species in Year 11; Table 6). The species with the highest absolute abundances also had the highest relative abundances (percentage of total bird abundance by each species; Tables 7 and 8), including American Coot, Abert's Towhee, Red-winged Blackbird, and Yellow-rumped Warbler. The relative frequency of each species (i.e., the percentage of total survey points at which the species was detected at least once) showed that the species that are most widespread within the study area include typical riparian songbirds, such as Yellow-rumped Warbler, Black Phoebe, Abert's Towhee, White-crowned Sparrow, Song Sparrow, and Verdin (Table 9).

Breeding Season Species Abundances in Relation to Regional Abundances

During the breeding season, the ten most abundant species at the Wash included Red-winged Blackbird, Abert's Towhee, Song Sparrow, Common Yellowthroat, Great-tailed Grackle, Brown-headed Cowbird, Bewick's Wren, Verdin, Lucy's Warbler, and American Coot (Tables 5 and 6). In comparison, the ten most abundant species recorded during ten years of NBC surveys within Clark County included Gambel's Quail, Abert's Towhee, Lucy's Warbler, Mourning Dove, Brown-headed Cowbird, Yellow Warbler, Verdin, House Finch, Red-winged Blackbird, and Song Sparrow (Table 10). Six of the ten most abundant species in the NBC were also among the ten most abundant for the Wash, and of the 50 most abundant species at the Wash, 34 (68%) were also in the 50 most abundant species in the NBC surveys (Table 10). Thus, there is a large degree of similarity between the Wash and other lowland riparian areas of the region.

The largest differences between the Wash and regional NBC data are associated with wetland, disturbed, and upland associated species. The Wash tended to support greater numbers of wetland species, such as Red-winged Blackbird, Song Sparrow, Bewick's Wren, Common

Yellowthroat, Mallard, and American Coot than are found in regional riparian areas. Disturbance-associated birds, such as Brown-headed Cowbird and Great-tailed Grackle, were also more abundant along the Wash than in regional riparian data. However, while Abert's Towhee and Blue Grosbeak were more abundant at the Wash, Gambel's Quail, Phainopepla, Bell's Vireo, and Black-throated Sparrow were all more abundant in the regional comparison sites (Table 10). This may be in part a result of construction and other barren areas adjacent to riparian areas at the Wash, thus reducing habitat for Black-throated Sparrows and Gambel's Quail near the survey points. Also, while mesquites and catclaws are present on the Wash, they may not yet be old enough to support sufficient mistletoe, and/or possibly not widespread enough, to support Phainopepla. Bell's Vireos tend to prefer dense riparian shrub habitats, and are often associated with mesquites. While the Wash does contain dense riparian shrub habitats, it may be that the mesquite component is not yet suitable.

Non-Breeding Season Species Abundances

During the non-breeding season, the ten most abundant species of the Wash included Yellow-rumped Warbler, American Coot, White-crowned Sparrow, Mallard, Abert's Towhee, American Pipit, Marsh Wren, Red-winged Blackbird, Gadwall, and Song Sparrow (Tables 5 and 6). No similar datasets were available from elsewhere, preventing us from making regional comparisons. The most abundant birds of the non-breeding season were a mix of year-round residents (e.g., Abert's Towhee, Red-winged Blackbird), abundant migrants and wintering species of the Mojave Desert (e.g., Yellow-rumped Warbler, White-crowned Sparrow, American Pipit), and wetland/aquatic species (e.g., American Coot, Gadwall, Mallard, Marsh Wren).

Trends in Species Abundances

Nine species showed significant increases over the 11-year study period, including Red-winged Blackbird, Yellow-rumped Warbler, Mallard, Marsh Wren, Gadwall, Black-tailed Gnatcatcher, Verdin, American Pipit, and Gambel's Quail (Table 11). These species tend to be found in marsh (e.g., Red-winged Blackbird, Marsh Wren), open water (Mallard, Gadwall), woodland canopy (e.g., Yellow-rumped Warbler), and drier or more open habitat types than riparian woodlands (e.g., Black-tailed Gnatcatcher, Verdin, American Pipit, Gambel's Quail).

Seven species showed significant declines over the 11-year survey period, including Abert's Towhee, Song Sparrow, Bewick's Wren, Ruby-crowned Kinglet, Lucy's Warbler, Yellow-breasted Chat, and Blue Grosbeak (Table 11). These species tend to be found in dense riparian shrub habitats (e.g., Song Sparrow, Bewick's Wren, Yellow-breasted Chat), and where stems are large enough to provide nest cavities (Lucy's Warbler). These species likely responded to the temporary reduction of such vegetation due to tamarisk removal. Population trends of these species are illustrated in Figures 6a-e.

Comparison of Restoration Treatments

Of the three analyzed treatment classes, the older and immature revegetation sites were similar overall (Table 12). Individual comparisons showed several species to be significantly more

abundant in these two classes (alpha = 0.1) than in recently cleared/flooded sites, including riparian birds that are active near the ground, such as Abert's Towhee, Crissal Thrasher, and Gambel's Quail, species associated with relatively dry riparian shrubs, such as Black-tailed Gnatcatcher and Verdin, and species associated with more mesic riparian shrubs and trees, such as Wilson's Warbler, Yellow Warbler, Orange-crowned Warbler, Ruby-crowned Kinglet, Bewick's Wren, Yellow-breasted Chat, and Blue Grosbeak (Table 12). Two species were significantly more abundant in older than in immature revegetation sites, the Lucy's Warbler and Northern Flicker, both of which use cavities for nesting and roosting, although the Northern Flicker is not a breeding season resident at the Wash.

Most of the species that were significantly more abundant in recently cleared/flooded sites than in older and immature revegetation sites were associated with marsh vegetation and open water, including Gadwall, Mallard, American Wigeon, American Coot, Great Blue Heron, Spotted Sandpiper, Green Heron, and Marsh Wren (Table 12). One species primarily found in cleared/flooded sites is associated with open areas, the American Pipit, and one species is associated with both open areas and water, the Killdeer. In addition, richness was also significantly higher in this treatment category and overall abundance, while not statistically significant, was substantially higher.

With only one survey point, the "no treatment" category could not be included in statistical analyses, but its density estimates were most similar to the older revegetation sites. Species that appeared to be (albeit not statistically) more abundant in the untreated site relative to the older revegetation sites include Black-tailed Gnatcatcher, Verdin, Northern Flicker, Bewick's Wren, and Lucy's Warbler, which are species that are more dependent than others on cavity nesting and on relatively dry portions of the riparian area. Species which appeared to be less abundant in the untreated survey site than in revegetation sites include species associated with mesic riparian woodlands, as well as wetlands, including Yellow Warbler, Gambel's Quail, Marsh Wren, Yellow-breasted Chat, Yellow-rumped Warbler, Red-winged Blackbird, Great-tailed Grackle, and Common Yellowthroat.

Conclusions

As of August 2016, 209 species had been recorded in these surveys, comprising 43% of all bird species ever recorded for the state of Nevada. The Wash's bird community is representative of other lowland riparian areas in the region. Over the course of the study, species richness tended to be highest in the fall, with numbers peaking in September for the first six years; however, this pattern shifted over the most recent two years of surveys, when richness tended to be lowest in fall and higher in winter. Total abundance tended to peak in October-December, with the lowest numbers typically found in either the winter or fall transition, but this also changed during the last two years of surveys, when numbers were highest during the winter transition, increasing by over 475% between Years 1 and 11. These changes coincided with a large jump in overall richness and an associated large increase in total abundance. Much of this increase in bird abundance and richness was due to increases in waterbirds, such as American Wigeon, Gadwall, Mallard, and American Coot. The site not only provides important habitat for 50 conservation

priority species, several of which were confirmed to be nesting, but also appears to be particularly important as wintering habitat and a stopover site for migrants.

Population trends showed significant changes over time, as some species requiring dense riparian shrub habitats and cavity nesters declined, at least temporarily, and species using marsh, open water, and dry/open habitats increased. These changes reflect the clearing of dense, old tamarisk stands associated with weir construction, and the development of open water and wetland habitats following the creation of the weirs. As revegetation sites and passive restoration areas continue to mature, we expect riparian shrub and woodland species to increase again.

The treatment effects analysis showed that birds in immature and older revegetation sites tended to respond fairly similarly to the change in vegetation (e.g., Abert's Towhee, Blue Grosbeak, Crissal Thrasher, and Gambel's Quail) although older sites contained significantly more cavity-using birds (e.g., Lucy's Warbler, Northern Flicker) than did immature sites. Recently cleared/flooded areas tended to have more waterbirds, and birds of open habitat types, such as American Pipit. This influx of waterbirds into flooded areas resulted in significantly greater richness in this treatment category.

The Wash stabilization and enhancement project is still under way. Construction is ongoing on the 20th weir and in the fall of 2017, preparation for the 21st and final weir commenced. This study should continue, to document any changes these activities cause on the landscape and in the bird community.

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Figures

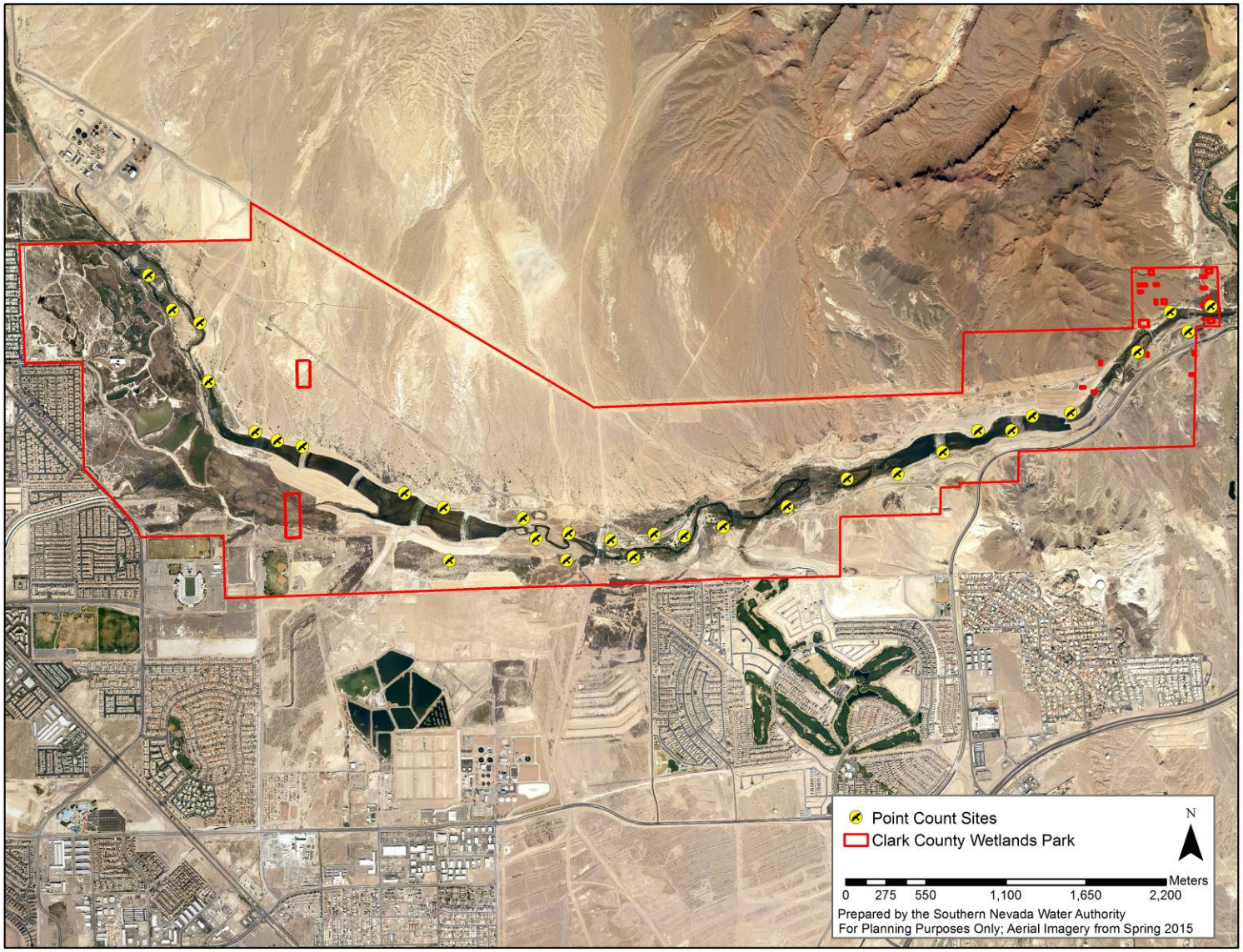

Figure 1. Distribution of point count sites across Las Vegas Wash. Map courtesy of Southern Nevada Water Authority.

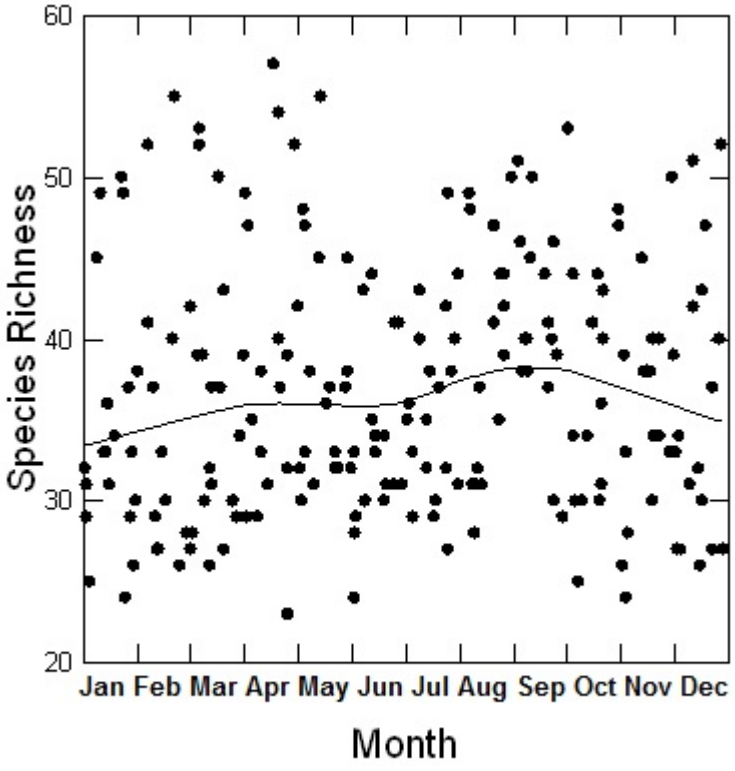

Figure 2. Seasonal species richness per survey visit from 208 surveys of the Las Vegas Wash (February 2005 – August 2016). Curve represents a LOWESS smoothed fit for variation in richness among survey events.

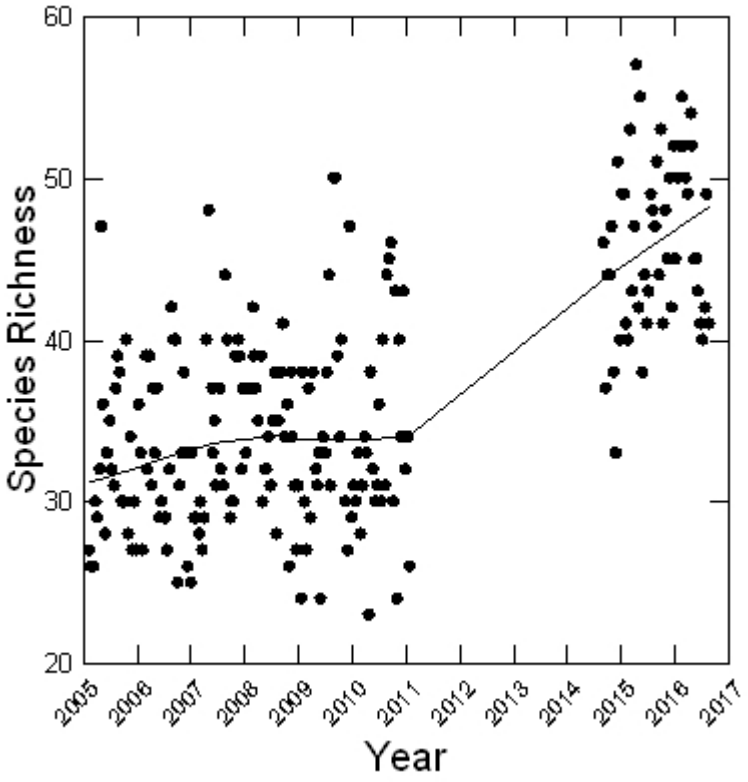

Figure 3. Annual variation in species richness from 208 surveys of the Las Vegas Wash (February 2005 – August 2016). Curve represents a LOWESS smoothed fit for variation in richness among survey events.

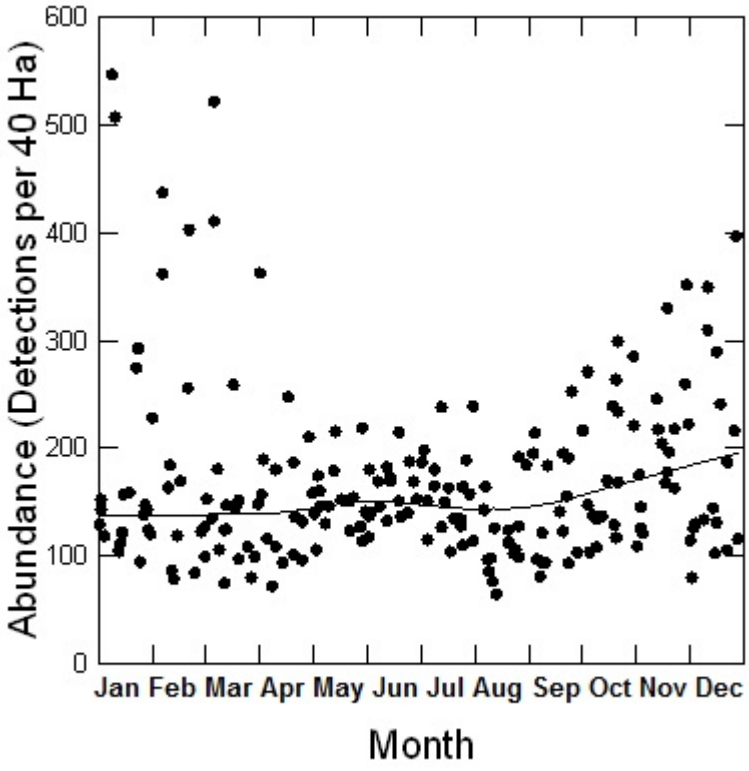

Figure 4. Seasonal total bird abundance per survey visit from 208 surveys of the Las Vegas Wash (February 2005 – August 2016). Curve represents a LOWESS smoothed fit for variation in abundance among survey events.

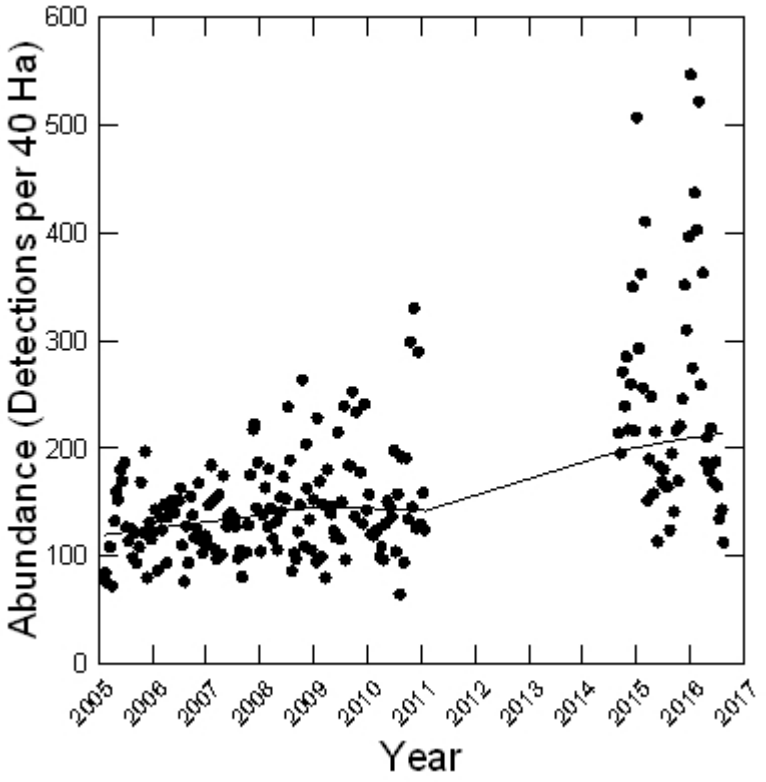

Figure 5. Total bird abundance per survey visit from 208 surveys of the Las Vegas Wash (February 2005 – August 2016). Curve represents a LOWESS smoothed fit for variation in abundance among survey events.

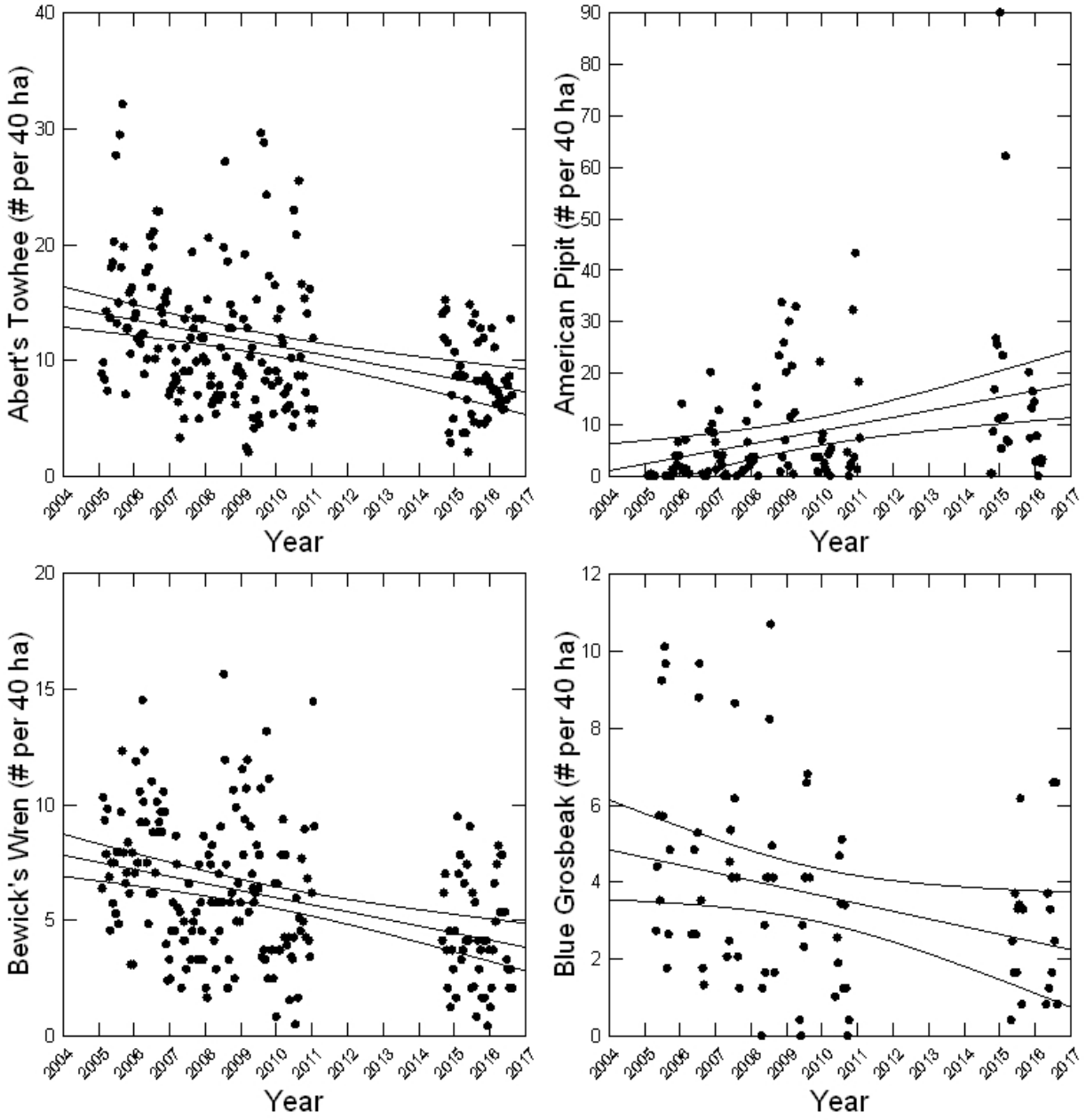

Figure 6a. Population trends of four common species along the Las Vegas Wash, by year (2005 – 2016). See Table 11 for statistical analysis results.

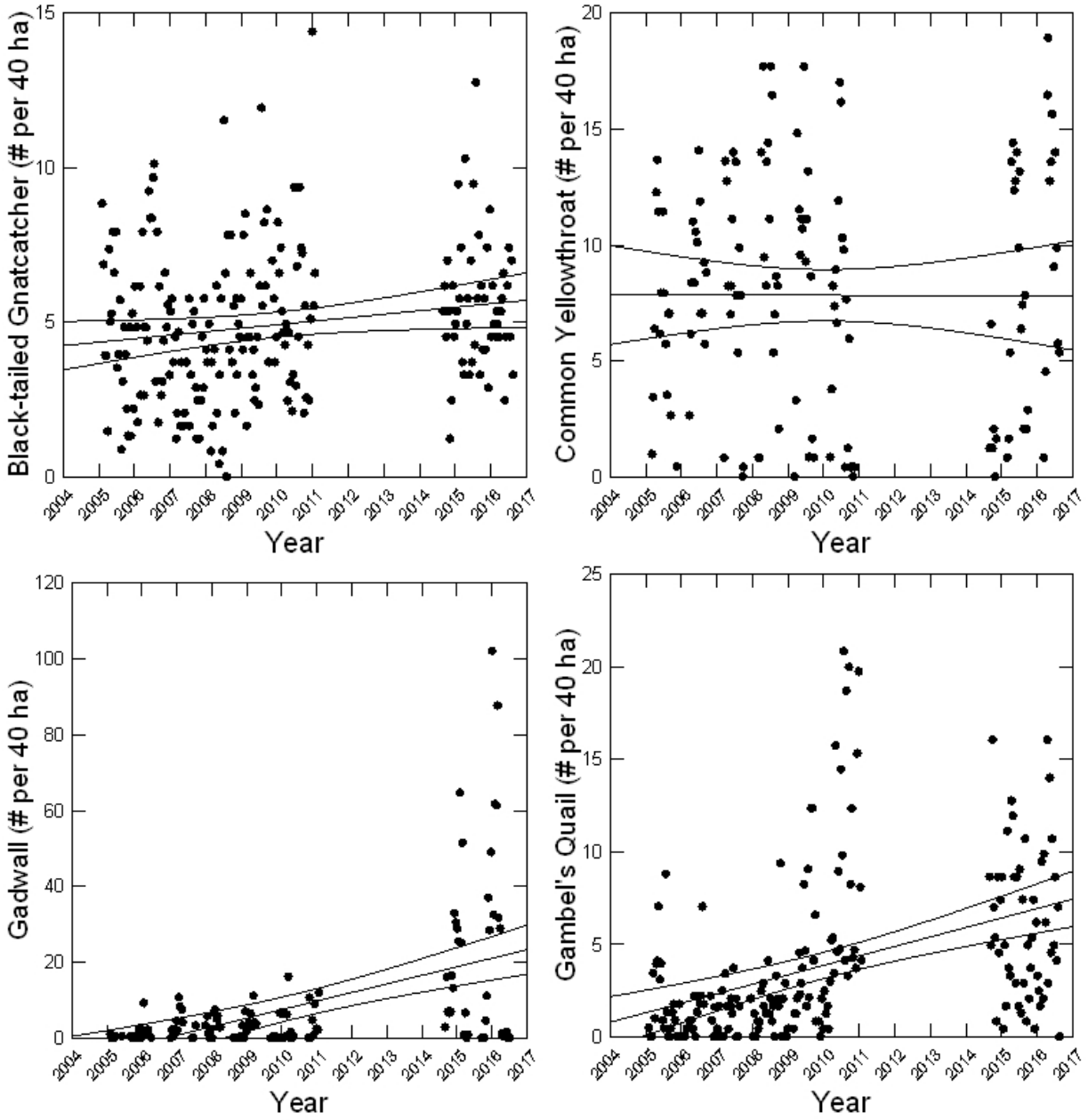

Figure 6b. Population trends of four common species along the Las Vegas Wash, by year (2005 – 2016). See Table 11 for statistical analysis results.

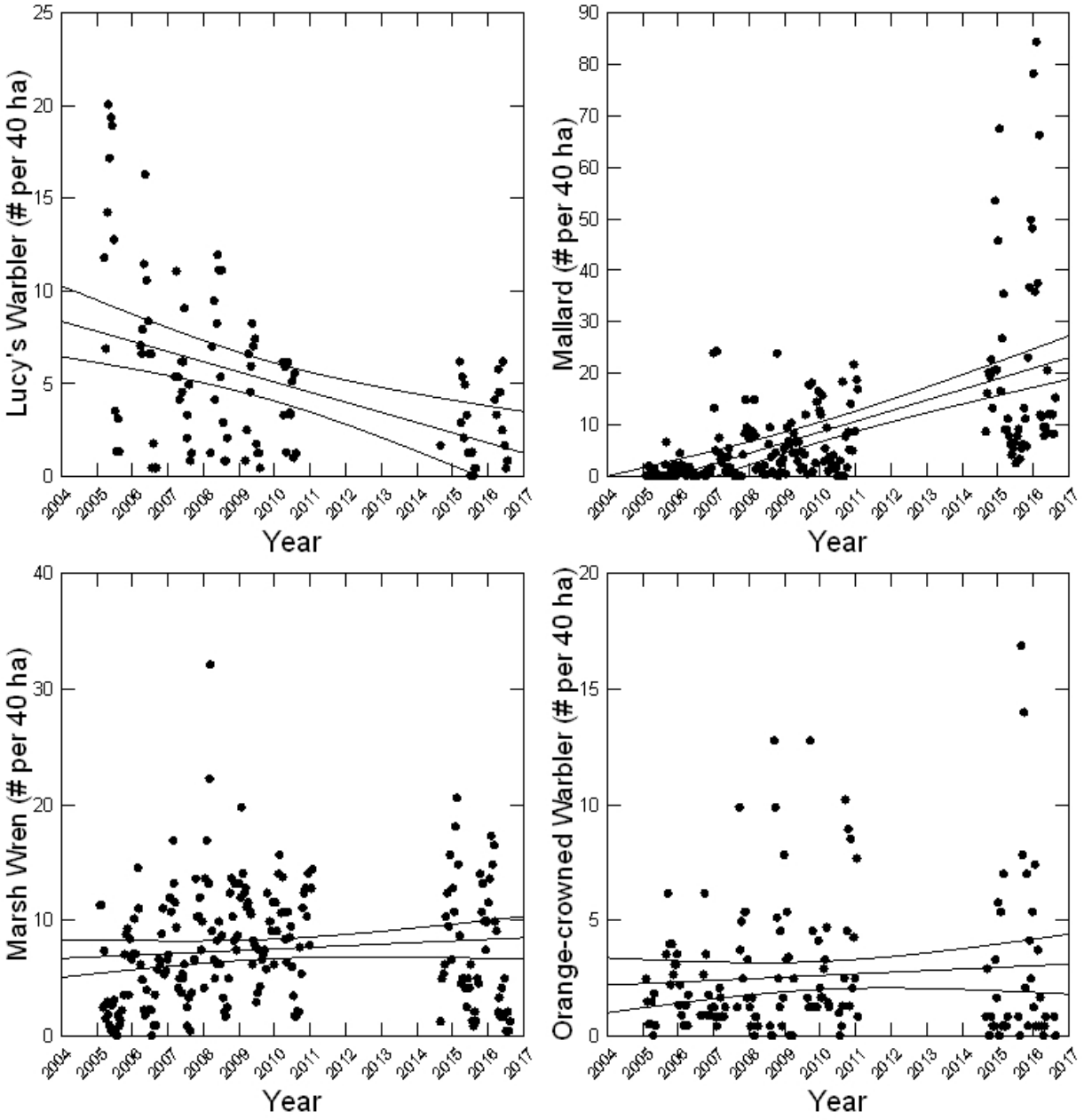

Figure 6c. Population trends of four common species along the Las Vegas Wash, by year (2005 – 2016). See Table 11 for statistical analysis results.

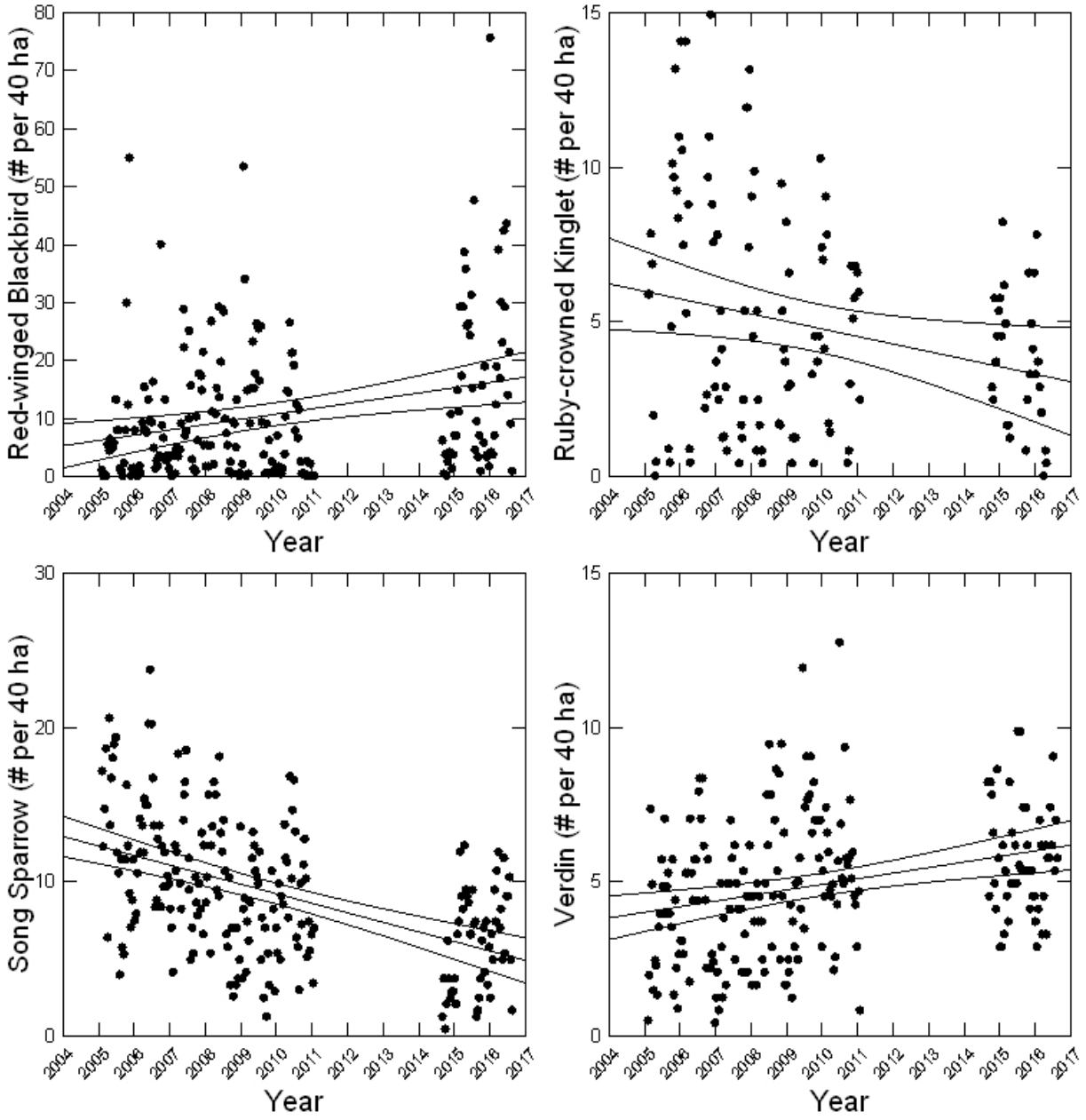

Figure 6d. Population trends of four common species along the Las Vegas Wash, by year (2005 – 2016). See Table 11 for statistical analysis results.

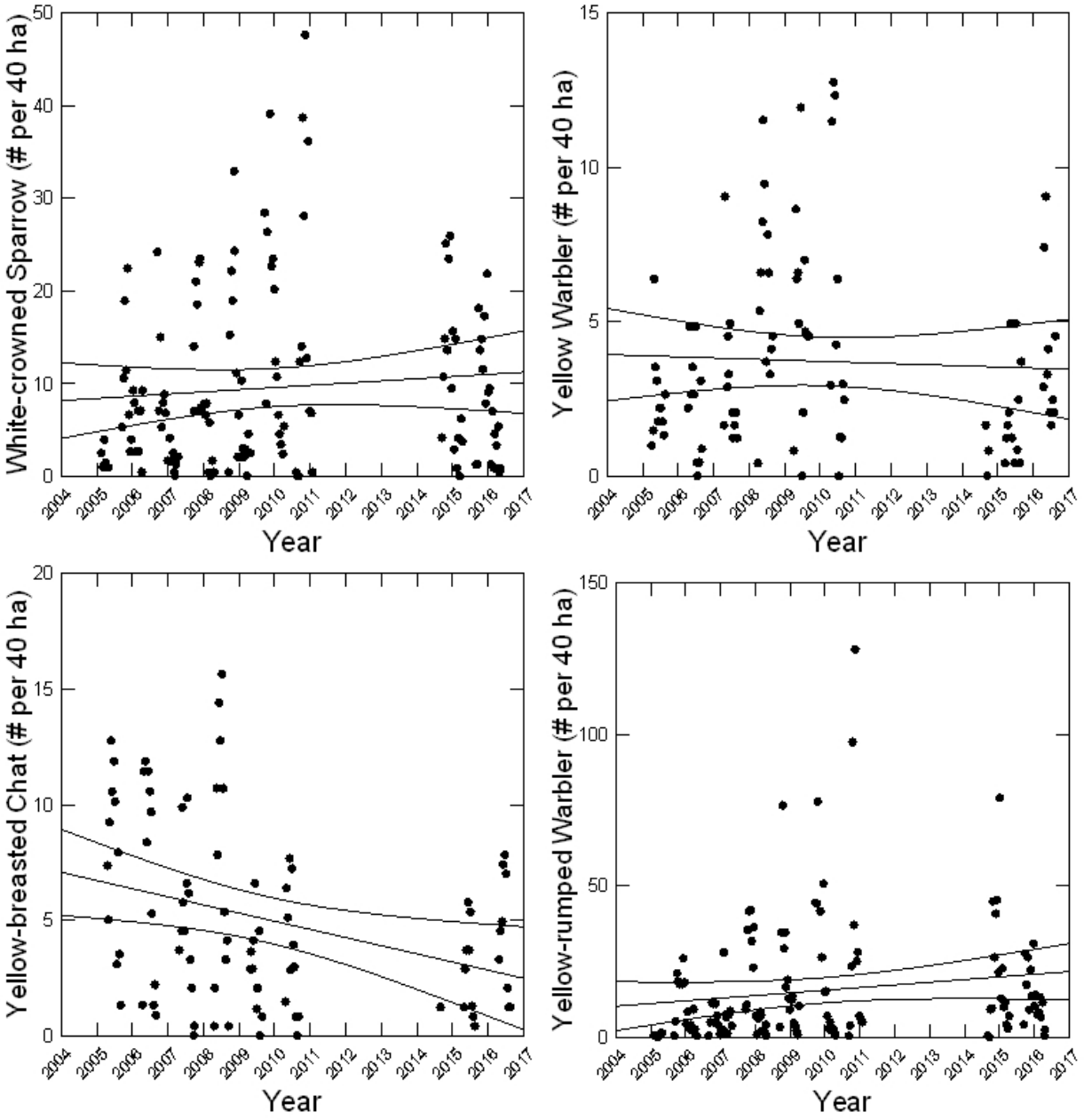

Figure 6e. Population trends of four common species along the Las Vegas Wash, by year (2005 – 2016). See Table 11 for statistical analysis results.

Tables

Table 1. Number of point count surveys conducted per year along the Las Vegas Wash.

Year	Points/Survey	Number of Surveys	Max. Number of Points/Year	Total Number of Survey-Visits
Year 1	26	6	29	26
	28	1		
	29	19		
Year 2	29	22	32	26
	31	3		
	32	1		
Year 3	30	2	31	26
	31	24		
Year 4	30	1	31	26
	31	25		
Year 5	22	1	31	26
	28	1		
	30	2		
	31	22		
Year 6	25	1	31	26
	26	2		
	27	2		
	29	1		
	30	11		
	31	9		
Year 10	30	1	37*	26
	31	25		
Year 11	31	26	33*	26

* Numbers are larger than 31, because they include original and replacement points.

Table 2. All bird species detected at Las Vegas Wash, February 2005 through August 2016, during breeding, non-breeding, and transitional seasons. Conservation status includes priority species from multiple sources: A (Clark County 2000); B (Bureau of Reclamation 2006); C (GBBO 2010); D (Rosenberg et al. 2016, Intermountain Partners in Flight); E (Rosenberg et al. 2016, Continental Partners in Flight). X denotes at least one detection in that season (for season definitions, see Methods). Asterisks indicate species that were recorded incidentally, as fly-overs, or >100 m from a survey point. Species listed in taxonomic order.

Common Name	Scientific Name	Conservation Status	Breeding Season	Non-Breeding Season	Trans-itional
Greater White-fronted Goose	*Anser albifrons*			*	
Snow Goose	*Chen caerulescens*		*	*	X
Ross's Goose	*Chen rossii*			*	
Graylag Goose	*Anser anser*		*	*	*
Canada Goose	*Branta canadensis*		X	X	X
Wood Duck	*Aix sponsa*			X	*
Gadwall	*Anas strepera*		X	X	X
American Wigeon	*Anas americana*		X	X	X
Mallard	*Anas platyrhynchos*		X	X	X
Blue-winged Teal	*Anas discors*		*	*	X
Cinnamon Teal	*Anas cyanoptera*	C	X	X	X
Northern Shoveler	*Anas clypeata*		X	X	X
Northern Pintail	*Anas acuta*	C	*	X	X
Green-winged Teal	*Anas crecca*		X	X	X
Canvasback	*Aythya valisineria*	C		*	
Redhead	*Aythya americana*	C	*	*	X
Ring-necked Duck	*Aythya collaris*		*	X	X
Lesser Scaup	*Aythya affinis*	C	X	X	*
Bufflehead	*Bucephala albeola*		X	X	X
Common Goldeneye	*Bucephala clangula*		X	X	X
Hooded Merganser	*Lophodytes cucullatus*		X	X	X
Common Merganser	*Mergus merganser*		X	X	X
Ruddy Duck	*Oxyura jamaicensis*		*	X	X
Gambel's Quail	*Callipepla gambelii*	C	X	X	X
Pied-billed Grebe	*Podilymbus podiceps*		X	X	X
Horned Grebe	*Podiceps auritus*		X	X	*
Eared Grebe	*Podiceps nigricollis*	C	X	X	X
Western Grebe	*Aechmophorus occidentalis*	C	X	X	*
Clark's Grebe	*Aechmophorus clarkii*	C	*	*	*
Neotropic Cormorant	*Phalacrocorax brasilianus*		X		X
Double-crested Cormorant	*Phalacrocorax auritus*		X	X	X
American White Pelican	*Pelecanus erythrorhynchos*	C	X	X	X

Common Name	Scientific Name	Conservation Status	Breeding Season	Non-Breeding Season	Trans-itional
American Bittern	*Botaurus lentiginosus*		X		X
Least Bittern	*Ixobrychus exilis*	C; B	X	X	X
Great Blue Heron	*Ardea herodias*		X	X	X
Great Egret	*Ardea alba*		X	X	X
Snowy Egret	*Egretta thula*	C	X	X	X
Cattle Egret	*Bubulcus ibis*		*		X
Green Heron	*Butorides virescens*		X	X	X
Black-crowned Night-Heron	*Nycticorax nycticorax*		X	X	X
White-faced Ibis	*Plegadis chihi*	C	X	*	X
Turkey Vulture	*Cathartes aura*		X	*	X
Osprey	*Pandion haliaetus*		X	X	X
White-tailed Kite	*Elanus leucurus*		*		
Northern Harrier	*Circus cyaneus*		X	X	X
Sharp-shinned Hawk	*Accipiter striatus*		X	X	X
Cooper's Hawk	*Accipiter cooperii*		X	X	X
Northern Goshawk	*Accipiter gentilis*	C		*	
Red-shouldered Hawk	*Buteo lineatus*		X	X	X
Swainson's Hawk	*Buteo swainsoni*	C	*		
Red-tailed Hawk	*Buteo jamaicensis*		X	X	X
Virginia Rail	*Rallus limicola*		X	X	X
Sora	*Porzana carolina*		X	X	X
Common Gallinule	*Gallinula galeata*		X	X	X
American Coot	*Fulica americana*		X	X	X
Sandhill Crane	*Grus canadensis*	C		*	*
Black-necked Stilt	*Himantopus mexicanus*	C	X		*
American Avocet	*Recurvirostra americana*	C	X	X	X
Semipalmated Plover	*Charadrius semipalmatus*		X		
Killdeer	*Charadrius vociferus*		X	X	X
Spotted Sandpiper	*Actitis macularius*		X	X	X
Greater Yellowlegs	*Tringa melanoleuca*		X	X	X
Willet	*Tringa semipalmata*	C	X		
Lesser Yellowlegs	*Tringa flavipes*		X	*	X
Whimbrel	*Numenius phaeopus*		*		
Long-billed Curlew	*Numenius americanus*	C			*
Marbled Godwit	*Limosa fedoa*	C			*
Dunlin	*Calidris alpina*		X		
Least Sandpiper	*Calidris minutilla*	C	X	X	X
Pectoral Sandpiper	*Calidris melanotos*				X
Semipalmated Sandpiper	*Calidris pusilla*		X		

Common Name	Scientific Name	Conservation Status	Breeding Season	Non-Breeding Season	Trans-itional
Western Sandpiper	*Calidris mauri*	C	X	X	X
Long-billed Dowitcher	*Limnodromus scolopaceus*	C	X	*	X
Wilson's Snipe	*Gallinago delicata*		X	X	X
Wilson's Phalarope	*Phalaropus tricolor*	C	*		
Bonaparte's Gull	*Chroicocephalus philadelphia*		*		
Franklin's Gull	*Leucophaeus pipixcan*	C	*		
Ring-billed Gull	*Larus delawarensis*		X	X	X
California Gull	*Larus californicus*		*	*	*
Lesser Black-backed Gull	*Larus fuscus*		*		
Caspian Tern	*Hydroprogne caspia*		*		*
Forster's Tern	*Sterna forsteri*		*		
Rock Pigeon	*Columba livia*		*	X	*
Eurasian Collared-Dove	*Streptopelia decaocto*		X	X	*
White-winged Dove	*Zenaida asiatica*		X	X	X
Mourning Dove	*Zenaida macroura*		X	X	X
Greater Roadrunner	*Geococcyx californianus*		X	X	X
Barn Owl	*Tyto alba*		X	X	X
Great Horned Owl	*Bubo virginianus*		X	X	X
Long-eared Owl	*Asio otus*	E	X		
Lesser Nighthawk	*Chordeiles acutipennis*		X		X
Vaux's Swift	*Chaetura vauxi*		*	*	*
White-throated Swift	*Aeronautes saxatalis*	C	*	*	*
Black-chinned Hummingbird	*Archilochus alexandri*		X	X	X
Anna's Hummingbird	*Calypte anna*		X	X	X
Costa's Hummingbird	*Calypte costae*	C	X	X	X
Broad-tailed Hummingbird	*Selasphorus platycercus*				X
Rufous Hummingbird	*Selasphorus rufus*	C; E	X		*
Belted Kingfisher	*Megaceryle alcyon*		X	X	X
Red-naped Sapsucker	*Sphyrapicus nuchalis*		X	X	
Ladder-backed Woodpecker	*Picoides scalaris*		X	X	X
Hairy Woodpecker	*Picoides villosus*			X	
Northern Flicker	*Colaptes auratus*		X	X	X
American Kestrel	*Falco sparverius*		X	X	X
Merlin	*Falco columbarius*			X	X
Peregrine Falcon	*Falco peregrinus*	C	X	X	*
Prairie Falcon	*Falco mexicanus*	C	*	X	*
Olive-sided Flycatcher	*Contopus cooperi*	C; D; E	X		
Western Wood-Pewee	*Contopus sordidulus*		X		X
Willow Flycatcher	*Empidonax traillii*	C; B; A	X		

Common Name	Scientific Name	Conservation Status	Breeding Season	Non-Breeding Season	Trans-itional
Hammond's Flycatcher	*Empidonax hammondii*		X		
Gray Flycatcher	*Empidonax wrightii*	C	X	X	X
Dusky Flycatcher	*Empidonax oberholseri*		X		X
Western Flycatcher (unidentified)	*Empidonax difficilis/occidentalis*		X		X
Black Phoebe	*Sayornis nigricans*		X	X	X
Say's Phoebe	*Sayornis saya*		X	X	X
Ash-throated Flycatcher	*Myiarchus cinerascens*		X		X
Brown-crested Flycatcher	*Myiarchus tyrannulus*		X		
Western Kingbird	*Tyrannus verticalis*		X		X
Eastern Kingbird	*Tyrannus tyrannus*		X		
Scissor-tailed Flycatcher	*Tyrannus forficatus*				X
Loggerhead Shrike	*Lanius ludovicianus*	D	X	X	X
Bell's Vireo	*Vireo bellii*	C; B; A	X		X
Plumbeous Vireo	*Vireo plumbeus*		X		
Warbling Vireo	*Vireo gilvus*		X	*	X
Common Raven	*Corvus corax*		X	X	X
Horned Lark	*Eremophila alpestris*	D	X	X	X
Tree Swallow	*Tachycineta bicolor*		X	X	*
Violet-green Swallow	*Tachycineta thalassina*		X	*	X
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*		X	*	X
Bank Swallow	*Riparia riparia*		*		
Cliff Swallow	*Petrochelidon pyrrhonota*		X	X	X
Barn Swallow	*Hirundo rustica*		X	*	X
Verdin	*Auriparus flaviceps*		X	X	X
Bushtit	*Psaltriparus minimus*		X	X	X
Red-breasted Nuthatch	*Sitta canadensis*			X	X
Brown Creeper	*Certhia americana*			X	
Rock Wren	*Salpinctes obsoletus*		X	X	X
Canyon Wren	*Catherpes mexicanus*		X	X	*
House Wren	*Troglodytes aedon*		X	X	X
Pacific Wren	*Troglodytes pacificus*			X	X
Marsh Wren	*Cistothorus palustris*		X	X	X
Bewick's Wren	*Thryomanes bewickii*		X	X	X
Cactus Wren	*Campylorhynchus brunneicapillus*			*	X
Blue-gray Gnatcatcher	*Polioptila caerulea*		X	X	X
Black-tailed Gnatcatcher	*Polioptila melanura*		X	X	X
Golden-crowned Kinglet	*Regulus satrapa*			X	X
Ruby-crowned Kinglet	*Regulus calendula*		X	X	X
Western Bluebird	*Sialia mexicana*			X	

Common Name	Scientific Name	Conservation Status	Breeding Season	Non-Breeding Season	Trans-itional
Mountain Bluebird	*Sialia currucoides*			X	
Hermit Thrush	*Catharus guttatus*		X	X	X
American Robin	*Turdus migratorius*		X	X	X
Crissal Thrasher	*Toxostoma crissale*		X	X	X
Northern Mockingbird	*Mimus polyglottos*		X	X	X
European Starling	*Sturnus vulgaris*		X	*	X
American Pipit	*Anthus rubescens*		X	X	X
Cedar Waxwing	*Bombycilla cedrorum*			X	X
Phainopepla	*Phainopepla nitens*	A	X	X	X
Ovenbird	*Seiurus aurocapilla*			X	
Orange-crowned Warbler	*Oreothlypis celata*		X	X	X
Lucy's Warbler	*Oreothlypis luciae*	C	X		X
Nashville Warbler	*Oreothlypis ruficapilla*		X	X	X
Virginia’s Warbler	*Oreothlypis virginiae*	C; D; E			X
MacGillivray's Warbler	*Geothlypis tolmiei*		X		X
Common Yellowthroat	*Geothlypis trichas*		X	X	X
Hooded Warbler	*Setophaga citrina*		*		
Yellow Warbler	*Setophaga petechia*	B	X	X	X
Blackpoll Warbler	*Setophaga striata*			X	
Yellow-rumped Warbler	*Setophaga coronata*		X	X	X
Black-throated Gray Warbler	*Setophaga nigrescens*			X	
Townsend's Warbler	*Setophaga townsendi*		X		X
Wilson's Warbler	*Cardellina pusilla*		X	X	X
Yellow-breasted Chat	*Icteria virens*		X	X	X
Green-tailed Towhee	*Pipilo chlorurus*	C	X		X
Spotted Towhee	*Pipilo maculatus*		X	X	X
Rufous-crowned Sparrow	*Aimophila ruficeps*		X		
Canyon Towhee	*Pipilo fusca*		X		
Abert's Towhee	*Melozone aberti*	C	X	X	X
Chipping Sparrow	*Spizella passerina*		X	X	X
Brewer's Sparrow	*Spizella breweri*	C	X	X	X
Vesper Sparrow	*Pooecetes gramineus*		X		X
Lark Sparrow	*Chondestes grammacus*		X		X
Black-throated Sparrow	*Amphispiza bilineata*		X	*	*
Sagebrush Sparrow	*Artemisiospiza nevadensis*	C		X	
Savannah Sparrow	*Passerculus sandwichensis*		X	X	X
Song Sparrow	*Melospiza melodia*		X	X	X
Lincoln's Sparrow	*Melospiza lincolnii*		X	X	X
White-crowned Sparrow	*Zonotrichia leucophrys*		X	X	X

Common Name	Scientific Name	Conservation Status	Breeding Season	Non-Breeding Season	Trans-itional
Dark-eyed Junco	*Junco hyemalis*		X	X	X
Summer Tanager	*Piranga rubra*	B; A			X
Western Tanager	*Piranga ludoviciana*		X		X
Black-headed Grosbeak	*Pheucticus melanocephalus*		X		X
Blue Grosbeak	*Passerina caerulea*	A	X	X	X
Lazuli Bunting	*Passerina amoena*		X	*	X
Indigo Bunting	*Passerina cyanea*		X		
Red-winged Blackbird	*Agelaius phoeniceus*		X	X	X
Western Meadowlark	*Sturnella neglecta*		X	X	X
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*		X	X	X
Brewer's Blackbird	*Euphagus cyanocephalus*	D	X	X	*
Great-tailed Grackle	*Quiscalus mexicanus*		X	X	X
Brown-headed Cowbird	*Molothrus ater*		X	X	X
Bullock's Oriole	*Icterus bullockii*		X	X	X
Hooded Oriole	*Icterus cucullatus*		X	*	
House Finch	*Haemorhous mexicanus*		X	X	X
Red Crossbill	*Loxia curvirostra*			X	
Pine Siskin	*Spinus pinus*	D	X	X	*
Lesser Goldfinch	*Spinus psaltria*		X	X	X
American Goldfinch	*Spinus tristis*		X	X	
House Sparrow	*Passer domesticus*		X	X	*
Species Richness	**209**	**50**	**181**	**157**	**169**
Conservation Priority Species Richness	**50**	**50**	**42**	**34**	**40**

Table 3. Average bird species richness along the Las Vegas Wash, by season and year, with numbers of weirs and revegetated acres.

Year	Breeding	Fall Transition	Non-Breeding	Winter Transition	COMBINED (avg # species/survey)	# Weirs	# Acres Reveg
Year 1	34.0	34.0	31.7	26.3	32.3	9	75
Year 2	32.9	40.0	30.3	32.7	32.5	10	135
Year 3	35.3	34.5	35.2	29.0	34.5	10	175
Year 4	33.8	39.5	31.2	39.3	34.0	11	195
Year 5	34.8	44.5	34.0	31.3	34.8	12	260
Year 6	33.1	45.5	33.9	30.7	34.2	12	280
Year 10	46.2	41.5	43.9	44.7	44.8	19	440
Year 11	45.9	47.5	48.1	50.0	47.3	19	470
COMBINED	**37.0**	**40.9**	**35.9**	**36.1**	**36.8**	**12.8**	**253.8**

Table 4. Average total bird abundance along the Las Vegas Wash, by season and year, with numbers of weirs and revegetated acres.

Year	Breeding	Fall Transition	Non-Breeding	Winter Transition	COMBINED (avg # birds per 40 ha/survey)	# Weirs	# Acres Reveg
Year 1	134.9	106.7	131.1	78.5	124.9	9	75
Year 2	132.3	123.8	126.2	114.7	127.5	10	135
Year 3	127.0	91.4	157.2	146.9	137.0	10	175
Year 4	143.8	109.3	151.9	156.3	145.4	11	195
Year 5	148.1	217.5	173.4	137.9	161.0	12	260
Year 6	131.3	141.7	192.1	121.4	152.0	12	280
Year 10	171.0	203.7	292.1	341.9	235.1	19	440
Year 11	193.2	167.4	302.7	452.9	259.1	19	470
COMBINED	**147.7**	**145.2**	**190.8**	**193.8**	**167.8**	**12.8**	**253.8**

Table 5. Estimated species-specific densities (birds per 40 ha) for survey visits overall, among seasons from the full dataset (2005-2016), and overall values by survey year. Species are in descending order of overall abundance. No entry means that the species was not detected. Conservation status includes priority species from multiple sources: A (Clark County 2000); B (Bureau of Reclamation 2006); C (GBBO 2010); D (Rosenberg et al. 2016, Intermountain Partners in Flight); E (Rosenberg et al. 2016, Continental Partners in Flight).

Species	Conservation Status	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
American Coot		14.10	5.21	21.37	2.23	8.74	10.06	5.37	4.80	3.71	34.77	43.11
Abert's Towhee	C	11.26	11.42	10.52	15.58	14.31	10.21	10.82	11.50	10.92	8.65	8.10
Red-winged Blackbird		10.77	15.01	8.10	7.03	7.37	9.67	9.92	12.30	6.92	15.63	17.33
Yellow-rumped Warbler		10.20	1.01	24.74	6.13	3.16	11.52	10.68	13.70	14.44	13.33	8.64
Song Sparrow		9.25	11.16	7.22	12.18	12.78	10.53	9.37	7.65	9.19	5.85	6.41
Mallard		8.61	3.94	13.13	0.98	2.15	4.58	4.01	8.37	6.26	17.97	24.55
Marsh Wren		7.55	4.97	9.70	4.47	5.48	7.52	9.87	9.19	8.96	7.60	7.30
White-crowned Sparrow		6.16	0.72	14.39	4.21	4.28	5.51	5.82	8.30	8.69	6.73	5.73
Bewick's Wren		5.99	5.99	5.30	7.40	8.00	4.94	6.81	6.67	5.42	4.65	4.04
Gadwall		5.40	0.98	7.92	0.70	1.08	1.61	1.52	2.05	2.55	12.91	20.76
Black-tailed Gnatcatcher		4.93	5.06	4.61	4.58	5.43	3.26	4.27	5.49	5.31	5.76	5.31
Verdin		4.92	5.34	4.33	3.54	4.46	3.92	4.94	5.65	5.40	5.91	5.51
Common Yellowthroat		4.86	9.58	0.17	4.15	4.64	4.63	5.97	4.77	4.51	4.86	5.36
American Pipit		4.72	0.76	9.71	1.34	2.72	2.10	5.83	6.02	4.87	11.36	3.51
Great-tailed Grackle		4.51	6.97	2.24	0.72	1.49	3.69	4.12	4.29	3.31	7.81	10.66
American Wigeon		4.26	1.86	5.34		0.07	0.22	0.21	0.28	0.67	11.15	21.47
Black Phoebe		3.97	2.41	5.20	3.86	4.39	3.39	3.85	3.69	3.82	4.90	3.89
Gambel's Quail	C	3.68	4.48	3.10	1.71	1.10	0.98	1.65	3.35	8.62	6.30	5.73
Brown-headed Cowbird		3.12	6.74	0.01	3.33	3.78	3.61	4.42	3.12	2.99	2.06	1.64
Ruby-crowned Kinglet		2.92	0.44	5.97	4.66	4.15	3.35	2.25	2.26	2.45	2.26	1.99
Lucy's Warbler	C	2.45	5.23		5.00	3.24	2.46	2.92	1.83	1.62	1.17	1.31
Yellow-breasted Chat		2.09	4.41	0.01	3.18	2.85	2.20	3.36	1.10	1.51	1.01	1.52
Mourning Dove		2.04	4.02	0.20	5.10	1.77	1.71	1.36	2.24	2.14	1.22	0.74
Orange-crowned Warbler		1.90	0.32	3.17	1.70	1.08	1.82	2.04	1.71	2.66	1.20	2.97

Species	Conservation Status	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
House Finch		1.88	1.44	2.40	0.93	1.34	1.39	1.28	4.00	2.82	0.92	2.40
Yellow Warbler	B	1.68	3.44	0.01	1.05	0.98	1.33	2.75	2.38	2.23	1.08	1.66
Crissal Thrasher		1.58	1.39	1.71	1.90	1.43	0.82	1.20	1.81	1.87	1.61	1.97
Blue Grosbeak	A	1.41	2.88	0.01	2.32	1.65	1.56	1.67	1.05	0.96	0.90	1.17
Yellow-headed Blackbird		1.14	1.23	0.05	0.91	0.27	0.05	0.32	0.35	0.10	5.41	1.69
Killdeer		1.04	1.23	0.78	1.71	0.86	0.35	0.78	0.92	0.33	2.05	1.33
Say's Phoebe		0.90	0.73	1.10	0.55	0.64	0.35	1.00	1.69	1.13	0.79	1.06
Lesser Goldfinch		0.81	0.45	0.77	0.36	0.66	0.25	0.60	1.11	2.77	0.33	0.41
Brewer's Sparrow	C	0.79	0.58	0.18	0.27	0.51	1.01	1.03	2.01	0.92	0.17	0.41
Greater Roadrunner		0.74	1.04	0.33	0.67	0.57	0.55	0.57	0.50	0.61	1.03	1.37
Northern Flicker		0.72	0.04	1.59	0.42	0.52	0.85	0.87	0.60	0.68	1.00	0.85
Great Blue Heron		0.65	0.60	0.64	0.19	0.27	0.28	0.24	0.68	0.39	1.42	1.69
Dark-eyed Junco		0.62	0.06	1.39	0.14	0.22	1.64	0.88	0.89	0.43	0.33	0.41
Wilson's Warbler		0.61	1.16	0.05	1.14	0.81	0.63	0.46	0.48	0.21	1.03	0.13
Western Kingbird		0.53	0.98		0.22	0.34	0.62	0.44	0.55	0.39	1.13	0.58
Spotted Sandpiper		0.44	0.59	0.24	0.31	0.56	0.10	0.35	0.55	0.23	0.79	0.63
Least Sandpiper	C	0.39	0.33	0.64					1.09	0.40	1.47	0.13
Lincoln's Sparrow		0.39	0.12	0.78	0.83	0.22	0.52	0.35	0.27	0.29	0.30	0.36
Northern Pintail	C	0.39		0.94		0.02				0.06	1.56	1.50
Bushtit		0.37	0.02	0.76	0.63	0.37	0.24	0.02	1.15	0.54		
Ring-billed Gull		0.36	0.00	0.76		0.63	1.25		0.03		0.13	0.85
Loggerhead Shrike	D	0.35	0.28	0.37	0.42	0.22	0.13	0.22	0.58	0.24	0.46	0.57
Black-chinned Hummingbird		0.33	0.66	0.03	0.15	0.30	0.33	0.27	0.35	0.31	0.40	0.49
Northern Rough-winged Swallow		0.33	0.57		0.20	0.20	0.16	1.03	0.35	0.13	0.14	0.39
Northern Mockingbird		0.31	0.37	0.26	0.03	0.22	0.16	0.06	0.24	0.16	0.54	1.06
Bufflehead		0.30	0.03	0.54			0.17	0.32	0.03	0.08	0.71	1.06
Double-crested Cormorant		0.30	0.22	0.35	0.03	0.08	0.58	0.21	0.14	0.02	0.68	0.65
Eared Grebe	C	0.30	0.63	0.02	0.02		0.22		0.05		0.05	2.04

Species	Conservation Status	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
Green Heron		0.30	0.53	0.07	0.28	0.54	0.28	0.25	0.20	0.23	0.44	0.14
Greater Yellowlegs		0.28	0.15	0.42	0.27	0.25	0.09	0.17	0.16	0.26	0.46	0.60
Savannah Sparrow		0.27	0.16	0.30	0.11		0.33	0.47	0.27	0.26	0.17	0.51
Anna's Hummingbird		0.25	0.30	0.14	0.14	0.03	0.02	0.05	0.11	0.03	0.62	0.98
Blue-gray Gnatcatcher		0.25	0.26	0.16	0.39	0.46	0.21	0.55	0.08	0.14	0.19	
Northern Shoveler		0.25	0.04	0.30	0.07	0.03			0.05		0.43	1.45
Green-winged Teal		0.24	0.08	0.31		0.15	0.30	0.14	0.08	0.07	0.51	0.70
White-winged Dove		0.24	0.52	0.01	0.31	0.19	0.33	0.32	0.38	0.23	0.16	0.03
Common Gallinule		0.23	0.30	0.16	0.12	0.17	0.16	0.09	0.20	0.18	0.49	0.43
Belted Kingfisher		0.22	0.07	0.37	0.22	0.17	0.19	0.21	0.21	0.15	0.24	0.39
Pied-billed Grebe		0.21	0.20	0.26	0.07	0.11	0.47	0.17	0.11	0.13	0.10	0.49
Canada Goose		0.17	0.22	0.09			0.22		0.03	0.08	0.52	0.54
Barn Swallow		0.16	0.32				1.18	0.06				
Snowy Egret	C	0.16	0.18	0.11	0.17	0.05	0.28	0.03	0.10	0.10	0.30	0.28
Chipping Sparrow		0.15	0.19	0.08	0.08	0.10	0.13	0.08	0.73	0.10		0.02
Cooper's Hawk		0.15	0.12	0.19	0.05	0.10	0.11	0.06	0.06	0.14	0.28	0.41
Rock Wren		0.15	0.10	0.24	0.08	0.13	0.06	0.16	0.30	0.31	0.05	0.09
Costa's Hummingbird	C	0.14	0.22	0.05	0.07	0.15	0.17	0.11	0.08	0.16	0.21	0.14
Bullock's Oriole		0.13	0.24	0.01	0.02	0.14	0.08		0.07	0.16	0.19	0.36
Cinnamon Teal	C	0.13	0.18	0.05	0.09			0.03	0.19		0.27	0.46
Brewer's Blackbird	D	0.12	0.02	0.32				0.44	0.13	0.41		
Common Merganser		0.12	0.07	0.12	0.04	0.02	0.08	0.05	0.09	0.02	0.24	0.44
Phainopepla	A	0.12	0.00	0.28	0.17	0.21	0.06	0.19	0.11	0.05	0.05	0.08
Spotted Towhee		0.12	0.03	0.26	0.09	0.08	0.19	0.29	0.09	0.07	0.09	0.05
Western Wood-Pewee		0.12	0.21		0.07	0.08	0.06	0.16	0.03	0.24	0.25	0.06
White-faced Ibis	C	0.12	0.22		0.07	0.24		0.02	0.03	0.05	0.41	0.16
Cliff Swallow		0.11	0.21	0.01			0.09	0.68	0.11			
Great Egret		0.10	0.06	0.12	0.09	0.03	0.08	0.06	0.17	0.10	0.06	0.17

Species	Conservation Status	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
Horned Lark	D	0.10	0.15	0.06	0.06		0.30	0.29	0.02	0.02	0.14	
Pine Siskin	D	0.10	0.02	0.26	0.10		0.25			0.23		0.21
Warbling Vireo		0.10	0.13		0.08	0.07	0.05	0.06	0.17	0.05	0.11	0.17
Western Meadowlark		0.10	0.01	0.18		0.03		0.02	0.09	0.14	0.21	0.33
Western Sandpiper	C	0.10	0.19	0.03	0.36	0.02			0.24	0.10	0.08	
American Kestrel		0.09	0.13	0.05	0.08	0.03	0.03	0.02	0.03	0.12	0.18	0.22
Black-crowned Night-Heron		0.09	0.07	0.13	0.05	0.10	0.06	0.03	0.03	0.11	0.22	0.14
Northern Harrier		0.09	0.02	0.16	0.03	0.11	0.25	0.11	0.05		0.05	0.08
Osprey		0.09	0.09	0.09	0.02	0.03	0.03	0.02	0.05	0.03	0.35	0.22
Red-tailed Hawk		0.09	0.02	0.20	0.07	0.03	0.06	0.06	0.03	0.14	0.22	0.11
Sharp-shinned Hawk		0.09	0.00	0.20	0.17	0.03	0.05	0.09	0.14	0.08	0.08	0.09
American White Pelican	C	0.08	0.07	0.08				0.03		0.02	0.30	0.27
Virginia Rail		0.08	0.05	0.11	0.07	0.05	0.09	0.06	0.05	0.17	0.06	0.08
American Avocet	C	0.07	0.10	0.01	0.20				0.05		0.30	0.02
Bell's Vireo	C; B; A	0.07	0.14		0.17		0.08			0.07	0.06	0.16
Lazuli Bunting		0.07	0.08		0.11	0.12	0.05	0.17	0.02		0.03	0.03
Indigo Bunting		0.06	0.14						0.11	0.07	0.09	0.24
Ladder-backed Woodpecker		0.06	0.03	0.11	0.02			0.02	0.03	0.21	0.08	0.14
Ring-necked Duck		0.06		0.09							0.11	0.38
Sora		0.06	0.04	0.11	0.03	0.05	0.03	0.05	0.02	0.10	0.08	0.14
American Robin		0.05	0.00	0.12	0.03	0.02	0.09	0.11	0.03	0.02	0.03	0.09
Ash-throated Flycatcher		0.05	0.08		0.07	0.02	0.09	0.02		0.09	0.06	0.05
Black-headed Grosbeak		0.05	0.07		0.12	0.07	0.03		0.03	0.09	0.02	0.03
Hermit Thrush		0.05	0.01	0.09	0.12	0.20	0.02	0.02	0.02		0.02	0.05
Common Goldeneye		0.04	0.01	0.04			0.05	0.08	0.03		0.05	0.09
Great Horned Owl		0.04	0.03	0.03		0.02	0.02		0.06	0.10	0.02	0.08
Least Bittern	CB;	0.04	0.07	0.02	0.02	0.02	0.06	0.08		0.03	0.08	0.05
Long-billed Dowitcher	C	0.04	0.06			0.07					0.11	0.11

Species	Conservation Status	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
Western Tanager		0.04	0.07		0.05	0.02	0.03	0.02	0.05	0.06	0.02	0.09
Black-necked Stilt	C	0.03	0.07		0.07				0.07		0.09	0.02
Dusky Flycatcher		0.03	0.05		0.02	0.03	0.13		0.02		0.02	
Hooded Merganser		0.03	0.00	0.05							0.02	0.25
House Wren		0.03	0.01	0.05	0.04	0.02			0.02		0.05	0.09
Lark Sparrow		0.03	0.05				0.03	0.03	0.02	0.07	0.05	0.02
Lesser Scaup	C	0.03	0.01	0.06							0.16	0.05
Nashville Warbler		0.03	0.03	0.01			0.05	0.05	0.02	0.05	0.05	0.05
Western Flycatcher (Unidentified)		0.03	0.05		0.02	0.05	0.08	0.02			0.08	
Barn Owl		0.02	0.03	0.01	0.07	0.03	0.02		0.02			
Common Raven		0.02	0.01	0.04			0.09		0.02		0.06	
Golden-crowned Kinglet		0.02		0.07	0.02		0.09	0.03	0.03	0.02		
Gray Flycatcher	C	0.02	0.04	0.01	0.02		0.08		0.05	0.02		0.03
Neotropic Cormorant		0.02	0.05								0.03	0.16
Red-naped Sapsucker		0.02	0.01	0.04	0.04	0.05	0.02				0.02	0.02
Red-shouldered Hawk		0.02	0.00	0.03						0.02	0.03	0.11
Ruddy Duck		0.02		0.05							0.16	0.03
Townsend's Warbler		0.02	0.04							0.08	0.08	
American Goldfinch		0.01	0.00	0.02					0.05		0.03	
Black-throated Sparrow		0.01	0.03			0.02				0.10		
Cedar Waxwing		0.01		0.01	0.05	0.02						
Dunlin		0.01	0.02								0.08	
Eurasian Collared-Dove		0.01	0.02	0.01					0.02		0.05	0.05
Hooded Oriole		0.01	0.01				0.05					
Horned Grebe		0.01	0.01	0.02							0.03	0.08
Lesser Nighthawk		0.01	0.02			0.02			0.02		0.03	0.02
Lesser Yellowlegs		0.01	0.01						0.02		0.03	
MacGillivray's Warbler		0.01	0.02		0.02	0.02	0.02			0.05	0.02	

Species	Conservation Status	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
Merlin		0.01		0.01		0.02			0.02			0.02
Olive-sided Flycatcher	C; D; E	0.01	0.02		0.02		0.02			0.02	0.02	0.02
Pacific Wren		0.01		0.03	0.03	0.02				0.03	0.02	0.02
Plumbeous Vireo		0.01	0.01					0.02			0.02	0.02
Red-breasted Nuthatch		0.01		0.01			0.02	0.02			0.02	0.03
Redhead	C	0.01						0.03			0.02	
Rock Pigeon		0.01		0.02			0.03	0.02				
Semipalmated Sandpiper		0.01	0.02			0.07						
Solitary Vireo (Unidentified)		0.01	0.03			0.02	0.02	0.08				
Tree Swallow		0.01	0.01	0.01			0.03	0.05				
Vesper Sparrow		0.01	0.01						0.03	0.05	0.02	
Violet-green Swallow		0.01	0.02				0.03	0.05	0.02			
Western Bluebird		0.01		0.02	0.05							
Western Grebe	C	0.01	0.01	0.02			0.02				0.05	0.05
Willow Flycatcher	C; B; A	0.01	0.01					0.03		0.02		
Wilson's Snipe		0.01	0.01	0.01					0.02		0.02	0.05
American Bittern		0.00	0.00			0.02			0.02			
Blackpoll Warbler		0.00		0.01								0.02
Black-throated Gray Warbler		0.00		0.01					0.02			
Blue-winged Teal		0.00		0.01								0.02
Broad-tailed Hummingbird		0.00								0.02		
Brown Creeper		0.00		0.01							0.02	
Brown-crested Flycatcher		0.00	0.01		0.03							
Cactus Wren		0.00										0.03
Canyon Towhee		0.00	0.00			0.02						
Canyon Wren		0.00	0.00	0.01	0.02	0.02						
Cattle Egret		0.00										0.02
Eastern Kingbird		0.00	0.01							0.02		0.02

Species	Conservation Status	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
European Starling		0.00	0.00							0.02		0.02
Green-tailed Towhee	C	0.00	0.00					0.02	0.02			
Hairy Woodpecker		0.00		0.01		0.02						
Hammond's Flycatcher		0.00	0.00								0.02	
House Sparrow		0.00	0.00	0.01	0.02						0.02	
Mountain Bluebird		0.00		0.01				0.02				
Ovenbird		0.00		0.01						0.02		
Pectoral Sandpiper		0.00							0.02			
Peregrine Falcon	C	0.00	0.00	0.01				0.02	0.02			
Prairie Falcon	C	0.00		0.01					0.02			
Red Crossbill		0.00		0.01								0.02
Rufous Hummingbird	C; E	0.00	0.01							0.03		
Rufous-crowned Sparrow		0.00	0.00				0.02					
Sagebrush Sparrow	C	0.00		0.01								0.03
Scissor-tailed Flycatcher		0.00								0.02		
Semipalmated Plover		0.00	0.00		0.02							
Snow Goose		0.00										0.02
Summer Tanager	A	0.00									0.02	
Turkey Vulture		0.00						0.02				
Virginia's Warbler	C; D; E	0.00					0.02					
Willet	C	0.00	0.00									0.02
Wood Duck		0.00		0.01				0.02				

Table 6. Breeding and non-breeding abundances (birds per 40 ha) by species for each of eight survey years (2005-2016). Species listed are in descending order of overall abundance. No entry means that the species was not detected.

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
American Coot	1.2	1.4	5.5	3.3	1.3	1.1	10.5	17.5	4.5	16.8	9.6	6.0	7.7	6.7	61.1	58.6
Abert's Towhee	17.4	15.8	9.9	11.1	11.0	10.8	7.8	7.5	13.1	12.6	10.5	9.3	11.1	9.9	8.8	8.9
Red-winged Blackbird	5.3	8.7	11.7	15.1	15.6	14.1	25.4	24.0	12.9	8.8	11.1	4.4	8.2	0.6	4.4	14.4
Yellow-rumped Warbler	0.3	1.1	1.7	0.7	0.9	0.4	1.2	1.7	16.6	6.1	25.3	27.1	32.3	39.6	32.0	19.0
Song Sparrow	14.2	15.2	12.1	12.0	9.1	10.9	7.9	7.9	10.2	9.7	9.5	5.9	6.8	7.7	2.9	5.2
Mallard	0.5	0.4	2.0	2.4	4.8	3.1	6.8	11.5	1.3	5.2	6.6	4.8	11.3	11.1	31.4	33.5
Marsh Wren	2.0	2.9	4.7	8.2	7.6	6.9	4.1	3.4	7.1	7.6	9.7	11.0	10.5	11.2	9.9	10.5
White-crowned Sparrow	0.6	1.4	0.3	0.2	0.6	0.7	0.8	1.2	10.4	6.5	13.5	15.0	19.2	21.2	15.7	13.7
Bewick's Wren	7.1	9.0	4.8	7.0	6.6	3.8	4.6	5.0	6.8	6.1	4.7	7.0	5.0	6.9	3.5	2.5
Gadwall	0.1	0.0	0.3	0.5	0.7	0.2	0.7	5.4	1.7	2.5	2.1	1.7	2.7	4.6	18.6	29.3
Black-tailed Gnatcatcher	5.0	6.8	3.2	4.2	5.2	4.8	6.2	5.2	3.6	4.6	3.1	4.4	5.7	5.4	4.6	5.5
Verdin	3.9	5.9	4.3	5.0	6.0	5.6	6.2	5.8	3.0	2.3	3.8	4.7	5.5	4.6	5.8	4.9
Common Yellowthroat	8.1	8.9	9.3	11.3	10.1	9.0	9.4	10.5	0.0		0.0	0.2		0.1	0.5	0.3
American Pipit		0.1	0.4		3.8	0.4	1.1	0.3	3.8	6.7	3.6	13.0	8.7	12.3	20.5	9.1
Great-tailed Grackle	0.6	2.0	5.2	5.9	7.2	4.4	13.4	17.0	1.2	1.2	2.6	2.8	1.2	2.9	2.8	3.2
American Wigeon			0.1	0.3			2.5	12.0			0.3	0.1	0.3	0.6	17.5	23.9
Black Phoebe	2.3	2.7	2.1	2.3	2.3	2.0	3.4	2.1	4.9	5.6	4.3	5.9	4.2	5.6	5.7	5.4
Gambel's Quail	3.2	1.8	1.5	1.7	4.6	9.6	6.2	7.4	0.6	0.7	0.6	1.8	1.6	8.9	6.5	4.0
Brown-headed Cowbird	7.2	8.2	7.8	9.5	6.7	6.4	4.4	3.6				0.0			0.0	
Ruby-crowned Kinglet	0.8	0.8	0.5	0.4	0.2	0.1	0.4	0.3	10.1	7.7	7.4	4.1	5.4	4.8	3.9	4.4
Lucy's Warbler	10.8	7.0	5.2	6.2	3.9	3.5	2.4	2.8								
Yellow-breasted Chat	6.8	6.1	4.6	6.9	2.4	3.2	2.1	3.3			0.0					
Mourning Dove	10.5	3.5	3.1	2.8	4.3	4.5	2.3	1.2	0.3		0.3	0.1	0.2		0.4	0.3
Orange-crowned Warbler	0.4	0.4	0.4	0.1	0.3	0.4	0.2	0.3	2.9	2.0	3.1	4.0	2.6	4.5	1.4	4.9
House Finch	1.3	1.1	0.9	1.1	4.3	1.6	0.7	0.6	0.3	1.9	2.6	1.9	1.2	4.1	1.6	5.5

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
Yellow Warbler	2.3	2.0	2.8	5.6	4.8	4.6	2.1	3.3							0.1	
Crissal Thrasher	1.5	1.7	0.5	1.0	1.7	1.4	1.8	1.5	2.4	0.9	1.0	1.5	2.0	2.2	1.3	2.4
Blue Grosbeak	4.4	3.5	3.3	3.5	2.3	1.9	2.0	2.3						0.0		
Yellow-headed Blackbird	1.9	0.2	0.1	0.4	0.7	0.2	4.9	1.4	0.0			0.3				0.0
Killdeer	2.3	1.0	0.4	0.4	1.6	0.5	2.2	1.4	1.1	0.4	0.2	1.0	0.2	0.1	2.0	1.2
Say's Phoebe	0.4	0.7	0.5	1.1	1.2	0.7	0.9	0.4	0.6	0.5	0.2	1.2	2.3	1.1	1.0	1.9
Lesser Goldfinch	0.1	0.4	0.2	0.1	0.5	1.8	0.3	0.1	0.2	0.1	0.2	0.8	0.6	3.6	0.3	0.3
Brewer's Sparrow		0.7	1.7	0.3	0.6	1.2	0.2	0.0	0.3			0.5	0.4		0.0	0.3
Greater Roadrunner	0.9	1.0	1.0	0.7	0.7	0.9	1.7	1.6	0.4	0.1	0.2	0.4	0.2	0.1	0.4	0.9
Northern Flicker			0.1	0.1		0.0	0.0	0.1	0.9	1.1	2.1	1.9	1.0	1.7	2.0	2.0
Great Blue Heron	0.2	0.1	0.3	0.1	0.8	0.3	1.5	1.5	0.2	0.4	0.3	0.2	0.6	0.4	1.4	1.7
Dark-eyed Junco	0.1			0.3			0.1		0.1	0.5	4.7	1.4	2.5	0.6	0.4	1.0
Wilson's Warbler	2.1	1.7	1.3	0.5	1.0	0.4	2.2	0.1	0.3							0.0
Western Kingbird	0.4	0.7	1.2	0.8	0.9	0.5	2.3	1.0								
Spotted Sandpiper	0.4	0.9	0.1	0.5	0.7	0.2	1.0	0.8	0.2	0.2		0.1	0.2	0.2	0.5	0.5
Least Sandpiper					1.2	0.7	0.5	0.3					1.6	0.0	3.5	
Lincoln's Sparrow	0.1	0.1	0.3	0.1	0.1	0.0	0.1	0.2	1.9	0.2	0.9	0.7	0.5	0.7	0.8	0.5
Northern Pintail														0.2	4.3	3.1
Bushtit	0.1					0.1			1.6	1.0	0.1		3.3			
Ring-billed Gull							0.0			1.8	3.1		0.1		0.2	1.0
Loggerhead Shrike	0.6	0.3	0.1	0.3	0.5	0.1	0.4	0.1	0.2	0.1	0.1	0.1	0.6	0.3	0.6	0.8
Black-chinned Hummingbird	0.3	0.7	0.7	0.5	0.7	0.6	0.6	1.0				0.0			0.1	0.0
Northern Rough-winged Swallow	0.2	0.4	0.3	2.0	0.7		0.2	0.8								
Northern Mockingbird	0.1	0.3	0.2	0.0	0.2	0.2	0.8	1.2		0.2	0.0	0.1	0.3	0.2	0.4	0.8
Bufflehead			0.0				0.1	0.0			0.5		0.1	0.2	1.5	2.1
Double-crested Cormorant	0.0	0.1	0.2	0.1	0.2	0.0	0.5	0.5		0.1	1.3	0.1	0.1		0.3	0.9
Eared Grebe	0.0		0.5		0.1			4.4							0.1	
Green Heron	0.5	0.8	0.4	0.5	0.4	0.4	0.9	0.3	0.1	0.2	0.1		0.0	0.1		

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
Greater Yellowlegs		0.1		0.0	0.1	0.3	0.3	0.3	0.7	0.2	0.3	0.3	0.2	0.1	0.5	1.0
Savannah Sparrow	0.2		0.4	0.2	0.0	0.1	0.2	0.1			0.2	0.6	0.5	0.4	0.1	0.5
Anna's Hummingbird	0.2	0.1		0.1	0.1	0.0	0.7	1.2	0.0			0.0	0.1		0.3	0.6
Blue-gray Gnatcatcher	0.6	0.3	0.3	0.9					0.3			0.0	0.2	0.4	0.3	
Northern Shoveler					0.1		0.1	0.1	0.2						0.6	1.6
Green-winged Teal		0.0		0.1		0.1	0.2	0.2		0.3	0.3	0.1	0.2	0.1	0.3	1.2
White-winged Dove	0.6	0.4	0.7	0.7	0.8	0.5	0.3	0.1	0.0							
Common Gallinule	0.1	0.2	0.2	0.1	0.3	0.3	0.7	0.5	0.1	0.2		0.1	0.1	0.1	0.2	0.4
Belted Kingfisher	0.0	0.1	0.0		0.0	0.1	0.1	0.2	0.5	0.2	0.4	0.3	0.1	0.1	0.5	0.7
Pied-billed Grebe		0.0	0.4	0.3	0.2	0.1	0.1	0.5	0.2	0.2	0.7		0.1	0.3	0.1	0.5
Canada Goose			0.2			0.1	1.0	0.3			0.4		0.1		0.0	0.2
Barn Swallow			2.6													
Snowy Egret	0.3		0.2	0.0	0.1		0.4	0.4		0.1	0.5		0.0	0.0	0.0	0.1
Chipping Sparrow	0.1		0.2		1.0	0.2						0.1	0.5			
Cooper's Hawk	0.0		0.0	0.1	0.0		0.3	0.4		0.1	0.2	0.0	0.1	0.3	0.3	0.4
Rock Wren	0.0	0.1	0.0	0.2	0.2	0.2	0.0		0.2	0.2	0.1	0.1	0.5	0.6	0.1	0.2
Costa's Hummingbird	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2				0.0		0.0	0.2	0.1
Bullock's Oriole	0.0	0.3	0.2		0.1	0.2	0.4	0.7						0.0		
Cinnamon Teal	0.2			0.1	0.1		0.1	1.0					0.1		0.3	
Brewer's Blackbird					0.2							1.3	0.1	1.2		
Common Merganser	0.1			0.0			0.2	0.2		0.0	0.1	0.0		0.0	0.2	0.5
Phainopepla						0.0			0.5	0.5	0.1	0.5	0.3	0.0	0.1	0.2
Spotted Towhee	0.1		0.0	0.1		0.0			0.1	0.2	0.5	0.6	0.1	0.1	0.2	0.1
Western Wood-Pewee	0.1	0.1	0.1	0.2	0.0	0.4	0.5	0.1								
White-faced Ibis	0.1	0.5		0.0	0.0	0.1	0.7	0.2								
Cliff Swallow			0.2	1.5	0.0								0.0			
Great Egret	0.0			0.0	0.2	0.1	0.1	0.0	0.1	0.0	0.2	0.0	0.1	0.1		0.2
Horned Lark	0.1		0.6	0.3	0.0		0.1				0.1	0.4		0.0		

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
Pine Siskin								0.2	0.3		0.7			0.7		0.4
Warbling Vireo	0.2	0.1	0.1	0.1	0.3	0.1	0.2	0.0								
Western Meadowlark		0.0					0.1					0.0	0.3	0.1	0.2	0.8
Western Sandpiper	0.8				0.5	0.2									0.2	
American Kestrel	0.1	0.1	0.1		0.1	0.1	0.3	0.3						0.2		0.2
Black-crowned Night-Heron	0.1	0.1	0.0	0.0		0.0	0.2	0.1		0.2	0.1	0.0		0.3	0.3	0.1
Northern Harrier		0.0	0.1		0.0				0.1	0.2	0.6	0.1	0.1		0.1	0.0
Osprey		0.1	0.0		0.1	0.0	0.2	0.3				0.0			0.5	0.1
Red-tailed Hawk		0.0		0.0			0.1		0.2		0.2	0.1	0.1	0.4	0.4	0.2
Sharp-shinned Hawk					0.0				0.4	0.0	0.1	0.2	0.2	0.2	0.2	0.2
American White Pelican				0.1		0.0	0.3	0.1							0.5	0.2
Virginia Rail	0.0	0.0	0.0	0.0		0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3		0.1
American Avocet	0.4				0.1		0.3								0.0	
Bell's Vireo	0.4		0.2			0.1	0.1	0.3								
Lazuli Bunting	0.1	0.2	0.1	0.0	0.0		0.1	0.1								
Indigo Bunting					0.2	0.1	0.2	0.5								
Ladder-backed Woodpecker	0.0			0.0		0.1	0.1						0.1	0.3	0.1	0.3
Ring-necked Duck															0.1	0.6
Sora		0.0	0.0	0.0		0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.2	0.2
American Robin								0.0	0.1	0.0	0.3	0.2	0.1		0.1	0.1
Ash-throated Flycatcher	0.1		0.2	0.0		0.2	0.1	0.1								
Black-headed Grosbeak	0.2	0.1			0.1	0.1	0.0	0.1								
Hermit Thrush	0.0	0.0							0.3	0.2	0.0	0.0				0.1
Common Goldeneye								0.1			0.1		0.1		0.0	0.0
Great Horned Owl			0.0		0.1	0.1	0.0						0.0	0.0		0.2
Least Bittern	0.0		0.1	0.1		0.1	0.2	0.1		0.0	0.1					
Long-billed Dowitcher		0.1					0.2	0.1								
Western Tanager	0.1	0.0	0.1		0.1	0.1	0.0	0.1								

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
Black-necked Stilt	0.1				0.2		0.2	0.0								
Dusky Flycatcher	0.0	0.0	0.3				0.0									
Hooded Merganser								0.0								0.4
House Wren		0.0					0.0		0.0				0.0		0.1	0.2
Lark Sparrow			0.1	0.1	0.0	0.1	0.0	0.0								
Lesser Scaup								0.1							0.5	
Nashville Warbler			0.1			0.0	0.1							0.0		0.0
Western Flycatcher (Unidentified)		0.0	0.2	0.0			0.2									
Barn Owl	0.1	0.1			0.0						0.0					
Common Raven							0.1				0.3				0.0	
Golden-crowned Kinglet									0.0		0.3	0.1	0.1	0.0		
Gray Flycatcher	0.0		0.2		0.1			0.0								0.0
Neotropic Cormorant							0.0	0.3								
Red-naped Sapsucker	0.0								0.0	0.1	0.0				0.0	0.0
Red-shouldered Hawk								0.0							0.0	0.2
Ruddy Duck															0.3	0.1
Townsend's Warbler						0.2	0.1									
American Goldfinch					0.0								0.1		0.1	
Black-throated Sparrow		0.0				0.2										
Cedar Waxwing									0.0							
Dunlin							0.2									
Eurasian Collared-Dove					0.0		0.1	0.0								0.1
Hooded Oriole			0.1													
Horned Grebe							0.0	0.1							0.0	0.1
Lesser Nighthawk		0.0			0.0		0.1									
Lesser Yellowlegs							0.1									
MacGillivray's Warbler	0.0		0.0			0.0	0.0									
Merlin										0.0			0.0			

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
Olive-sided Flycatcher	0.0		0.0			0.0	0.0	0.0								
Pacific Wren									0.1					0.1	0.0	
Plumbeous Vireo				0.0			0.0	0.0								
Red-breasted Nuthatch												0.0				0.0
Rock Pigeon											0.1	0.0				
Semipalmated Sandpiper		0.1														
Solitary Vireo (Unidentified)		0.0	0.0	0.2												
Tree Swallow				0.1							0.1					
Vesper Sparrow					0.1	0.0										
Violet-green Swallow			0.1	0.1												
Western Bluebird									0.1							
Western Grebe							0.1				0.0					0.1
Willow Flycatcher				0.1		0.0										
Wilson's Snipe					0.0		0.0	0.0								0.0
American Bittern		0.0														
Blackpoll Warbler																0.0
Black-throated Gray Warbler													0.0			
Blue-winged Teal																0.0
Brown Creeper															0.0	
Brown-crested Flycatcher	0.1															
Canyon Towhee		0.0														
Canyon Wren	0.0									0.0						
Eastern Kingbird						0.0		0.0								
European Starling								0.0								
Green-tailed Towhee				0.0												
Hairy Woodpecker										0.0						
Hammond's Flycatcher							0.0									
House Sparrow							0.0		0.0							

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
Mountain Bluebird												0.0				
Ovenbird														0.0		
Peregrine Falcon				0.0									0.0			
Prairie Falcon													0.0			
Red Crossbill																0.0
Rufous Hummingbird						0.1										
Rufous-crowned Sparrow			0.0													
Sagebrush Sparrow																0.1
Semipalmated Plover	0.0															
Willet								0.0								
Wood Duck												0.0				

Table 7. Relative species abundance (percent of total bird abundance) for all eight years (overall), among seasons, and by survey year (2005-2016). Only species that represent at least 1% of the overall bird abundances in one or more periods are listed (in descending order of overall relative abundance). No entry means that the species was not detected.

Species	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
American Coot	8.4	3.5	11.2	1.8	6.9	7.3	3.7	3.0	2.4	14.8	16.6
Abert's Towhee	6.7	7.7	5.5	12.5	11.2	7.5	7.4	7.1	7.2	3.7	3.1
Red-winged Blackbird	6.4	10.2	4.2	5.6	5.8	7.1	6.8	7.6	4.6	6.6	6.7
Yellow-rumped Warbler	6.1	0.7	13.0	4.9	2.5	8.4	7.3	8.5	9.5	5.7	3.3
Song Sparrow	5.5	7.6	3.8	9.7	10.0	7.7	6.4	4.8	6.0	2.5	2.5
Mallard	5.1	2.7	6.9	0.8	1.7	3.3	2.8	5.2	4.1	7.6	9.5
Marsh Wren	4.5	3.4	5.1	3.6	4.3	5.5	6.8	5.7	5.9	3.2	2.8
White-crowned Sparrow	3.7	0.5	7.5	3.4	3.4	4.0	4.0	5.2	5.7	2.9	2.2
Bewick's Wren	3.6	4.1	2.8	5.9	6.3	3.6	4.7	4.1	3.6	2.0	1.6
Gadwall	3.2	0.7	4.1	0.6	0.8	1.2	1.0	1.3	1.7	5.5	8.0
Black-tailed Gnatcatcher	2.9	3.4	2.4	3.7	4.3	2.4	2.9	3.4	3.5	2.4	2.0
Verdin	2.9	3.6	2.3	2.8	3.5	2.9	3.4	3.5	3.6	2.5	2.1
Common Yellowthroat	2.9	6.5	0.1	3.3	3.6	3.4	4.1	3.0	3.0	2.1	2.1
American Pipit	2.8	0.5	5.1	1.1	2.1	1.5	4.0	3.7	3.2	4.8	1.4
Great-tailed Grackle	2.7	4.7	1.2	0.6	1.2	2.7	2.8	2.7	2.2	3.3	4.1
American Wigeon	2.5	1.3	2.8		0.1	0.2	0.1	0.2	0.4	4.7	8.3
Black Phoebe	2.4	1.6	2.7	3.1	3.4	2.5	2.6	2.3	2.5	2.1	1.5
Gambel's Quail	2.2	3.0	1.6	1.4	0.9	0.7	1.1	2.1	5.7	2.7	2.2
Brown-headed Cowbird	1.9	4.6	0.0	2.7	3.0	2.6	3.0	1.9	2.0	0.9	0.6
Ruby-crowned Kinglet	1.7	0.3	3.1	3.7	3.3	2.4	1.5	1.4	1.6	1.0	0.8
Lucy's Warbler	1.5	3.5		4.0	2.5	1.8	2.0	1.1	1.1	0.5	0.5
Yellow-breasted Chat	1.2	3.0	0.0	2.5	2.2	1.6	2.3	0.7	1.0	0.4	0.6
Mourning Dove	1.2	2.7	0.1	4.1	1.4	1.2	0.9	1.4	1.4	0.5	0.3
Orange-crowned Warbler	1.1	0.2	1.7	1.4	0.9	1.3	1.4	1.1	1.8	0.5	1.1
House Finch	1.1	1.0	1.3	0.7	1.1	1.0	0.9	2.5	1.9	0.4	0.9

Species	Overall	Breeding	Non-Breeding	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11
Yellow Warbler	1.0	2.3	0.0	0.8	0.8	1.0	1.9	1.5	1.5	0.5	0.6
Crissal Thrasher	0.9	0.9	0.9	1.5	1.1	0.6	0.8	1.1	1.2	0.7	0.8
Blue Grosbeak	0.8	2.0	0.0	1.9	1.3	1.1	1.2	0.6	0.6	0.4	0.5
Yellow-headed Blackbird	0.7	0.8	0.0	0.7	0.2	0.0	0.2	0.2	0.1	2.3	0.7
Killdeer	0.6	0.8	0.4	1.4	0.7	0.3	0.5	0.6	0.2	0.9	0.5
Say's Phoebe	0.5	0.5	0.6	0.4	0.5	0.3	0.7	1.0	0.7	0.3	0.4
Lesser Goldfinch	0.5	0.3	0.4	0.3	0.5	0.2	0.4	0.7	1.8	0.1	0.2
Brewer's Sparrow	0.5	0.4	0.1	0.2	0.4	0.7	0.7	1.2	0.6	0.1	0.2
Dark-eyed Junco	0.4	0.0	0.7	0.1	0.2	1.2	0.6	0.5	0.3	0.1	0.2

Table 8. Breeding and non-breeding relative species abundances (percent of total bird abundance) for each of eight survey years (2005-2016). Only species that represent at least 1% of the overall bird abundances in one or more periods are listed (in descending order of overall relative abundance). No entry means that the species was not detected.

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
American Coot	0.9	1.0	4.4	2.3	0.9	0.8	6.1	9.1	3.4	13.3	6.1	4.0	4.4	3.5	20.9	19.4
Abert's Towhee	12.9	12.0	7.8	7.7	7.4	8.3	4.6	3.9	10.0	10.0	6.7	6.1	6.4	5.2	3.0	2.9
Red-winged Blackbird	3.9	6.6	9.2	10.5	10.6	10.8	14.9	12.4	9.8	7.0	7.1	2.9	4.7	0.3	1.5	4.7
Yellow-rumped Warbler	0.2	0.8	1.4	0.5	0.6	0.3	0.7	0.9	12.6	4.8	16.1	17.9	18.6	20.6	11.0	6.3
Song Sparrow	10.5	11.5	9.6	8.4	6.2	8.3	4.6	4.1	7.8	7.7	6.0	3.9	3.9	4.0	1.0	1.7
Mallard	0.3	0.3	1.6	1.7	3.2	2.4	4.0	6.0	1.0	4.1	4.2	3.2	6.5	5.8	10.7	11.1
Marsh Wren	1.5	2.2	3.7	5.7	5.1	5.2	2.4	1.8	5.4	6.1	6.2	7.2	6.1	5.8	3.4	3.5
White-crowned Sparrow	0.4	1.1	0.2	0.1	0.4	0.5	0.5	0.6	7.9	5.1	8.6	9.9	11.1	11.1	5.4	4.5
Bewick's Wren	5.3	6.8	3.8	4.9	4.5	2.9	2.7	2.6	5.2	4.9	3.0	4.6	2.9	3.6	1.2	0.8
Gadwall	0.1	0.0	0.2	0.3	0.4	0.1	0.4	2.8	1.3	2.0	1.3	1.1	1.6	2.4	6.4	9.7
Black-tailed Gnatcatcher	3.7	5.1	2.5	2.9	3.5	3.7	3.6	2.7	2.7	3.6	2.0	2.9	3.3	2.8	1.6	1.8
Verdin	2.9	4.5	3.3	3.5	4.1	4.3	3.6	3.0	2.3	1.8	2.4	3.1	3.2	2.4	2.0	1.6
Common Yellowthroat	6.0	6.7	7.4	7.9	6.8	6.9	5.5	5.5	0.0		0.0	0.2		0.1	0.2	0.1
American Pipit		0.1	0.3		2.5	0.3	0.7	0.1	2.9	5.3	2.3	8.5	5.0	6.4	7.0	3.0
Great-tailed Grackle	0.4	1.5	4.1	4.1	4.9	3.4	7.9	8.8	0.9	1.0	1.7	1.9	0.7	1.5	1.0	1.1
American Wigeon			0.1	0.2			1.5	6.2			0.2	0.1	0.2	0.3	6.0	7.9
Black Phoebe	1.7	2.0	1.7	1.6	1.6	1.6	2.0	1.1	3.8	4.5	2.8	3.9	2.4	2.9	2.0	1.8
Gambel's Quail	2.3	1.3	1.2	1.2	3.1	7.3	3.6	3.8	0.5	0.6	0.4	1.2	0.9	4.6	2.2	1.3
Brown-headed Cowbird	5.3	6.2	6.2	6.6	4.5	4.9	2.6	1.8				0.0			0.0	
Ruby-crowned Kinglet	0.6	0.6	0.4	0.3	0.1	0.1	0.2	0.1	7.7	6.1	4.7	2.7	3.1	2.5	1.3	1.5
Lucy's Warbler	8.0	5.3	4.1	4.3	2.6	2.7	1.4	1.5								
Yellow-breasted Chat	5.0	4.6	3.6	4.8	1.6	2.4	1.2	1.7			0.0					
Mourning Dove	7.8	2.6	2.5	1.9	2.9	3.4	1.4	0.6	0.2		0.2	0.1	0.1		0.1	0.1
Orange-crowned Warbler	0.3	0.3	0.3	0.1	0.2	0.3	0.1	0.2	2.2	1.6	2.0	2.7	1.5	2.3	0.5	1.6
House Finch	0.9	0.8	0.7	0.7	2.9	1.3	0.4	0.3	0.3	1.5	1.7	1.2	0.7	2.1	0.6	1.8

Species	Breeding Season / Year								Non-Breeding Season / Year							
	1	2	3	4	5	6	10	11	1	2	3	4	5	6	10	11
Yellow Warbler	1.7	1.5	2.2	3.9	3.2	3.5	1.2	1.7							0.0	
Crissal Thrasher	1.1	1.3	0.4	0.7	1.1	1.1	1.0	0.8	1.9	0.7	0.6	1.0	1.2	1.2	0.4	0.8
Blue Grosbeak	3.3	2.6	2.6	2.4	1.5	1.5	1.1	1.2						0.0		
Yellow-headed Blackbird	1.4	0.1	0.1	0.3	0.5	0.2	2.9	0.7	0.0			0.2				0.0
Killdeer	1.7	0.7	0.3	0.3	1.1	0.4	1.3	0.7	0.8	0.3	0.1	0.7	0.1	0.0	0.7	0.4
Say's Phoebe	0.3	0.6	0.4	0.8	0.8	0.5	0.5	0.2	0.4	0.4	0.1	0.8	1.3	0.6	0.3	0.6
Lesser Goldfinch	0.1	0.3	0.2	0.1	0.3	1.4	0.2	0.1	0.1	0.1	0.1	0.5	0.4	1.9	0.1	0.1
Brewer's Sparrow		0.5	1.3	0.2	0.4	0.9	0.1	0.0	0.2			0.3	0.2		0.0	0.1
Greater Roadrunner	0.6	0.7	0.8	0.5	0.5	0.7	1.0	0.8	0.3	0.1	0.1	0.2	0.1	0.0	0.1	0.3
Northern Flicker			0.1	0.1		0.0	0.0	0.1	0.7	0.9	1.3	1.2	0.6	0.9	0.7	0.6
Dark-eyed Junco	0.1			0.2			0.0		0.1	0.4	3.0	0.9	1.4	0.3	0.1	0.3
Wilson's Warbler	1.5	1.3	1.0	0.4	0.7	0.3	1.3	0.1	0.3							0.0
Western Kingbird	0.3	0.5	0.9	0.5	0.6	0.4	1.3	0.5								
Least Sandpiper					0.8	0.5	0.3	0.1					0.9	0.0	1.2	
Lincoln's Sparrow	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.1	1.4	0.2	0.6	0.5	0.3	0.4	0.3	0.2
Northern Pintail														0.1	1.5	1.0
Bushtit	0.1					0.1			1.2	0.8	0.1		1.9			
Ring-billed Gull							0.0			1.4	1.9		0.1		0.1	0.3
Northern Rough-winged Swallow	0.2	0.3	0.2	1.4	0.5		0.1	0.4								
Eared Grebe	0.0		0.4		0.1			2.3							0.0	
Barn Swallow			2.0													
Cliff Swallow			0.2	1.0	0.0								0.0			

Table 9. Relative frequencies (percent of survey points with detections on any of 26 surveys) of bird species in each of the eight years of surveys in the Las Vegas Wash (February 2005 – August 2016). Number of survey points increased from 29 to 31 after the second year (see Methods; Table 1). Birds recorded incidentally, as fly-overs, or > 100 m from the survey point are excluded. Species listed in descending order of average frequency.

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11	Average Frequency
Yellow-rumped Warbler	100	97	100	97	100	90	97	100	98
Black Phoebe	100	100	100	94	94	90	100	97	97
Abert's Towhee	100	100	97	97	97	94	90	97	96
White-crowned Sparrow	93	100	97	97	97	84	94	97	95
Song Sparrow	100	97	97	97	100	87	87	90	94
Verdin	93	97	90	97	100	87	90	94	93
Bewick's Wren	97	100	90	97	97	90	84	77	92
Black-tailed Gnatcatcher	93	97	94	90	100	81	84	84	90
Brown-headed Cowbird	97	97	94	94	94	84	77	84	90
Common Yellowthroat	93	90	94	90	90	81	90	90	90
Red-winged Blackbird	72	86	97	94	94	84	81	90	87
Ruby-crowned Kinglet	100	97	94	87	90	74	68	71	85
Marsh Wren	93	83	81	87	81	81	77	87	84
Orange-crowned Warbler	93	83	77	87	74	81	68	90	82
Blue Grosbeak	97	86	81	84	74	68	68	61	77
Crissal Thrasher	90	83	77	77	90	77	61	61	77
Mourning Dove	90	76	87	71	84	84	48	52	74
American Coot	59	69	74	74	77	74	84	77	74
Lucy's Warbler	93	90	77	84	74	68	55	42	73
Gambel's Quail	76	52	48	71	58	84	84	84	70
Yellow-breasted Chat	90	76	77	84	61	65	45	58	69
Great-tailed Grackle	34	41	55	71	84	68	90	100	68
Greater Roadrunner	66	66	68	71	65	58	77	68	67
Mallard	31	45	81	68	81	71	81	77	67

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11	Average Frequency
Say's Phoebe	52	48	35	68	97	77	68	71	65
House Finch	59	76	68	68	68	68	42	68	64
Yellow Warbler	59	48	55	61	74	68	55	74	62
Northern Flicker	59	66	65	77	55	52	58	58	61
American Pipit	59	62	77	61	52	65	52	45	59
Wilson's Warbler	76	66	65	48	35	29	58	23	50
Gadwall	31	34	42	48	55	52	45	48	44
Killdeer	55	55	29	48	32	19	55	48	43
Western Kingbird	24	17	55	32	45	39	87	42	43
Loggerhead Shrike	52	31	13	35	58	35	48	65	42
Great Blue Heron	24	41	32	29	42	42	61	65	42
Brewer's Sparrow	21	28	42	58	65	55	19	39	41
Lincoln's Sparrow	66	28	61	39	29	29	35	39	41
Lesser Goldfinch	24	34	32	39	45	48	39	19	35
Dark-eyed Junco	21	24	61	45	39	29	23	29	34
Spotted Sandpiper	31	34	10	32	32	29	45	55	34
Green Heron	21	55	32	29	19	29	52	29	33
Black-chinned Hummingbird	17	38	35	32	32	32	32	39	32
Blue-gray Gnatcatcher	52	62	29	58	10	19	23	0	32
Belted Kingfisher	38	28	26	29	32	23	35	39	31
Northern Mockingbird	7	31	23	13	29	19	32	52	26
White-winged Dove	45	21	39	29	16	23	13	3	24
Greater Yellowlegs	31	10	13	16	13	19	32	52	23
American Wigeon	0	3	19	13	13	13	42	68	21
Northern Rough-winged Swallow	21	21	13	45	19	16	13	23	21
Western Wood-Pewee	10	17	13	26	6	29	42	13	20
Double-crested Cormorant	3	14	35	23	19	3	29	26	19
Savannah Sparrow	14	0	19	16	19	32	19	29	19

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11	Average Frequency
Pied-billed Grebe	7	17	26	19	16	13	16	32	18
Common Gallinule	10	10	16	13	19	23	29	26	18
Cooper's Hawk	10	14	16	10	10	26	26	32	18
Costa's Hummingbird	14	17	26	16	6	23	19	16	17
Anna's Hummingbird	24	3	3	10	16	6	35	39	17
Spotted Towhee	17	14	16	39	13	10	16	10	17
Bullock's Oriole	3	21	16	0	13	23	19	35	16
Yellow-headed Blackbird	10	7	10	16	10	6	35	32	16
Rock Wren	14	14	10	16	23	29	6	13	16
Sharp-shinned Hawk	24	7	10	19	23	13	13	10	15
Phainopepla	21	31	6	23	16	6	3	10	15
Snowy Egret	7	3	23	6	13	13	16	29	14
Great Egret	14	7	13	6	13	16	13	26	13
Red-tailed Hawk	14	7	13	10	6	16	23	19	13
Warbling Vireo	17	14	10	10	19	6	10	19	13
Northern Harrier	7	14	35	19	6	0	10	13	13
American Kestrel	14	7	6	3	6	13	23	26	12
Lazuli Bunting	17	24	6	29	3	0	6	6	12
Black-crowned Night-Heron	10	10	13	3	3	10	23	19	11
Virginia Rail	14	7	6	6	6	23	10	16	11
Green-winged Teal	0	17	13	6	6	6	19	19	11
Bushtit	31	21	6	3	16	10	0	0	11
Chipping Sparrow	17	7	16	10	23	10	0	3	11
Osprey	3	3	6	3	10	6	29	19	10
Ash-throated Flycatcher	14	3	16	3	0	13	13	10	9
Common Merganser	7	3	10	6	6	3	16	19	9
Sora	3	7	6	10	3	10	13	19	9
Western Meadowlark	0	7	0	3	10	13	19	19	9

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11	Average Frequency
Ladder-backed Woodpecker	3	0	0	3	6	23	10	23	8
Indigo Bunting	0	0	0	0	16	10	16	26	8
Bell's Vireo	21	0	10	0	0	6	13	16	8
American Robin	7	3	16	13	6	3	6	10	8
Black-headed Grosbeak	14	14	6	0	6	13	3	6	8
White-faced Ibis	7	7	0	3	6	6	16	16	8
Eared Grebe	3	0	3	0	6	0	6	42	8
Canada Goose	0	0	10	0	3	10	23	16	8
Hermit Thrush	14	28	3	3	3	0	3	6	8
Western Tanager	10	3	6	3	10	10	3	13	7
Cinnamon Teal	3	0	0	3	10	0	19	13	6
Bufflehead	0	0	6	3	3	3	19	13	6
Northern Pintail	0	3	0	0	0	3	23	16	6
Great Horned Owl	0	3	3	0	10	19	3	6	6
Western Flycatcher (Unidentified)	3	7	13	3	0	0	16	0	5
Ring-billed Gull	0	3	16	0	3	0	6	13	5
Dusky Flycatcher	3	7	23	0	3	0	3	0	5
Least Bittern	3	3	6	6	0	6	6	6	5
Nashville Warbler	0	0	3	6	3	6	10	10	5
Pine Siskin	7	0	6	0	0	13	0	10	4
Least Sandpiper	0	0	0	0	3	10	19	3	4
Northern Shoveler	3	3	0	0	6	0	6	13	4
Horned Lark	3	0	10	6	3	3	6	0	4
Lark Sparrow	0	0	6	3	3	6	10	3	4
House Wren	7	3	0	0	3	0	3	13	4
American Avocet	7	0	0	0	6	0	13	3	4
Common Goldeneye	0	0	6	6	3	0	6	6	4
Red-naped Sapsucker	7	10	3	0	0	0	3	3	3

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11	Average Frequency
Western Sandpiper	10	3	0	0	6	3	3	0	3
Gray Flycatcher	3	0	6	0	6	3	0	6	3
American White Pelican	0	0	0	3	0	3	10	10	3
Cliff Swallow	0	0	6	10	10	0	0	0	3
Red-shouldered Hawk	0	0	0	0	0	3	6	16	3
Ring-necked Duck	0	0	0	0	0	0	6	19	3
Townsend's Warbler	0	0	0	0	0	13	13	0	3
Barn Owl	10	7	3	0	3	0	0	0	3
MacGillivray's Warbler	3	3	3	0	0	10	3	0	3
Golden-crowned Kinglet	3	0	10	3	3	3	0	0	3
Solitary Vireo (Unidentified)	0	3	3	16	0	0	0	0	3
Pacific Wren	7	3	0	0	0	3	3	3	3
Black-necked Stilt	3	0	0	0	3	0	10	3	2
Common Raven	0	0	10	0	3	0	6	0	2
Eurasian Collared-Dove	0	0	0	0	3	0	10	6	2
Olive-sided Flycatcher	3	0	3	0	0	3	3	3	2
Long-billed Dowitcher	0	3	0	0	0	0	6	6	2
Brewer's Blackbird	0	0	0	3	10	3	0	0	2
Hooded Merganser	0	0	0	0	0	0	3	13	2
Horned Grebe	0	0	0	0	0	0	6	10	2
Neotropic Cormorant	0	0	0	0	0	0	6	10	2
Wilson's Snipe	0	0	0	0	3	0	3	10	2
Red-breasted Nuthatch	0	0	3	3	0	0	3	6	2
Cedar Waxwing	10	3	0	0	0	0	0	0	2
Lesser Nighthawk	0	3	0	0	3	0	3	3	2
Ruddy Duck	0	0	0	0	0	0	6	6	2
Vesper Sparrow	0	0	0	0	3	6	3	0	2
Violet-green Swallow	0	0	3	6	3	0	0	0	2

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11	Average Frequency
Western Grebe	0	0	3	0	0	0	6	3	2
Black-throated Sparrow	0	3	0	0	0	6	0	0	1
Merlin	0	3	0	0	3	0	0	3	1
American Goldfinch	0	0	0	0	6	0	3	0	1
Lesser Yellowlegs	0	0	0	0	3	0	6	0	1
Plumbeous Vireo	0	0	0	3	0	0	3	3	1
Tree Swallow	0	0	6	3	0	0	0	0	1
Brown-crested Flycatcher	7	0	0	0	0	0	0	0	1
Canyon Wren	3	3	0	0	0	0	0	0	1
American Bittern	0	3	0	0	3	0	0	0	1
House Sparrow	3	0	0	0	0	0	3	0	1
Barn Swallow	0	0	3	3	0	0	0	0	1
Cactus Wren	0	0	0	0	0	0	0	6	1
Eastern Kingbird	0	0	0	0	0	3	0	3	1
European Starling	0	0	0	0	0	3	0	3	1
Green-tailed Towhee	0	0	0	3	3	0	0	0	1
Hooded Oriole	0	0	6	0	0	0	0	0	1
Lesser Scaup	0	0	0	0	0	0	3	3	1
Peregrine Falcon	0	0	0	3	3	0	0	0	1
Redhead	0	0	0	3	0	0	3	0	1
Rock Pigeon	0	0	3	3	0	0	0	0	1
Rufous Hummingbird	0	0	0	0	0	6	0	0	1
Willow Flycatcher	0	0	0	3	0	3	0	0	1
Canyon Towhee	0	3	0	0	0	0	0	0	0
Hairy Woodpecker	0	3	0	0	0	0	0	0	0
Semipalmated Plover	3	0	0	0	0	0	0	0	0
Semipalmated Sandpiper	0	3	0	0	0	0	0	0	0
Western Bluebird	3	0	0	0	0	0	0	0	0

Species	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 10	Year 11	Average Frequency
Blackpoll Warbler	0	0	0	0	0	0	0	3	0
Black-throated Gray Warbler	0	0	0	0	3	0	0	0	0
Blue-winged Teal	0	0	0	0	0	0	0	3	0
Broad-tailed Hummingbird	0	0	0	0	0	3	0	0	0
Brown Creeper	0	0	0	0	0	0	3	0	0
Cattle Egret	0	0	0	0	0	0	0	3	0
Dunlin	0	0	0	0	0	0	3	0	0
Hammond's Flycatcher	0	0	0	0	0	0	3	0	0
Mountain Bluebird	0	0	0	3	0	0	0	0	0
Ovenbird	0	0	0	0	0	3	0	0	0
Pectoral Sandpiper	0	0	0	0	3	0	0	0	0
Prairie Falcon	0	0	0	0	3	0	0	0	0
Red Crossbill	0	0	0	0	0	0	0	3	0
Rufous-crowned Sparrow	0	0	3	0	0	0	0	0	0
Sagebrush Sparrow	0	0	0	0	0	0	0	3	0
Scissor-tailed Flycatcher	0	0	0	0	0	3	0	0	0
Snow Goose	0	0	0	0	0	0	0	3	0
Summer Tanager	0	0	0	0	0	0	3	0	0
Turkey Vulture	0	0	0	3	0	0	0	0	0
Virginia's Warbler	0	0	3	0	0	0	0	0	0
Willet	0	0	0	0	0	0	0	3	0
Wood Duck	0	0	0	3	0	0	0	0	0

Table 10. Estimated densities (birds per 40 ha) and abundance ranks for Nevada Bird Count (NBC) Mojave lowland riparian transects within Clark County (2005-2014) compared to Las Vegas Wash breeding season data (2005-2016). Species are listed in descending order of abundance from the NBC data, and include the 50 most abundant species from each of the datasets.

Species	NBC		Wash	
	Abundance	Rank	Abundance	Rank
Gambel's Quail	7.68	1	4.48	13
Abert's Towhee	7.49	2	11.42	2
Lucy's Warbler	6.14	3	5.23	9
Mourning Dove	4.96	4	4.02	15
Brown-headed Cowbird	4.58	5	6.74	6
Yellow Warbler	4.20	6	3.44	17
Verdin	3.97	7	5.34	8
House Finch	3.93	8	1.44	21
Red-winged Blackbird	3.88	9	15.01	1
Song Sparrow	3.62	10	11.16	3
Bewick's Wren	3.59	11	5.99	7
Yellow-breasted Chat	3.19	12	4.41	14
Phainopepla	2.82	13	0	
Northern Rough-winged Swallow	2.42	14	0.57	38
Black-tailed Gnatcatcher	2.24	15	5.06	11
Cliff Swallow	2.17	16	0.21	
Black-throated Sparrow	2.14	17	0.03	
Common Yellowthroat	2.05	18	9.58	4
Ash-throated Flycatcher	2.00	19	0.08	
Crissal Thrasher	1.37	20	1.39	22
Blue Grosbeak	1.32	21	2.88	18
Blue-gray Gnatcatcher	1.10	22	0.26	50
Bell's Vireo	1.01	23	0.14	
Lesser Goldfinch	0.98	24	0.45	41
Spotted Towhee	0.97	25	0.03	
Great-tailed Grackle	0.96	26	6.97	5
Mallard	0.83	27	3.94	16
Say's Phoebe	0.78	28	0.73	31
Northern Mockingbird	0.75	29	0.37	43
Bullock's Oriole	0.74	30	0.24	
Brewer's Sparrow	0.70	31	0.58	37
American Coot	0.64	32	5.21	10
White-winged Dove	0.62	33	0.52	40
Wilson's Warbler	0.60	34	1.16	25
Rock Wren	0.56	35	0.10	

Species	NBC		Wash	
	Abundance	Rank	Abundance	Rank
Black-chinned Hummingbird	0.54	36	0.66	33
Killdeer	0.53	37	1.23	23
White-crowned Sparrow	0.53	37	0.72	32
Woodhouse's Scrub-Jay	0.53	37		
Western Kingbird	0.52	40	0.98	28
White-faced Ibis	0.52	40	0.22	
Yellow-rumped Warbler	0.51	42	1.01	27
Lazuli Bunting	0.50	43	0.08	
House Sparrow	0.49	44	0.00	
Eurasian Collared-Dove	0.45	45	0.02	
Western Meadowlark	0.44	46	0.01	
Black Phoebe	0.43	47	2.41	19
Cactus Wren	0.43	47		
Marsh Wren	0.39	49	4.97	12
Common Raven	0.39	49	0.01	
Canyon Wren	0.39	49	0.00	
Bushtit	0.37	50	0.02	
Greater Roadrunner	0.31		1.04	26
Anna's Hummingbird	0.24		0.30	47
Spotted Sandpiper	0.18		0.59	36
Loggerhead Shrike	0.18		0.28	49
Yellow-headed Blackbird	0.16		1.23	23
Orange-crowned Warbler	0.10		0.32	45
Ruby-crowned Kinglet	0.06		0.44	42
Great Blue Heron	0.05		0.60	35
Green Heron	0.05		0.53	39
Eared Grebe	0.03		0.63	34
Barn Swallow	0.01		0.32	46
Least Sandpiper	0.00		0.33	44
American Wigeon			1.86	20
Gadwall			0.98	28
American Pipit			0.76	30
Common Gallinule			0.30	48

Table 11. Summary trends from regression statistics for 20 species that were detected within 100 m of survey points at the Las Vegas Wash during at least 40 (of a total of 208) survey visits between February 2005 and August 2016. Species listed in descending order of detections. Dark gray shading indicates significantly negative trends (seven species), and light gray shading indicates significantly positive trends (nine species). Where the residuals were not normally distributed, Spearman rank correlation was used (*).

Species	No. of Visits with Detections	Total No. of Birds Detected	Overall Density Estimate (Birds/40 ha)	Transform-ation (Detections/ 40 ha)	Adj. R^2	Regression Coefficient (Correlation Coefficient)	P
Abert's Towhee	208	5539	11.26	Ln	0.137	-0.047	<0.001
Red-winged Blackbird	193	5333	10.77	-	-	(0.209)	0.002*
Yellow-rumped Warbler	133	5105	10.20	Cube Root	0.046	0.052	0.007
Song Sparrow	208	4517	9.25	Square Root	0.243	-0.107	<0.001
Mallard	175	4332	8.61	Cube Root	0.423	0.153	<0.001
Marsh Wren	206	3746	7.55	-	-	(0.169)	0.014*
White-crowned Sparrow	127	3069	6.16	Cube Root	0.000	0.015	0.372
Bewick's Wren	208	2942	5.99	Square Root	0.146	-0.067	<0.001
Gadwall	96	2724	5.40	-	-	(0.358)	<0.001*
Black-tailed Gnatcatcher	207	2433	4.93	Square Root	0.032	0.030	0.006
Verdin	208	2433	4.92	Square Root	0.095	0.046	<0.001
Common Yellowthroat	125	2388	4.86	-	-	(-0.015)	0.866*
American Pipit	91	2365	4.72	Cube Root	0.185	0.111	<0.001
Gambel's Quail	168	1825	3.68	Ln	0.253	0.114	<0.001
Ruby-crowned Kinglet	124	1437	2.92	Square Root	0.026	-0.045	0.040
Lucy's Warbler	96	1182	2.45	Square Root	0.183	-0.117	<0.001
Yellow-breasted Chat	83	1023	2.09	Square Root	0.071	-0.074	0.007
Orange-crowned Warbler	136	944	1.90	-	-	(-0.044)	0.590*
Yellow Warbler	90	829	1.68	Ln	0.000	-0.010	0.570
Blue Grosbeak	77	692	1.41	Square Root	0.060	-0.052	0.016

Table 12. Comparison of species richness, total abundance and estimated densities (birds per 40 ha) in three vegetation treatments of 41 species (see Methods). Single survey point with "no treatment" included for reference. Species listed in descending order of statistical significance. Green shading indicates high values in comparisons that showed statistically significant differences (P < 0.1).

Treatment	No Treatment (n=1)	Older Reveg (n=13)	Immature Reveg (n=5)	Recently Cleared/ Flooded (n=14)	R^2	P
Abundance	128.55	159.84	115.08	252.86	0.15	0.111
Richness	44.00	52.64	45.20	62.21	0.167	0.085
Abert's Towhee	10.77	12.35	12.78	3.50	0.521	<0.001
Black-tailed Gnatcatcher	17.38	7.88	9.06	1.58	0.469	<0.001
Killdeer	0.00	0.22	0.10	3.54	0.442	<0.001
Verdin	12.49	9.44	7.54	1.65	0.488	<0.001
Wilson's Warbler	0.49	0.98	0.78	0.19	0.400	0.001
Gadwall	0.00	0.20	0.05	37.18	0.362	0.002
Mallard	0.00	2.89	1.71	44.30	0.372	0.002
American Wigeon	0.00	0.56	0.15	35.74	0.343	0.003
Northern Flicker	3.18	1.56	0.59	0.38	0.349	0.003
American Coot	0.24	5.34	1.62	81.60	0.329	0.005
Blue Grosbeak	1.47	1.58	1.32	0.47	0.307	0.007
Yellow Warbler	0.24	2.49	1.47	0.52	0.301	0.008
American Pipit	0.00	0.71	0.00	15.93	0.297	0.009
Orange-crowned Warbler	2.45	2.45	3.67	1.21	0.281	0.012
Ruby-crowned Kinglet	1.96	3.67	2.20	0.89	0.277	0.012
Bewick's Wren	11.75	6.54	5.58	1.64	0.262	0.017
Crissal Thrasher	1.96	2.58	3.33	0.61	0.254	0.019
Great Blue Heron	0.00	0.40	0.59	2.92	0.251	0.020
Spotted Sandpiper	0.00	0.27	0.20	1.30	0.247	0.022
Gambel's Quail	6.61	9.73	9.94	1.66	0.204	0.046
Green Heron	0.00	0.27	0.05	0.42	0.203	0.047
Marsh Wren	0.24	4.79	5.58	10.74	0.196	0.053
Lucy's Warbler	5.88	2.29	0.73	0.26	0.188	0.060
Yellow-breasted Chat	0.24	1.49	2.55	0.70	0.164	0.088
Greater Roadrunner	1.96	1.56	1.67	0.70	0.155	0.102
Yellow-rumped Warbler	5.88	14.45	8.13	9.67	0.156	0.102
Red-winged Blackbird	0.00	10.04	13.52	23.73	0.149	0.113
Mourning Dove	4.90	1.67	0.10	0.47	0.923	0.175
Great-tailed Grackle	1.71	6.70	4.02	13.63	0.115	0.193
House Finch	2.94	1.65	3.18	1.03	0.095	0.259
Loggerhead Shrike	0.49	0.47	0.93	0.40	0.088	0.290

Treatment	No Treatment (n=1)	Older Reveg (n=13)	Immature Reveg (n=5)	Recently Cleared/ Flooded (n=14)	R^2	P
White-crowned Sparrow	6.86	6.08	8.52	5.49	0.074	0.354
Western Kingbird	1.71	1.07	0.93	0.60	0.059	0.441
Northern Mockingbird	2.20	0.53	1.27	0.74	0.051	0.492
Brown-headed Cowbird	2.94	2.29	1.81	1.43	0.048	0.515
Belted Kingfisher	0.00	0.42	0.24	0.28	0.042	0.564
Lincoln's Sparrow	0.49	0.36	0.15	0.37	0.03	0.659
Say's Phoebe	0.24	0.78	1.08	1.03	0.022	0.742
Black Phoebe	3.67	4.94	3.92	4.18	0.021	0.749
Common Yellowthroat	0.98	4.94	4.80	5.64	0.009	0.88
Song Sparrow	2.94	5.88	5.53	6.77	0.009	0.88