BIRD POPULATION TRENDS AND HABITAT TREATMENT EFFECTS AT THE LAS VEGAS WASH, 2005-2011

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Abstract

The Great Basin Bird Observatory (GBBO) completed the sixth year of bird surveys and vegetation assessments along an 8.7 km stretch of the Las Vegas Wash (hereafter: Wash) between February 2009 and April 2011. This effort is a two-year continuation of major work done in the first four years of the project by the San Bernardino County Museum and the Southern Nevada Water Authority, the latter of which also heads a major stabilization and enhancement project designed to prevent erosion and reclaim wetland and riparian habitat in the Wash. In this report, we summarize bird species occurrence, trends in abundance, and effects of treatments on bird populations. In each of the six 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 185 bird species were recorded over the course of six years, constituting about half of the total bird species richness recorded in Nevada. Of these, 36 are conservation priority species according to current assessments in regional bird initiatives, as well as the Clark County Multiple Species Habitat Conservation Plan and the Lower Colorado River Multi-Species Conservation Program. Average species richness slightly increased over the six survey years, and total bird abundance increased significantly. Species-specific trends were mixed with nine species showing significant declines and 15 showing significant increases over the study period. Several of the declining birds are riparian shrub-associated, and several 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. Treatment effects were examined for untreated, cleared, recently revegetated, and old revegetation sites, and we found that species richness and total abundance were higher in old revegetation sites than in the other treatment categories. In our recommendations, we included several options for continuing monitoring of landbirds, which should show the majority of bird benefits from the project activities, as conditions will likely continue to improve as the vegetation from plantings matures. For conservation and adaptive management goals, we selected seven species, the Bell's Vireo, Lucy's Warbler, Gambel's Quail, Yellow Warbler, Phainopepla, Yellow-breasted Chat, and Ladder-backed Woodpecker as bellwethers for measuring improvements and making adjustments in management.

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Introduction

The Las Vegas Wash (Wash), located in the southeastern portion of the Las Vegas Valley, is the primary drainage of the Las Vegas Valley Hydrographic Basin. The lower Wash extends approximately 20 km, terminating in Las Vegas Bay, in Lake Mead. While the Wash was historically ephemeral, it has become a permanent riverine and wetland complex from treated wastewater runoff and wetland creation projects over the past 40 years. From the significant 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 through to the present. Plan activities include installing weirs and other control structures to halt the down-cutting, 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. 2009). The purpose of these bird surveys was to (1) inventory bird population and bird habitat parameters to provide a baseline, (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 all six years of surveys, the past two of which were conducted by the Great Basin Bird Observatory in 2009 and 2010 (ending in April 2011), and analyzes all data together to summarize bird community structure, early population

trends, and initial effects of project activities. Bird-habitat changes and bird community changes based on the first five survey years are discussed in detail in GBBO (2011).

Methods

Study Area

The study area encompasses 8.7 km of the Las Vegas Wash between the Upper Diversion and Powerline Crossing Weirs (Figure 1). The upland habitat is dominated by Mojave scrub (dominated by creosote bush, *Larrea tridentata*). The riparian area is still dominated by the invasive, non-native tamarisk and common reed (*Phragmites australis*). Native vegetation present includes Goodding willow (*Salix gooddingii*), sandbar willow (*Salix 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.).

Active channel stabilization and revegetation activities occurred along the length of the study area throughout the study period, with nine weirs and 75 acres of revegetation in place by the end of the first year and 12 weirs and approximately 280 acres of revegetation in place by the end of the sixth. Since project activities have been ongoing throughout this study, our monitoring data are likely directly or indirectly affected by them.

Bird Data and Analyses

Data Collection Methods

Birds were surveyed using standardized 5-minute point counts (Ralph and Scott 1981). The study began with 29 points in 2005 and with later additions and a deletion comprised 31 points by the end of 2006, arranged along both sides of the Wash (Figure 1). The survey points were established 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.

Each survey event occurred approximately every two weeks, over a two-day period. The order in which points were sampled was rotated among surveys. 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 using standard breeding bird atlas methods (e.g., Floyd et al. 2007), which consider nesting 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 of the points were done per year (except in 2010, when some sites were occasionally inaccessible due to construction), with the survey year typically running from mid-February through January (Year 5 surveys began on January 31). The majority of this report covers the full six years between 12 February 2005 and 30 January 2011. The few seventh-year surveys conducted in 2011 (through 24 April 2011) were not included in most of our analyses, but they were used for the comprehensive species list.

While surveyors were rotated to minimize observer effects, a review of the data suggested that some observer effects remained, particularly with regard to distance measurements. Prior to 2009, rangefinders were not used to determine distances to birds, which adds to the difficulty in interpreting distance data in the full dataset. For future surveys, the use of rangefinders should be required, if distance data are to be used in analyses.

Data Analysis

Species List

A comprehensive species list of all birds recorded in Las Vegas Wash was generated based on all visits between 12 February 2005 and 24 April 2011, including all survey points (the total of which varied among years between 29 and 31 over the study period), all detection distances, and all birds detected incidentally in the Wash 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 detections were included regardless of survey effort.

Species Richness and Abundance

Unlike our approach for the full 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 life style, such as swallows, swifts, and nighthawks. For these species, a separate analysis that includes flyovers 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 relatively insignificant, particularly given that the added and deleted survey points were similar to the rest of the study area in habitat and species composition.

To make the abundance results useful for comparing data from this project to other regional and national abundance data (and to help control for small variations in survey effort), we used the standardized estimate of density of number of birds per 40 ha, converted from the fixed radius of 100 m around each point (3.14 ha). Using this approach, we plotted the number of bird species and the number of bird detections per 40 ha by survey event in order to illustrate temporal variation in species richness and abundance and to show differences among treatment areas. We performed linear regression analyses to determine whether population trends over time were significant. For all statistical analysis results in this report, those showing $p < 0.05$ were considered significant.

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 resident and migrant species. In this report, we used the same definitions for consistency with previous analyses. This time period also encompasses spring and early fall migration of several mid and long-distance migrants so, inevitably, 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, where described, cover dates not included in either the breeding or non-breeding seasons.

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 overall bird community in one or more periods. Only species that were detected during at least 40 survey events between February 2005 and January 2011 were included in the trend analyses. The arbitrarily chosen 40-event threshold was necessary because meaningful population trends over six years can only be established for at least moderately common species using linear regression. Survey data from all survey points for which data were available were included in these analyses.

Breeding season abundances from the Wash surveys were also compared to data collected as a part of GBBO's Nevada Bird Count (NBC) in the Mojave Desert riparian areas of Nevada. 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 with 1120 point count surveys on 27 ten-point transects in the same six-year period (2005-2011) as the Wash surveys, which included 2157 point count surveys. 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 10 minute survey period per point, rather than the 5 minute period used in 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.

Treatment Effects

The channel stabilization and revegetation treatments included building of weirs that impounded some of the stream and increased marshy vegetation cover and clearing of non-native vegetation before planting of native riparian woodland and riparian-transitional vegetation covers. For our analyses of treatment effects on bird populations, we divided the 31 survey points into four categories based on the 2010 status of project implementation, no treatment (n = 5 survey points), cleared (n = 7), recently or newly revegetated (n = 5), and old revegetation sites (planted no later than 2005; n = 13). Ongoing clearing sometimes made it difficult to survey some points at times, so Point 24 was dropped because only nine surveys were possible in 2010. Categories were assigned by dominant vegetation type at the point, defined as affecting ≥ 50% of the surface area within a 100 m radius. To determine bird responses to treatments, we used only the 2010 bird survey data, as these reflected the bird populations using the sites at the time they were classified according to treatment status. To compare species richness effects of treatments, we calculated cumulative species richness per point for the 2010 surveys. Total abundance and species abundances were calculated as the number of birds per 40 ha. Species abundances were calculated only for the 34 species that were detected at the Wash on at least 15 of the 30 points in 2010. Differences between treatment classes were determined using Analysis of Variance (ANOVA).

Results

Species List

Between 12 February 2005 and 30 January 2011, 185 bird species were observed during visits to the Wash (App. 1). In the sixth year, nine new species were detected for the first time in the Wash, including Ruddy Duck, Northern Goshawk, Sandhill Crane, Semipalmated Plover, Broad-tailed Hummingbird, Eastern Kingbird, Scissor-tailed Flycatcher, Ovenbird, and Townsend's Warbler (all scientific names in App. 1). Forty species that had been recorded at least once during the first five years were not found in the sixth year, including for example, Cinnamon Teal, Caspian Tern, Barn Owl, Red-naped Sapsucker, Dusky Flycatcher, House Wren, Western Bluebird, Hermit Thrush, and Cedar Waxwing. No new species were detected in the few seventh-year surveys that were conducted between 1 February and 24 April 2011.

Of the 185 species observed during the six-year period, 152 were recorded during the breeding season (15 March - 31 August), and 139 were recorded during the non-breeding season (1 October - 31 January). Only a small number of species (4) 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.

Thirty-six 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), or the Lower Colorado River Multi-Species Conservation Program (Bureau of Reclamation 2006; App. 1). Twenty-two of the priority species were recorded during the non-breeding season, and 28 were recorded during the breeding season, while two priority species were only detected in the transitional seasons. Five of the priority species were confirmed to nest within the Wash, including Abert's Towhee, Blue Grosbeak, Gambel's Quail, Yellow Warbler, and Lucy's Warbler. Also, four new species were confirmed as breeders in the sixth year (Cooper's Hawk, Red-tailed Hawk, Yellow-breasted Chat, and Brown-headed Cowbird), resulting in a total of 25 species (listed below) confirmed to be nesting in the Wash based on breeding evidence gathered in 2009-2010 (the two years GBBO collected data).

Abert's Towhee
American Kestrel
Bewick's Wren
Black-crowned Night-Heron
Black-tailed Gnatcatcher
Blue Grosbeak
Brown-headed Cowbird
Common Yellowthroat
Cooper's Hawk
Crissal Thrasher
Gambel's Quail
Great-tailed Grackle
Greater Roadrunner
Loggerhead Shrike
Lucy's Warbler
Mallard
Mourning Dove
Northern Rough-winged Swallow
Northern Harrier
Red-tailed Hawk
Say's Phoebe
Song Sparrow
Verdin
Yellow Warbler
Yellow-breasted Chat

Species Richness and Total Abundance

Seasonal patterns of species richness were similar among years, with richness being lowest in December-January, and peaking during August-September due to migration and juvenile dispersal (Figure 2). Species richness remained similar, but showed a slight increase (Figure 3), for the six survey years, as detailed in the summary table below.

	Breeding	Fall Transition	Non-Breeding	Winter Transition	COMBINED (avg. # species/survey)
Year 1	34.0	34.0	31.7	26.3	**32.3**
Year 2	32.9	40.0	30.3	32.7	**32.5**
Year 3	35.3	34.5	35.2	29.0	**34.5**
Year 4	33.8	39.5	31.2	39.3	**34.0**
Year 5	34.8	44.5	34.0	31.3	**34.8**
Year 6	33.1	45.5	34.9	30.7	**34.3**
COMBINED	**34.0**	**39.7**	**32.8**	**31.6**	**33.8**

Total bird abundance (birds per 40 ha) varied seasonally, but patterns were similar among years, with peaks observed during the late breeding season (May-June) and during the late fall migration period (October-November; Figure 4). Total abundance increased almost every year, as detailed in the summary table below, and showed an overall increasing trend (Figure 5).

	Breeding	Fall Transition	Non-Breeding	Winter Transition	COMBINED (avg. # birds/40 ha)
Year 1	134.7	106.5	131.4	78.5	**124.9**
Year 2	132.1	123.6	126.2	114.7	**127.4**
Year 3	126.8	91.4	157.0	148.9	**137.1**
Year 4	143.4	107.4	151.6	156.3	**145.0**
Year 5	147.0	214.4	173.2	137.4	**160.1**
Year 6	128.0	140.0	200.5	121.4	**150.5**
COMBINED	**135.2**	**130.5**	**155.8**	**126.2**	**140.8**

Species-Specific Abundances

Overall Abundance Patterns

For the whole study period, the species with the greatest absolute abundances included Abert's Towhee, Song Sparrow, Yellow-rumped Warbler, Red-winged Blackbird, Marsh Wren, Bewick's Wren, White-crowned Sparrow, American Coot, Common Yellowthroat, and Black-tailed Gnatcatcher (Table 1a). Density estimates by species, averaged for years and seasons, are provided in Tables 1a and b. The species with the highest absolute abundances also contributed the greatest proportions to total bird abundance, i.e., had the highest relative abundances. Relative abundances (% of total bird abundance by each species) are reported in Tables 2a and b for all species that represented at least 1% of the total bird community in any season or year. The relative frequency of each species (i.e., the percentage of total survey points at which the species was detected at least once) is detailed in Table 3.

Breeding Season Species Abundances in Relation to Regional Abundances

During the breeding season, the ten most abundant species included Abert's Towhee, Song Sparrow, Red-winged Blackbird, Common Yellowthroat, Brown-headed Cowbird, Bewick's Wren, Lucy's Warbler, Marsh Wren, Verdin, and Yellow-breasted Chat (Table 1a). In comparison, the ten most abundant species recorded during seven years of Nevada Bird Count (NBC) surveys included Gambel's Quail, Lucy's Warbler, Mourning Dove, Song Sparrow, Yellow Warbler, House Finch, Cliff Swallow, Bewick's Wren, Abert's Towhee, and Brown-headed Cowbird (Table 4). Half of these two species lists were the same among the two monitoring efforts, indicating an overall large degree of similarity between the Wash and other lowland riparian areas of the region. In fact, some of the dissimilar species included upland-associated and generalist species in the NBC data set (e.g., Mourning Dove) that were not among the most abundant in the Wash. Other interesting species in this comparison include Song Sparrow, Common Yellowthroat, Yellow-breasted Chat, Red-winged Blackbird, Marsh Wren,

and Mallard, all of which had much higher abundances in the Wash than in the regional transects (Table 4).

When comparing the Wash's breeding abundances of select conservation priority species to regional NBC data from similar habitats, the Wash supported lower numbers of Gambel's Quail, Bell's Vireo, and Phainopepla, but much higher numbers of Abert's Towhee, which in fact also had the highest relative abundance in the Wash, and Blue Grosbeak (Tables 4 and 1a). The Wash and the NBC data showed similar abundance estimates for Lucy's Warbler, and for the two high-priority species Costa's Hummingbird and Willow Flycatcher.

Non-breeding Season Species Abundances

During the non-breeding season, the ten most abundant species of the Wash included Yellow-rumped Warbler, White-crowned Sparrow, Abert's Towhee, Marsh Wren, American Coot, Song Sparrow, American Pipit, Red-winged Blackbird, Ruby-crowned Kinglet, and Mallard (Table 1a). 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) and the most abundant migrants and wintering species of the Mojave Desert (e.g., Yellow-rumped Warbler, White-crowned Sparrow, and American Pipit).

Trends

Trends in Species Richness and Total Abundance

Regression analysis results of species richness over time showed a slight (but not significant) increase over the six-year period, with $R^2 = 0.02$ and $p = 0.06$ (Figure 3) and total bird abundance increased significantly with $R^2 = 0.08$ and $p < 0.01$ (Figure 5).

Trends in Species Abundances

Nine species showed significant declines over the six-year survey period, including Abert's Towhee, Song Sparrow, Bewick's Wren, Mourning Dove, Killdeer, Ruby-crowned Kinglet, Lucy's Warbler, Yellow-breasted Chat, and Blue Grosbeak (Table 5). Many of these species are woodland-associated and some (Mourning Dove and Killdeer) are disturbance or upland-associated. Fifteen species showed significant increases over the same time period, including the shrub-associated species Verdin, Gambel's Quail, Orange-crowned Warbler, and White-crowned Sparrow, the marsh and open-water associated species Marsh Wren, Mallard, Great Blue Heron, and Gadwall, and the generalist and upland species Great-tailed Grackle, Say's Phoebe, House Finch, Yellow-rumped Warbler, American Pipit, Lesser Goldfinch, and Rock Wren (Table 5). Population trends of the species with significantly decreasing or increasing trends are also illustrated in Figures 6a – f. The remaining 23 species, for which sufficient sample sizes existed, showed stable population trends over the study period, and no particular habitat guilds stood out in this group.

As found in GBBO (2011), trends in the relative frequency of each species (i.e., the percentage of total survey points at which the species was detected at least once) were similar to their absolute and relative abundances, and so for brevity are not included here.

Changes in Vegetation Cover

Throughout the five-year (2005-2009) period analyzed in GBBO (2011), tamarisk remained the dominant cover at Wash bird survey points, although it experienced significant decreases in cover due to project activities. The proportion of native trees increased slightly, although not significantly, likely as a result of revegetation efforts and possibly greater survival of trees with decreased competition. While vegetation monitoring was conducted at survey points in the fall of 2010 (as in prior years), a rigorous quantitative analysis of these data was not performed for this report, as little habitat alteration occurred during the year. Project activities were initiated or continued at just ~15% of the points in 2010 (as compared to 40% in 2009), the most significant of which was the ongoing construction of the Lower Narrows and Homestead weirs. Although the points impacted by that construction had largely been cleared of vegetation in 2009, there was likely a continued decline in overall vegetative cover and particularly cover by tamarisk resulting from their final clearing and the clearing of tamarisk from another site in advance of revegetation.

Comparison of Treatments

The four treatment classes, no treatment, cleared, newly revegetated, and old revegetation, resulted in several interesting patterns, with both bird species richness and total bird abundance highest in old revegetation sites (Table 6). Newly revegetated sites had significantly higher numbers of Say's Phoebe ($p < 0.01$), which is associated with open or disturbed habitat types, and the abundances of American Coot, which is associated with open water, and Orange-crowned Warbler, which uses a variety of riparian habitat types during migration, were substantially higher. Older revegetation sites had the most species showing treatment effects, with significantly higher abundances of Yellow Warbler and Ruby-crowned Kinglet ($p < 0.01$), and substantially higher abundances of Abert's Towhee, Brown-headed Cowbird, and Northern Flicker, all of which are riparian-associated species during the seasons of detection at the Wash. Overall, our statistical comparisons were affected by low sample sizes and the fact that much revegetation was recent or still in progress during the sixth year of bird surveys. It would be useful to repeat these comparisons at a later time, when more revegetation is completed and bird-habitats have had time to mature (apprx. five to ten years after plantings).

Discussion

As discussed in detail in the previous report (GBBO 2011), the bird community of the Las Vegas Wash is rich, featuring about half of the bird diversity recorded for the state of Nevada, and it is representative of other lowland riparian areas in the region. Bird diversity and total abundance are highest during breeding and post-breeding, as is typical for temperate riparian areas. The site

not only provides important habitat for 36 conservation priority species, some of which were confirmed to be nesting in the site, but also appears to be particularly important as a stopover site for migrants and post-breeding vagrant populations of species that nest in other habitat types.

Population trends, as could be determined from the short monitoring period, are partly as expected in an active restoration site. Some species showed signs of short-term impacts from such project activities as clearing non-native vegetation and construction of large structures, but perhaps more importantly, we found that species richness and total abundance slightly increased despite these activities. Likely a result of the large-scale activities that involved vegetation clearing, Yellow Warbler, Gambel's Quail, and Bell's Vireo occur in much lower abundances at the Wash than documented in other Mojave riparian areas (Table 4). These species are known to be associated with a vigorous shrub component of riparian areas, and are therefore expected to recover as revegetation sites mature. Regardless of short-term impacts to the riparian area from construction and revegetation activities, strong riparian bird populations remain in the Wash, and several, particularly marsh and water-associated, species actually already occur in higher than average numbers. For further details on the natural history and habitat use of these species, see GBBO (2010, 2011). Also, several shrub-associated species that are likely more tolerant of disturbed habitat conditions than the above-mentioned conservation priority species, occurred in double or multifold abundances at the Wash compared to regional riparian areas, for example Song Sparrow and Bewick's Wren. These two species are difficult to distinguish by ear, as they have very similar songs and occasionally mimic each other's vocalizations. For future monitoring, the option of combining their data may be considered depending on the experience of future field surveyors, because we estimate that about 20% of the records of either species could be misidentifications, and this proportion would increase with less experienced field surveyors. We also recommend re-analyzing the six-year monitoring data based on the precise survey season selected for future monitoring efforts, which also differed slightly in our comparisons among NBC and Wash breeding bird data.

The treatment effects analysis showed that most effects on riparian birds occurred in the older revegetation sites, which showed significantly higher species richness and total bird abundance, as well as the majority of positive effects on riparian species trends, including for Yellow Warbler and Ruby-crowned Kinglet, and to a lesser extent, on Abert's Towhee, Brown-headed Cowbird, and Northern Flicker (possibly due to sample size issues). This supports our earlier conclusion that negative effects from project activities on birds and their habitats are likely short term. We expected that, because of the low sample sizes available for the treatment comparisons and the short time elapsed since most revegetation efforts, we would find less pronounced patterns. Our experience is that the largest effects of riparian revegetation on the bird community occur when woodlands and new wetlands have had time to mature. Therefore, if this comparison is repeated with future data from the revegetation sites, we expect additional species to show significant responses.

The currently relatively low numbers of riparian shrub-associated species in the Wash give reason to continue (or return to) monitoring birds in the Wash in future years, as we expect these species groups to recover more slowly than marsh and water-associated species. Also, many of our most important conservation priority species in this region, for example Willow Flycatcher,

Bell's Vireo, and Lucy's Warbler, perform best in the mosaics created, once they have had time to mature, and the types of riparian woodlands planted in the Wash (GBBO 2010).

Recommendations

Monitoring

We recommend continuation of landbird monitoring along the Wash to the extent that future resources allow. Several options can be pursued, which include (1) continuation/return of the full survey schedule as it has been implemented in 2005-2011, (2) a survey schedule and sampling design that is scaled back to either particular seasons (e.g., just the breeding season) or reduced in survey-event frequency, but otherwise the same as previously implemented, (3) a survey schedule that is scaled back to particular seasons and frequency of survey events (e.g., once instead of twice a month), or (4) a full integration of landbird sampling into the NBC program, which would require a revision of the sampling site selection and slight revisions to the protocols.

The last option has the advantages of easy regional comparisons and the ability to select wider spacing of sampling sites, which are currently tight for the 100 m radius we selected as a basis for density estimation. The other options have the advantage of most accurate compatibility with previous survey efforts. However, we maintain that the standardization of our abundance metric to estimated density should allow for flexibility in sampling design, so long as the sampling design allows for calculation of this metric. We also find that a 10 minute survey period per point has the advantage that the birds present at a survey point are more completely recorded than with shorter visits, a circumstance that was at least partially mitigated in the past Wash surveys by more frequent visits than usually done under the NBC program.

Depending on other possible focus points of the Wash project, such as migration monitoring and public education, other sampling methods may also be explored, for example migration banding stations. These have the advantage of being able to monitor retention and return rates of migrant individuals, but they have the disadvantage of being most useful when operated for several years in a row, which can be more costly than passive monitoring methods.

Future data analyses may focus on time series analyses and trend monitoring to confirm increasing recovery of riparian landbirds. For this we recommend focusing on the focal species mentioned below, all of which are riparian-obligate, and possibly expanding this list to include all riparian priority species mentioned in GBBO (2010) under Mojave lowland riparian, which would add Snowy Egret, Swainson's Hawk, Yellow-billed Cuckoo, White-throated Swift, Costa's and Rufous hummingbirds, Willow Flycatcher, and Abert's Towhee. These species were left off the conservation and management indicator list below for a variety of reasons, such as (1) not being a landbird for which point counts are most useful (Snowy Egret), (2) being primarily aerial foragers/hunters (Swainson's Hawk, White-throated Swift, and the hummingbirds), and (3) being less useful for documenting habitat improvements through population trend monitoring (Willow Flycatcher and Yellow-billed Cuckoo because they are inherently rare in the region, and Abert's Towhee because it is already abundant in the Wash). While the point count method and

our approach to data analyses used here are not ideal for some of these species without some adjustments, they are certainly designed to detect these species, if present, and implementing point counts is certainly preferable over not monitoring them at all.

If further analyses are possible in the future, we recommend including other riparian-obligate landbirds that are not conservation priorities, specifically, Song Sparrow, Bewick's Wren, Verdin, Common Yellowthroat, Ash-throated Flycatcher, Black-tailed Gnatcatcher, Blue Grosbeak (which is, in fact, a priority species under the Clark County MSHCP), and Black-chinned Hummingbird. This list of additional indicator species for monitoring only includes landbirds that are likely to nest in the recovering riparian vegetation, and presumes that most monitoring efforts will focus on the breeding season. Other riparian indicator species may be added, if monitoring will include the migration seasons, for example Wilson's and Orange-crowned warblers.

Regardless of what monitoring scheme is selected for future surveys, we recommend keeping landbirds separate from other bird groups in monitoring planning. For instance, secretive marshbirds and other aquatic species (coots, ducks, etc.) are poorly covered by point counts even though they are often detected and recorded during these. Modified area search and call play-back methods, as they have already been implemented (Van Dooremolen 2010a, 2010b) are most appropriate for monitoring these species groups. Also, special species surveys that involve call play-back are necessary for detecting some high priority species, such as Southwestern Willow Flycatcher and Yellow-billed Cuckoo, regardless of the fact that they are landbirds, because these are rare and secretive enough to warrant more intensive surveys, and they nest at slightly different times than most other landbirds. Wash surveys for the flycatcher have been ongoing since 1998 using the federally mandated protocol (Van Dooremolen 2010c) and SNWA assesses habitat on the Wash annually to determine whether cuckoo surveys, which had been conducted from 2000-2004, should recommence (Van Dooremolen Pers. Comm.).

Conservation, Management, and Adaptive Management

Based on the six-year data set, we recommend focusing management and adaptive management of the Wash project on a handful of species that are high conservation priorities, but are also expected to represent the bird community effects of revegetation and construction activities. Several non-priority species have already been recovered at the Wash, likely as a result of the project activities, for example Mallard, Marsh Wren, and Red-winged Blackbird. These are less useful for future monitoring, as they are not conservation priorities and they may decline slightly as riparian woodlands begin to mature after recovery from plantings. Therefore, we recommend the following species for focused evaluation of bird responses to project activities:

- Bell's Vireo
- Lucy's Warbler
- Phainopepla
- Yellow Warbler
- Gambel's Quail
- Yellow-breasted Chat

- Ladder-backed Woodpecker

The first five of these species are conservation priorities under the criteria used in this report, roughly in descending order of conservation urgency, but they are common enough in the region and specialized enough on the habitats targeted by revegetation efforts that they are likely to respond positively to the project with increasing breeding populations. The remaining two species are not conservation priorities, but represent habitat use guilds that are poorly represented by the other species, namely riparian shrub thickets and ground cover (Yellow-breasted Chat), and mature riparian trees (required for cavity nesting by Ladder-backed Woodpecker). All of these seven species are currently underrepresented in the Wash, when compared to their regional abundances in the same habitat type (Table 4). Together, they likely represent the needs of a larger suite of riparian landbirds and therefore lend themselves for measuring recovery progress of riparian habitats and adaptive management planning, should their populations stay low.

Depending on how intensive conservation activities and public involvement will be in the Wash in future years, several conservation strategies would further benefit the riparian bird community (GBBO 2010), many of which are similar to recommended actions in the Las Vegas Wash Wildlife Management Plan (Shanahan et al. 2008). Possible conservation strategies for the Wash include:

- Discouraging the establishment of feral cat colonies in or near the riparian areas
- Selecting routes for public trails that are near enough to woodland groves and wetlands so that wildlife can be enjoyed, but not disturbed; large shrub thickets should not be disrupted by trails to the extent possible
- Allowing a natural mosaic of native trees, native shrubs, wetlands, and transitional woodlands (mesquite, acacia, baccharis, etc.) to develop; some non-native plants are likely always part of the community and are not considered a problem, as long as they are not dominating
- Protecting old trees or tree groves from excessive trampling and other land uses
- Avoiding major disturbances during the main nesting season of landbirds (April 1 – July 1)
- Exploring activities for the public that enhance awareness of wildlife issues, such as building of nest boxes, and creating species checklists and outreach materials focusing on riparian conservation

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Figures

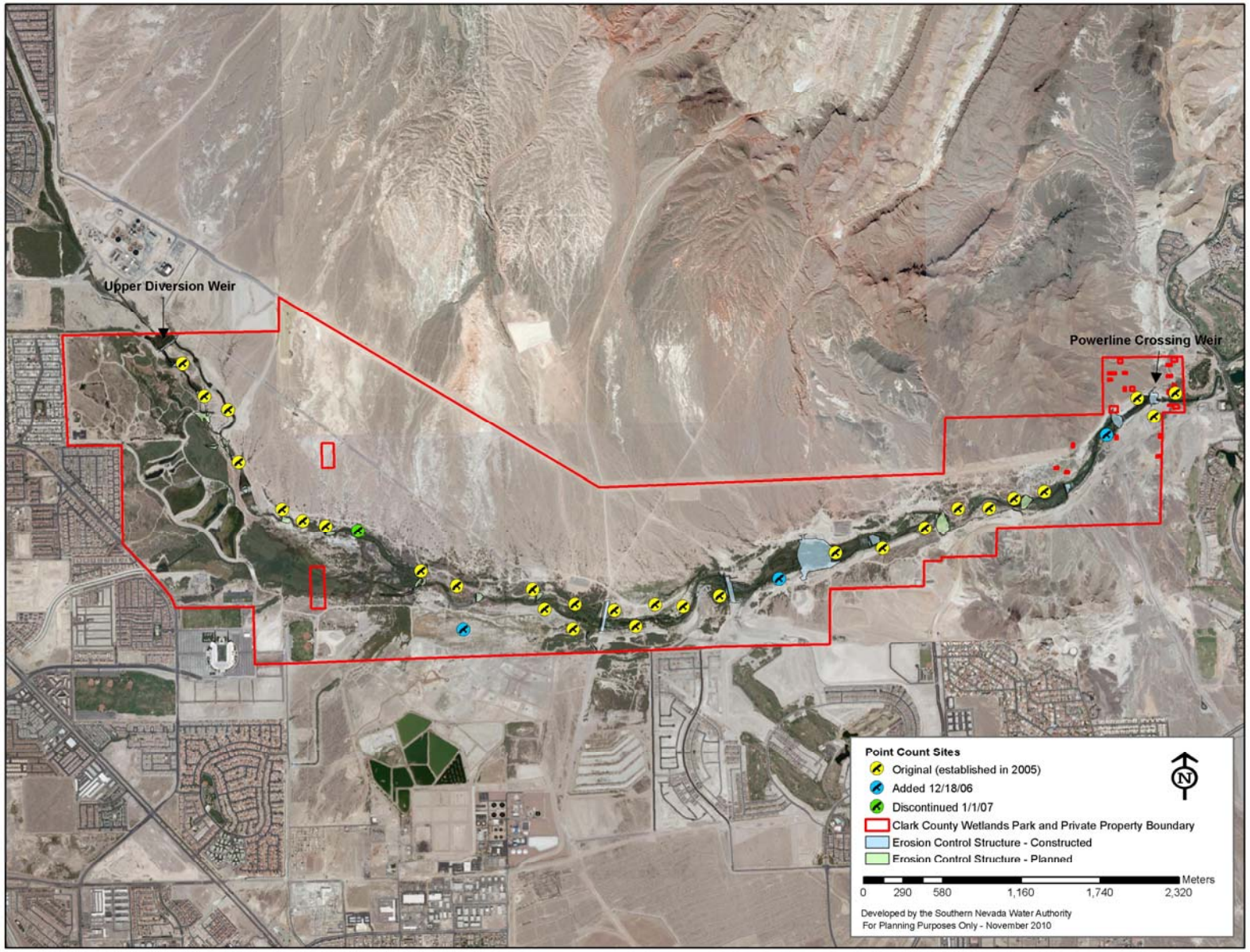

Figure 1. Distribution of point counts across Las Vegas Wash. Map courtesy of Southern Nevada Water Authority.

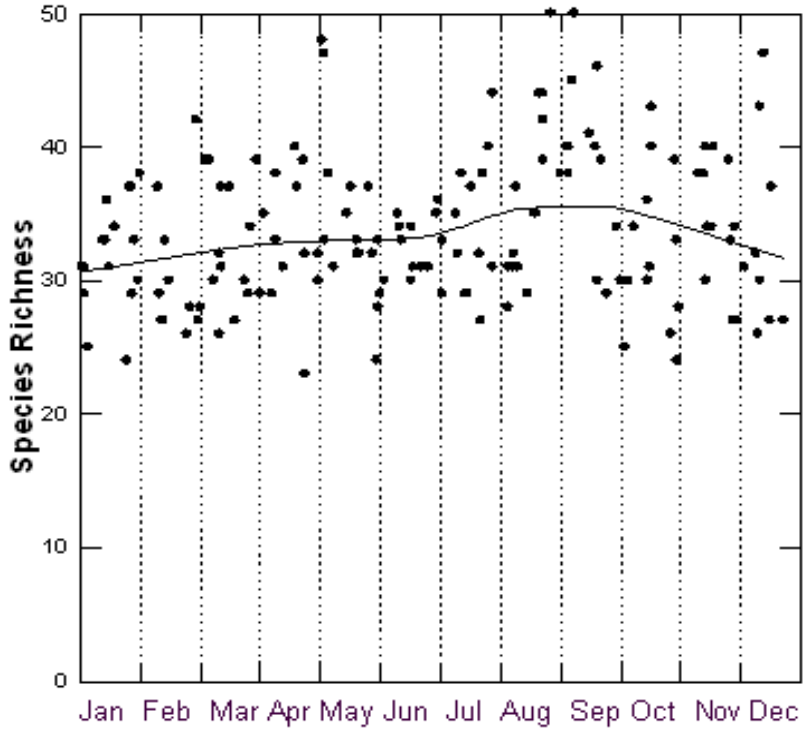

Figure 2. Seasonal species richness per survey event from 156 surveys of the Las Vegas Wash (February 2005 – January 2011). Curve represents a LOWESS smoothed fit for variation in richness among survey events.

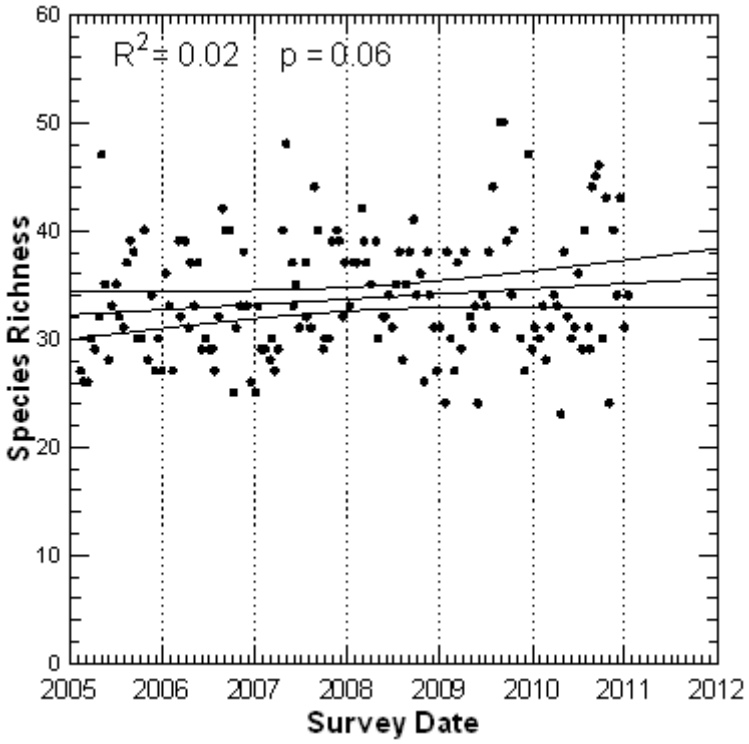

Figure 3. Trend in species richness from 156 surveys of the Las Vegas Wash (February 2005 – January 2011).

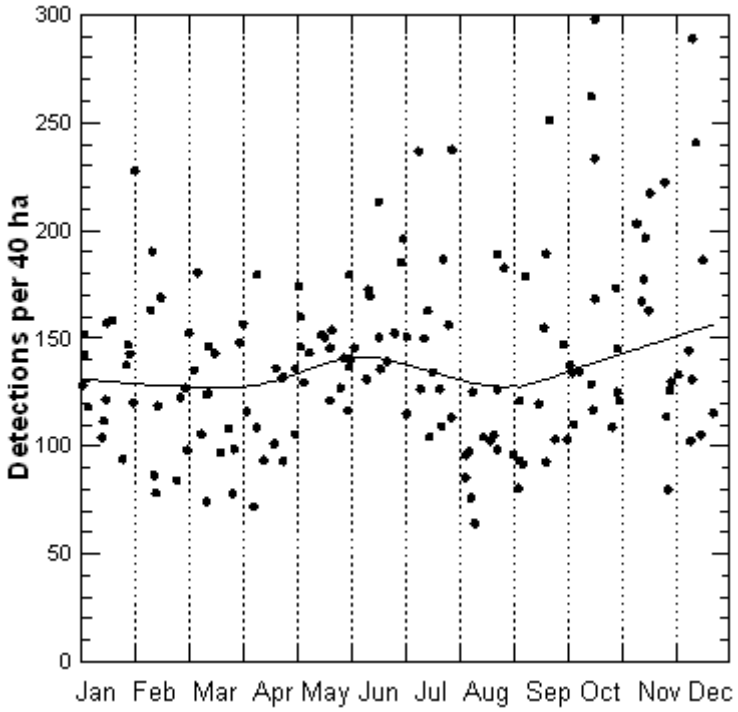

Figure 4. Seasonal total bird abundance per survey event from 156 surveys of the Las Vegas Wash (February 2005 – January 2011). Curve represents a LOWESS smoothed fit for variation in richness among survey events.

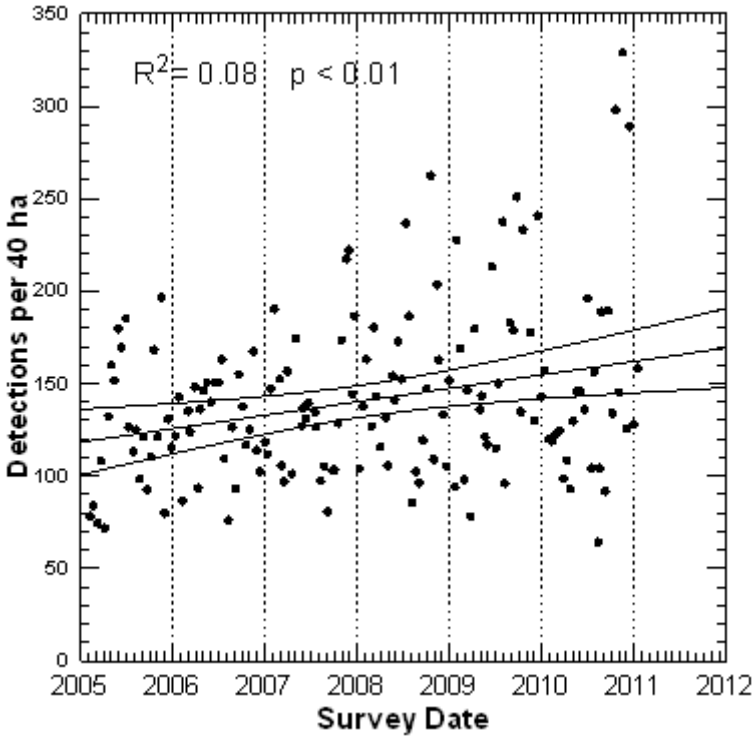

Figure 5. Trend in estimated total bird abundance from 156 surveys of the Las Vegas Wash (February 2005 – January 2011).

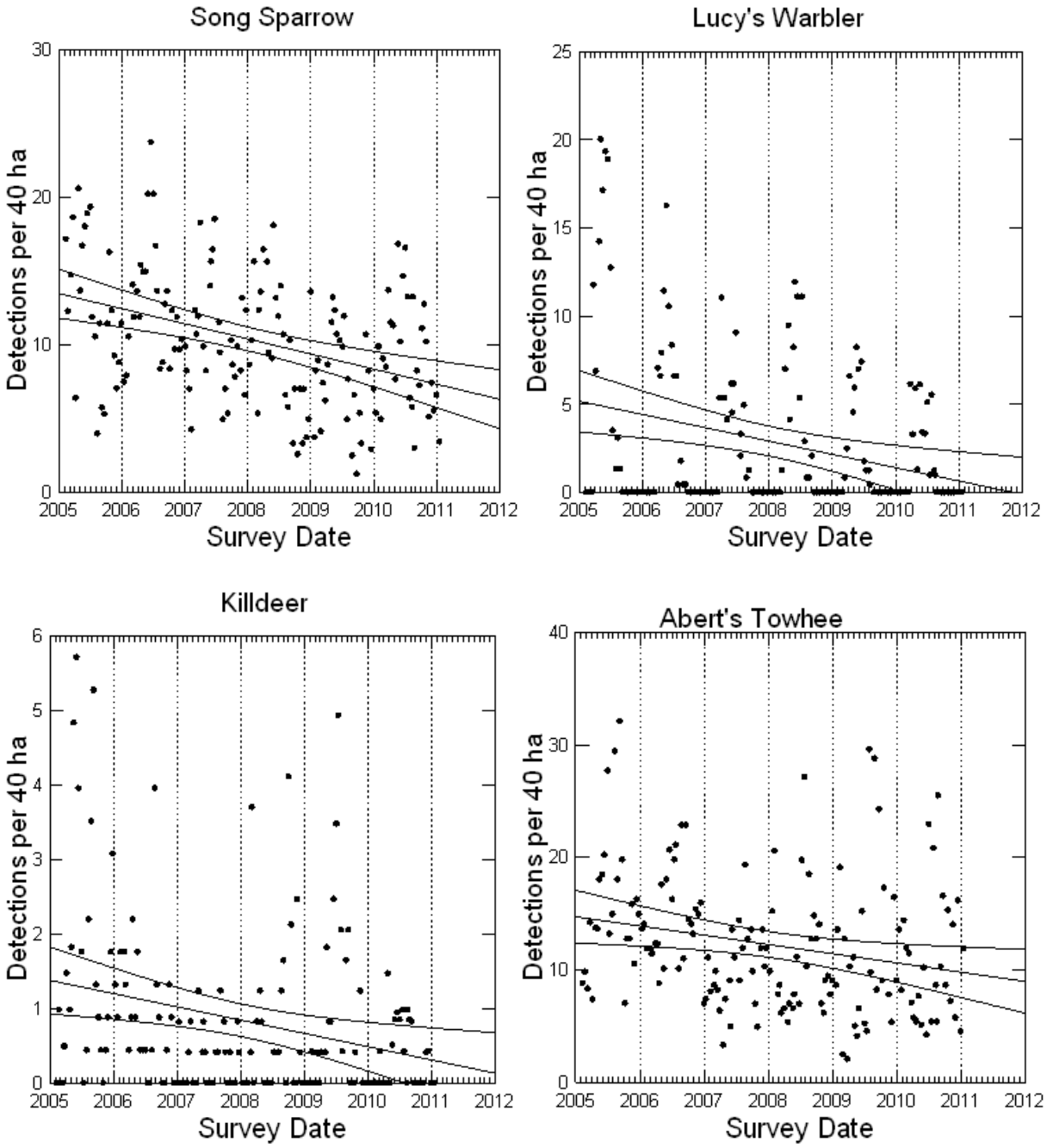

Figure 6a. Population trends of four common species along the Las Vegas Wash (2005 – 2011). See also Table 5 for statistical analysis results.

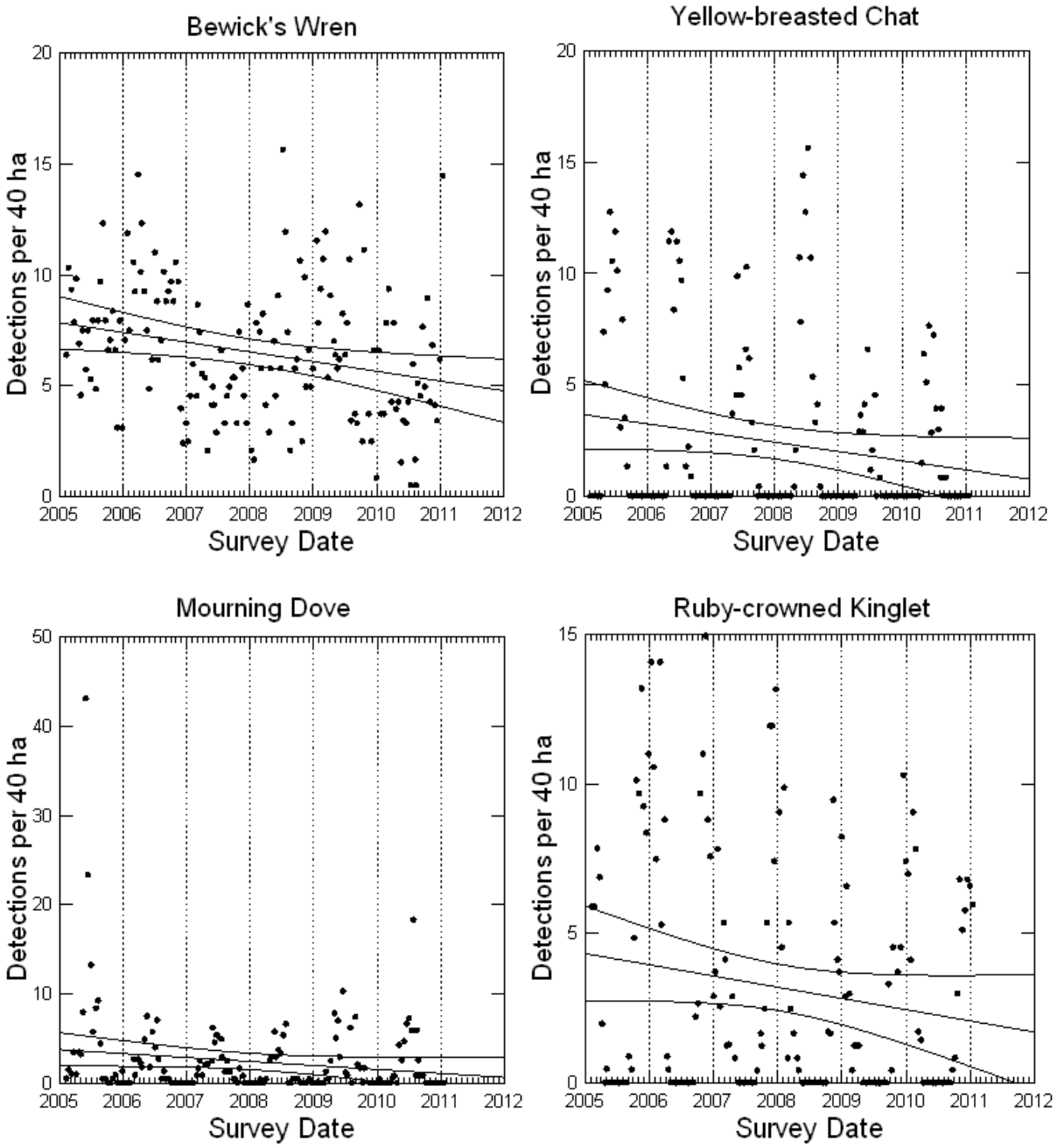

Figure 6b. Population trends of four common species along the Las Vegas Wash (2005 – 2011). See also Table 5 for statistical analysis results.

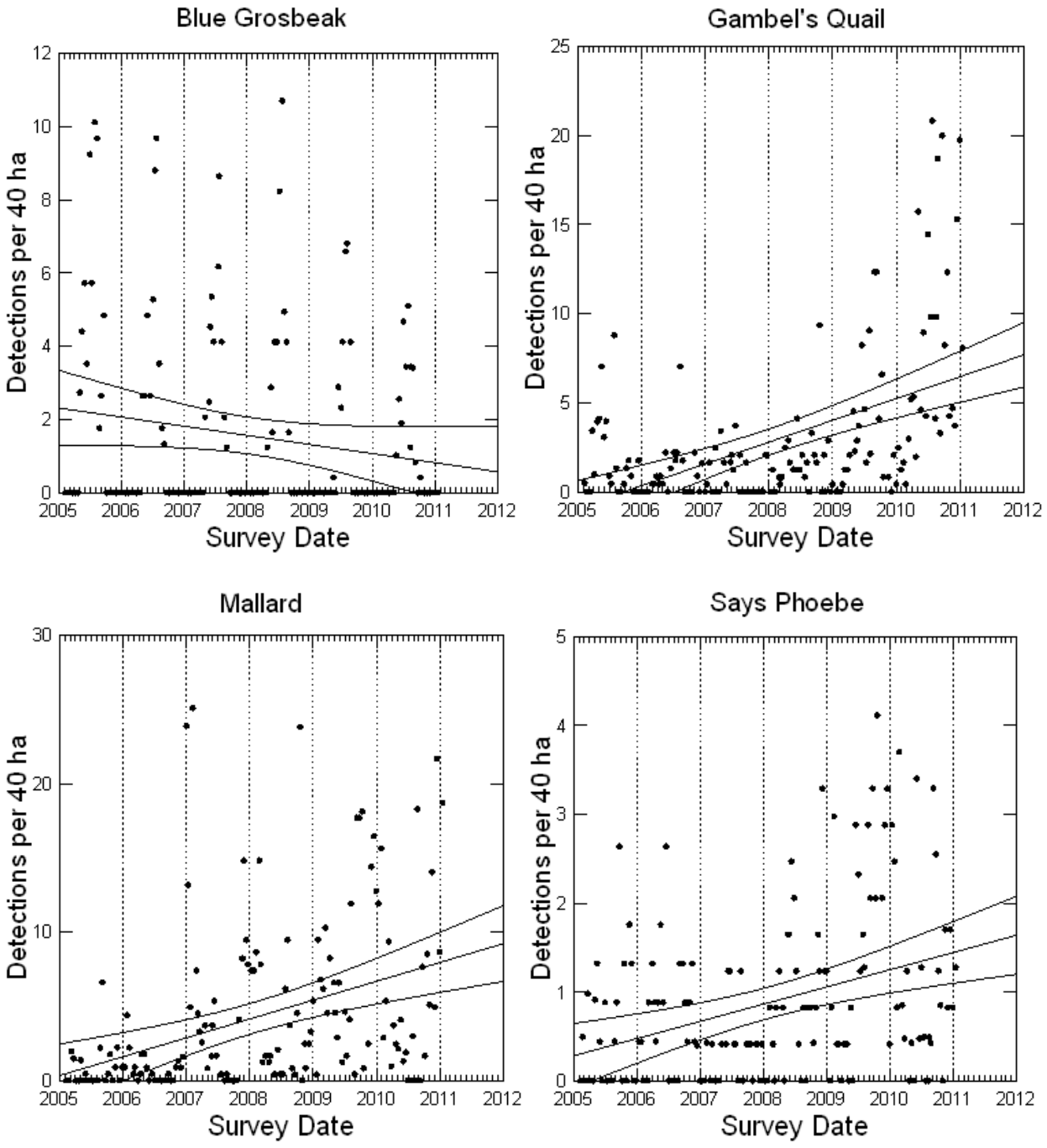

Figure 6c. Population trends of four common species along the Las Vegas Wash (2005 – 2011). See also Table 5 for statistical analysis results.

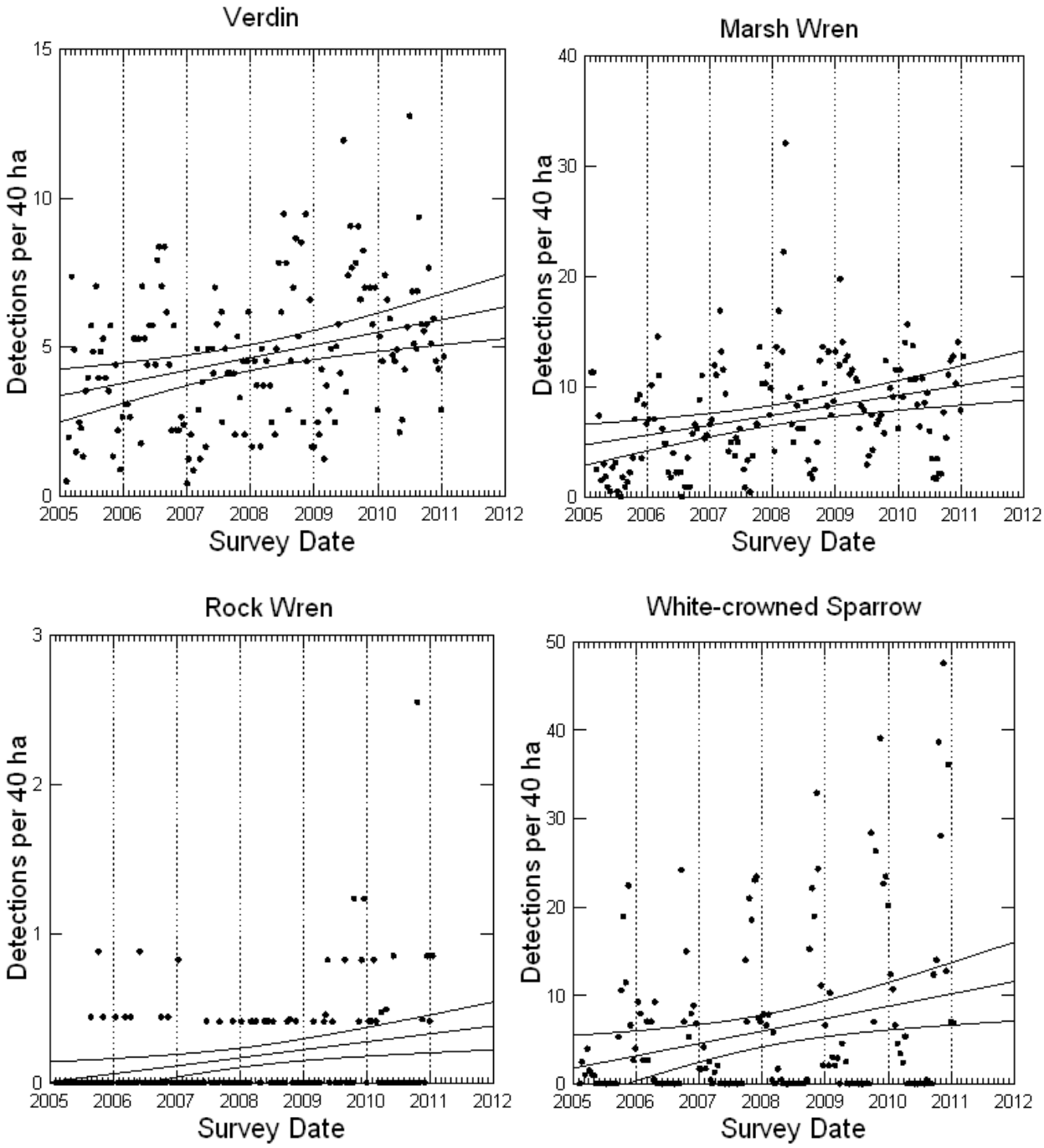

Figure 6d. Population trends of four common species along the Las Vegas Wash (2005 – 2011). See also Table 5 for statistical analysis results.

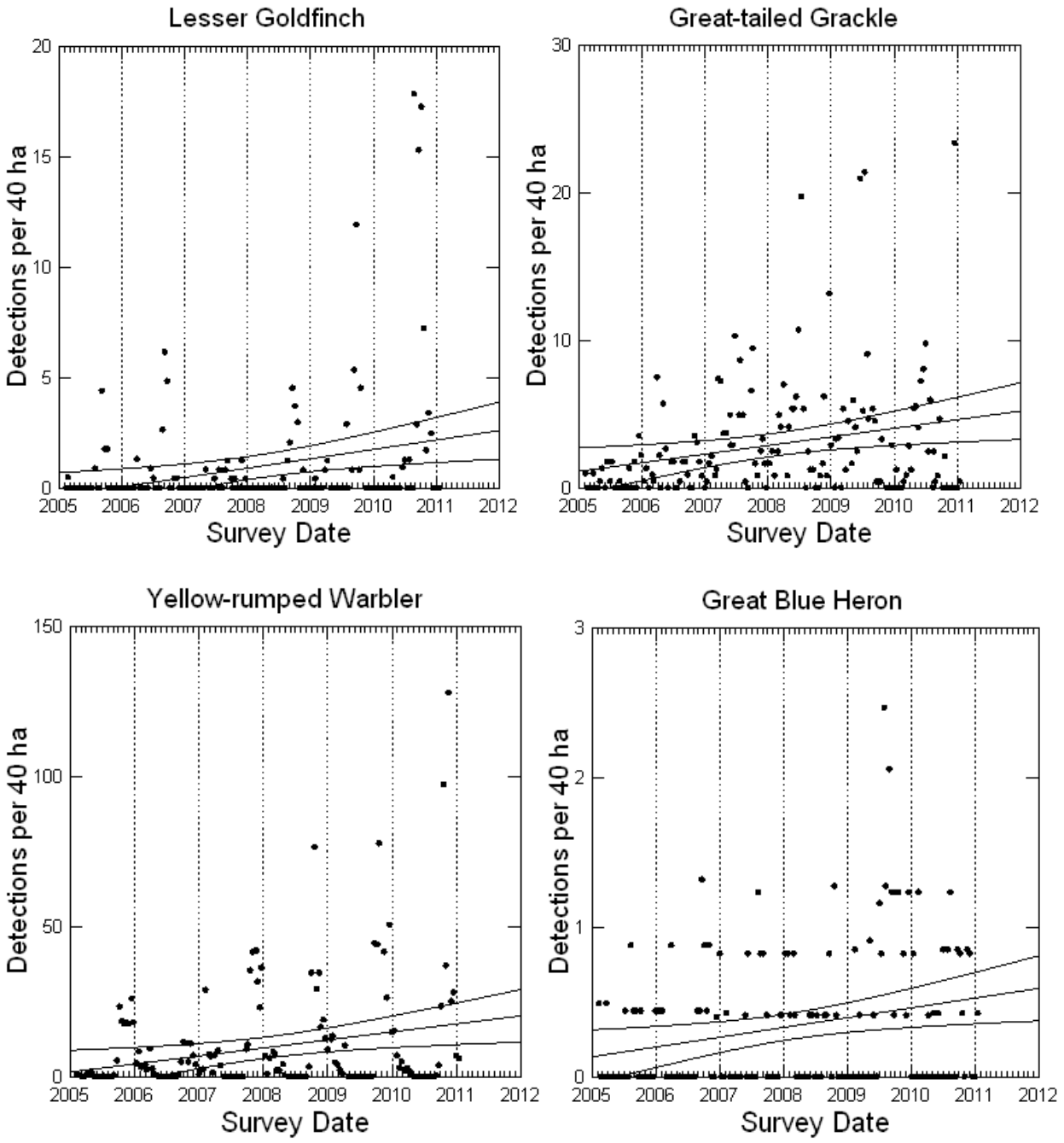

Figure 6e. Population trends of four common species along the Las Vegas Wash (2005 – 2011). See also Table 5 for statistical analysis results.

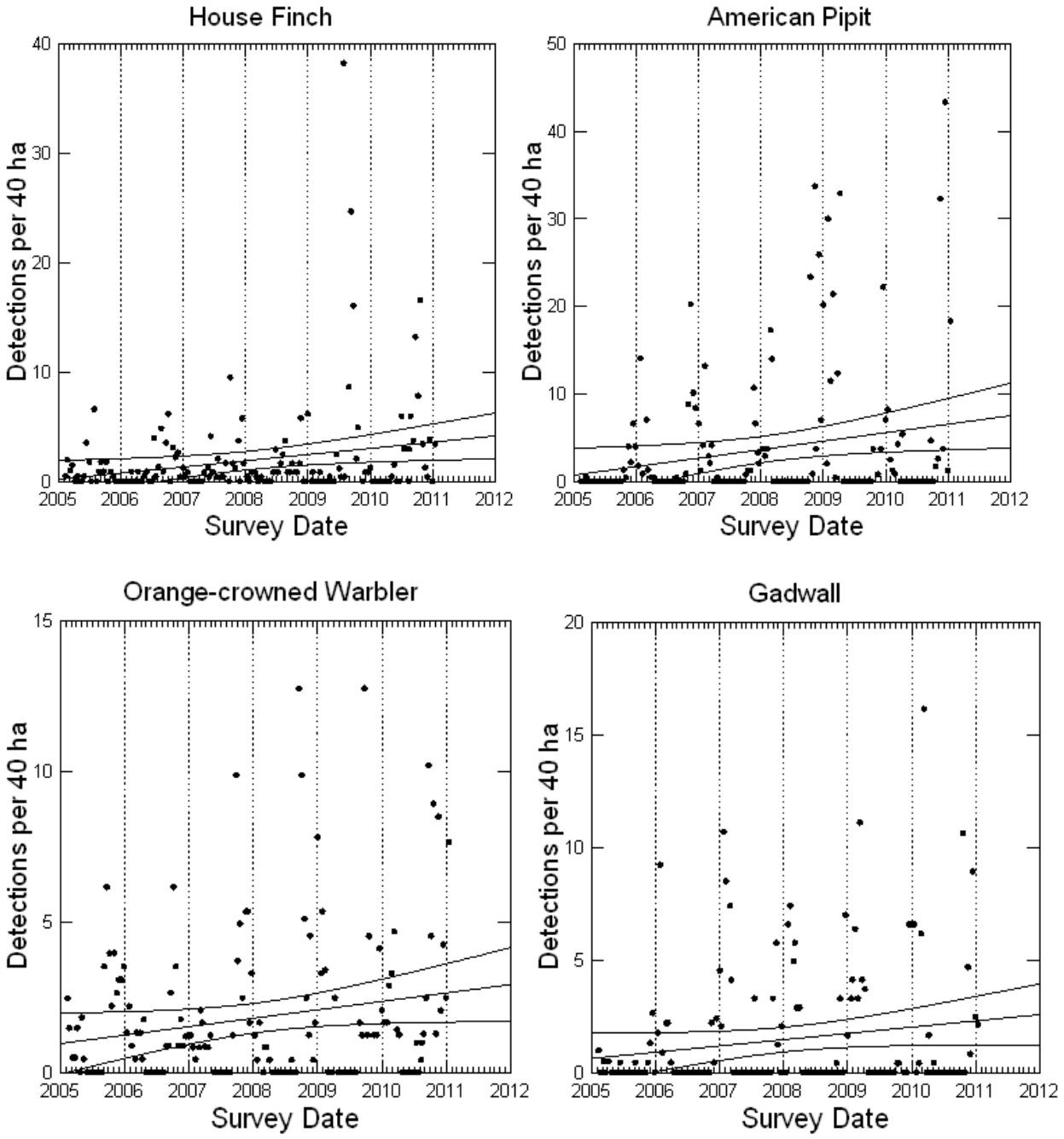

Figure 6f. Population trends of four common species along the Las Vegas Wash (2005 – 2011). See also Table 5 for statistical analysis results.

Tables

Table 1a. Estimated species-specific densities (# birds per 40 ha) for survey events overall, among seasons from the full data set (2005-2011), and overall values by year**.** Species are in descending order of overall 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
Abert's Towhee	12.21	12.59	11.14	15.71	14.27	10.23	10.82	11.59	10.98
Song Sparrow	10.23	12.19	8.27	12.11	12.73	10.53	9.38	7.59	9.22
Yellow-rumped Warbler	10.10	0.86	24.93	6.36	3.15	11.54	10.60	13.94	14.60
Red-winged Blackbird	8.90	11.75	7.73	7.15	7.31	9.69	9.92	12.09	6.96
Marsh Wren	7.58	5.39	9.46	4.43	5.51	7.52	9.87	9.26	8.55
Bewick's Wren	6.47	6.32	5.99	7.40	7.94	4.94	6.80	6.67	5.18
White-crowned Sparrow	6.22	0.60	14.56	4.28	4.27	5.53	5.80	8.41	8.90
American Coot	5.86	2.28	8.59	2.27	8.98	10.04	5.38	4.82	3.40
Common Yellowthroat	4.81	9.49	0.08	4.14	4.59	4.62	5.98	4.71	4.74
Black-tailed Gnatcatcher	4.70	4.84	4.43	4.56	5.42	3.26	4.27	5.53	5.24
Verdin	4.70	5.16	4.06	3.55	4.42	3.93	4.93	5.67	5.64
Mallard	4.37	2.20	6.57	0.99	2.24	4.59	3.99	8.42	5.71
American Pipit	3.84	0.81	8.01	1.37	2.75	2.11	5.80	6.11	4.69
Black Phoebe	3.81	2.31	5.02	3.88	4.39	3.39	3.84	3.73	3.68
Brown-headed Cowbird	3.54	7.64	0.01	3.33	3.74	3.61	4.43	3.10	3.01
Ruby-crowned Kinglet	3.17	0.47	6.61	4.66	4.17	3.36	2.25	2.30	2.43
Great-tailed Grackle	2.98	4.26	2.03	0.73	1.49	3.69	4.13	4.26	3.33
Gambel's Quail	2.92	3.74	2.36	1.71	1.10	0.98	1.64	3.34	8.82
Lucy's Warbler	2.80	6.00		4.97	3.20	2.45	2.93	1.82	1.58
Mourning Dove	2.39	4.78	0.16	5.18	1.75	1.71	1.36	2.25	2.31
Yellow-breasted Chat	2.38	5.00	0.01	3.22	2.82	2.20	3.37	1.09	1.60
House Finch	2.00	1.75	2.04	0.94	1.33	1.39	1.28	4.05	2.96
Orange-crowned Warbler	1.86	0.34	3.22	1.71	1.08	1.82	2.04	1.74	2.73
Yellow Warbler	1.79	3.68		1.06	0.97	1.33	2.75	2.40	2.16
Blue Grosbeak	1.55	3.17	0.01	2.37	1.64	1.57	1.68	1.03	1.05
Gadwall	1.54	0.29	2.40	0.71	1.12	1.62	1.52	2.07	2.15
Crissal Thrasher	1.52	1.33	1.67	1.91	1.42	0.82	1.20	1.83	1.96
Brewer's Sparrow	0.98	0.76	0.20	0.28	0.50	1.01	1.03	2.04	0.93
Lesser Goldfinch	0.97	0.53	0.95	0.36	0.65	0.25	0.60	1.13	2.85
Say's Phoebe	0.89	0.76	0.98	0.55	0.63	0.35	1.00	1.69	1.12
Killdeer	0.82	1.02	0.50	1.73	0.85	0.35	0.78	0.88	0.37
Dark-eyed Junco	0.72	0.07	1.68	0.14	0.22	1.65	0.89	0.90	0.45
Northern Flicker	0.66	0.04	1.46	0.42	0.52	0.86	0.87	0.61	0.63
Wilson's Warbler	0.61	1.13	0.06	1.14	0.80	0.63	0.46	0.47	0.22
Greater Roadrunner	0.59	0.86	0.23	0.68	0.57	0.55	0.57	0.50	0.70
Bushtit	0.50	0.02	1.02	0.64	0.37	0.24	0.02	1.17	0.57
Western Kingbird	0.43	0.77		0.23	0.33	0.62	0.44	0.53	0.43
Lincoln's Sparrow	0.41	0.12	0.82	0.83	0.22	0.52	0.35	0.27	0.30
N. Rough-winged Swallow	0.35	0.61		0.19	0.20	0.16	1.03	0.35	0.13

SPECIES	Overall	Breeding	Non-breeding	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Great Blue Heron	0.34	0.30	0.35	0.19	0.27	0.29	0.24	0.68	0.38
Spotted Sandpiper	0.34	0.46	0.15	0.31	0.55	0.10	0.35	0.51	0.22
Yellow-headed Blackbird	0.33	0.58	0.06	0.94	0.27	0.05	0.32	0.35	0.10
Ring-billed Gull	0.33		0.86		0.67	1.25		0.03	
Blue-gray Gnatcatcher	0.31	0.35	0.17	0.40	0.45	0.21	0.55	0.08	0.15
Loggerhead Shrike	0.30	0.30	0.27	0.43	0.22	0.13	0.22	0.58	0.25
Green Heron	0.29	0.50	0.09	0.28	0.53	0.29	0.25	0.19	0.23
White-winged Dove	0.29	0.62	0.01	0.31	0.18	0.33	0.32	0.37	0.23
Black-chinned Hummingbird	0.29	0.61	0.01	0.16	0.30	0.33	0.27	0.34	0.33
Least Sandpiper	0.26	0.33	0.28					1.11	0.43
Savannah Sparrow	0.25	0.16	0.30	0.10		0.33	0.47	0.27	0.27
American Wigeon	0.22	0.06	0.13		0.07	0.22	0.21	0.29	0.50
Barn Swallow	0.22	0.44				1.19	0.06		
Greater Yellowlegs	0.21	0.12	0.29	0.28	0.25	0.10	0.17	0.16	0.33
Chipping Sparrow	0.21	0.26	0.11	0.09	0.10	0.13	0.08	0.74	0.10
Belted Kingfisher	0.19	0.04	0.30	0.23	0.17	0.19	0.21	0.21	0.15
Double-crested Cormorant	0.18	0.12	0.28	0.03	0.08	0.59	0.21	0.14	0.02
Pied-billed Grebe	0.18	0.17	0.25	0.07	0.12	0.48	0.17	0.11	0.13
Rock Wren	0.18	0.13	0.28	0.09	0.13	0.06	0.16	0.31	0.32
Brewer's Blackbird	0.17	0.03	0.44				0.44	0.13	0.42
Cliff Swallow	0.15	0.30	0.01			0.10	0.68	0.11	
Common Moorhen	0.15	0.20	0.12	0.12	0.17	0.16	0.09	0.19	0.17
Northern Mockingbird	0.15	0.17	0.15	0.03	0.22	0.16	0.06	0.24	0.17
Spotted Towhee	0.14	0.04	0.28	0.09	0.08	0.19	0.28	0.10	0.07
Phainopepla	0.13	0.01	0.32	0.17	0.22	0.06	0.19	0.11	0.05
Costa's Hummingbird	0.13	0.21	0.02	0.07	0.15	0.17	0.11	0.08	0.17
Green-winged Teal	0.13	0.04	0.17		0.15	0.30	0.14	0.08	0.07
Snowy Egret	0.12	0.10	0.13	0.17	0.05	0.29	0.03	0.10	0.10
Western Sandpiper	0.12	0.25		0.36	0.02			0.24	0.10
Horned Lark	0.11	0.18	0.09	0.05		0.30	0.28	0.02	0.02
Bufflehead	0.10	0.01	0.13			0.17	0.32	0.03	0.08
Western Wood-Pewee	0.10	0.17		0.07	0.08	0.06	0.16	0.03	0.22
Pine Siskin	0.10		0.28	0.10		0.25			0.23
Northern Harrier	0.10	0.02	0.19	0.03	0.12	0.25	0.11	0.05	
Great Egret	0.09	0.06	0.12	0.09	0.03	0.08	0.06	0.18	0.10
Cooper's Hawk	0.09	0.03	0.13	0.05	0.10	0.11	0.06	0.06	0.13
Sharp-shinned Hawk	0.09	0.01	0.19	0.17	0.03	0.05	0.09	0.14	0.03
Warbling Vireo	0.08	0.14		0.09	0.07	0.05	0.06	0.18	0.05
Virginia Rail	0.08	0.05	0.13	0.07	0.05	0.10	0.06	0.05	0.15
Lazuli Bunting	0.08	0.08		0.10	0.12	0.05	0.17	0.02	
Bullock's Oriole	0.07	0.13	0.01	0.02	0.13	0.08		0.06	0.15
Black-crowned Night-Heron	0.07	0.05	0.11	0.05	0.10	0.06	0.03	0.03	0.12
White-faced Ibis	0.07	0.14		0.07	0.23		0.02	0.03	0.05

SPECIES	Overall	Breeding	Non-breeding	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Anna's Hummingbird	0.06	0.08	0.03	0.14	0.03	0.02	0.05	0.11	0.03
Red-tailed Hawk	0.06	0.01	0.15	0.07	0.03	0.06	0.06	0.03	0.12
Hermit Thrush	0.06	0.01	0.10	0.12	0.20	0.02	0.02	0.02	
Canada Goose	0.06	0.06	0.08			0.22		0.03	0.08
American Kestrel	0.05	0.08	0.04	0.09	0.03	0.03	0.02	0.03	0.13
Black-headed Grosbeak	0.05	0.08		0.12	0.07	0.03		0.03	0.08
American Robin	0.05		0.13	0.03	0.02	0.10	0.11	0.03	0.02
Bell's Vireo	0.05	0.11		0.17		0.08			0.07
Cinnamon Teal	0.05	0.06	0.02	0.09			0.03	0.19	
Common Merganser	0.05	0.02	0.05	0.03	0.02	0.08	0.05	0.10	0.02
Eared Grebe	0.05	0.10		0.02		0.22		0.05	
Western Meadowlark	0.05	0.01	0.07		0.03		0.02	0.10	0.15
Ash-throated Flycatcher	0.05	0.08		0.07	0.02	0.10	0.02		0.08
Ladder-backed Woodpecker	0.05	0.02	0.07	0.02			0.02	0.03	0.22
Sora	0.05	0.04	0.08	0.03	0.05	0.03	0.05	0.02	0.10
American Avocet	0.04	0.08		0.21				0.05	
Least Bittern	0.04	0.05	0.02	0.02	0.02	0.06	0.08		0.03
Western Tanager	0.04	0.07		0.05	0.02	0.03	0.02	0.05	0.05
Dusky Flycatcher	0.03	0.06		0.02	0.03	0.13		0.02	
Golden-crowned Kinglet	0.03		0.09	0.02		0.10	0.03	0.03	0.02
Great Horned Owl	0.03	0.04	0.02		0.02	0.02		0.06	0.10
Osprey	0.03	0.04	0.01	0.02	0.03	0.03	0.02	0.05	0.03
Common Goldeneye	0.03		0.04			0.05	0.08	0.03	
Gray Flycatcher	0.03	0.05		0.02		0.08		0.05	0.02
Indigo Bunting	0.03	0.06						0.10	0.07
Nashville Warbler	0.03	0.02	0.01			0.05	0.05	0.02	0.05
“Western” Flycatcher	0.03	0.04		0.02	0.05	0.08	0.02		
Lark Sparrow	0.02	0.05				0.03	0.03	0.02	0.07
Northern Shoveler	0.02	0.01	0.03	0.07	0.03			0.05	
Barn Owl	0.02	0.04	0.01	0.07	0.03	0.02		0.02	
Black-necked Stilt	0.02	0.05		0.07				0.06	
“Solitary” Vireo	0.02	0.05			0.02	0.02	0.09		
Black-throated Sparrow	0.02	0.04			0.02				0.10
Common Raven	0.02		0.05			0.10		0.02	
MacGillivray's Warbler	0.02	0.02		0.02	0.02	0.02			0.05
Red-naped Sapsucker	0.02	0.01	0.04	0.03	0.05	0.02			
Violet-green Swallow	0.02	0.03				0.03	0.05	0.02	
Northern Pintail	0.01		0.03		0.02				0.07
Pacific Wren	0.01		0.03	0.03	0.02				0.03
Townsend's Warbler	0.01	0.03							0.08
Tree Swallow	0.01	0.02	0.02			0.03	0.05		
Vesper Sparrow	0.01	0.02						0.03	0.05
Cedar Waxwing	0.01		0.01	0.05	0.02				
House Wren	0.01	0.01	0.02	0.03	0.02			0.02	
Long-billed Dowitcher	0.01	0.01			0.07				

SPECIES	Overall	Breeding	Non-breeding	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Semipalmated Sandpiper	0.01	0.02			0.07				
American Goldfinch	0.01	0.01	0.02					0.05	
American White Pelican	0.01	0.02					0.03		0.02
Hooded Oriole	0.01	0.02				0.05			
Olive-sided Flycatcher	0.01	0.02		0.02		0.02			0.02
Rock Pigeon	0.01		0.02			0.03	0.02		
Western Bluebird	0.01		0.02	0.05					
Willow Flycatcher	0.01	0.02					0.03		0.02
American Bittern	0.01	0.01			0.02			0.02	
Brown-crested Flycatcher	0.01	0.01		0.03					
Canyon Wren	0.01	0.01	0.01	0.02	0.02				
Green-tailed Towhee	0.01	0.01					0.02	0.02	
Lesser Nighthawk	0.01	0.01			0.02			0.02	
Merlin	0.01		0.02		0.02			0.02	
Peregrine Falcon	0.01	0.01	0.01				0.02	0.02	
Red-breasted Nuthatch	0.01		0.01			0.02	0.02		
Redhead	0.01						0.03		
Rufous Hummingbird	0.01	0.01							0.03
Black-throated Gray Warbler	0.00		0.01					0.02	
Broad-tailed Hummingbird	0.00								0.02
Canyon Towhee	0.00	0.01			0.02				
Eastern Kingbird	0.00	0.01							0.02
Eurasian Collared-Dove	0.00	0.01						0.02	
European Starling	0.00								0.02
Hairy Woodpecker	0.00		0.01		0.02				
House Sparrow	0.00		0.01	0.02					
Lesser Yellowlegs	0.00							0.02	
Mountain Bluebird	0.00		0.01				0.02		
Ovenbird	0.00		0.01						0.02
Pectoral Sandpiper	0.00							0.02	
Prairie Falcon	0.00		0.01					0.02	
Red-shouldered Hawk	0.00								0.02
Rufous-crowned Sparrow	0.00	0.01				0.02			
Scissor-tailed Flycatcher	0.00								0.02
Semipalmated Plover	0.00	0.01		0.02					
Turkey Vulture	0.00						0.02		
Virginia's Warbler	0.00					0.02			
Western Grebe	0.00		0.01			0.02			
Wilson's Snipe	0.00	0.01						0.02	
Wood Duck	0.00		0.01				0.02		

Table 1b. Breeding and non-breeding abundances (# birds per 40 ha) by species for each of six survey years (2005-2011). Species listed are in descending order of overall abundance. No entry means that the species was not detected.

	Breeding Season						Non-breeding Season					
SPECIES	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6
Abert's Towhee	17.55	15.81	9.88	11.09	11.21	10.59	13.07	12.47	10.50	9.30	11.14	10.37
Song Sparrow	14.13	15.18	12.11	12.01	9.08	10.87	10.20	9.61	9.49	5.86	6.75	7.75
Yellow-rumped Warbler	0.26	1.10	1.72	0.72	0.96	0.38	16.83	5.91	25.33	26.93	32.26	43.59
Red-winged Blackbird	5.35	8.74	11.77	15.09	15.36	13.56	12.88	8.54	11.09	4.40	8.21	0.68
Marsh Wren	1.92	2.89	4.74	8.21	7.66	6.52	7.12	7.60	9.72	10.95	10.54	10.74
Bewick's Wren	7.08	8.96	4.77	7.02	6.67	3.66	6.83	6.00	4.65	6.96	5.02	6.60
White-crowned Sparrow	0.57	1.39	0.27	0.17	0.60	0.66	10.39	6.33	13.51	14.98	19.08	23.68
American Coot	1.17	1.35	5.46	3.29	1.24	1.00	4.49	17.07	9.63	6.05	7.71	6.18
Common Yellowthroat	8.06	8.85	9.33	11.29	10.18	9.07	0.05		0.05	0.23		0.16
Black-tailed Gnatcatcher	4.97	6.77	3.23	4.18	5.28	4.76	3.56	4.60	3.15	4.40	5.66	5.24
Verdin	3.88	5.93	4.26	5.00	6.10	5.76	2.98	2.30	3.79	4.72	5.52	5.08
Mallard	0.45	0.44	1.99	2.40	4.75	2.97	1.27	5.30	6.57	4.72	11.32	10.32
American Pipit		0.11	0.38		3.90	0.45	3.81	6.61	3.61	12.92	8.67	12.73
Black Phoebe	2.34	2.67	2.09	2.29	2.38	2.10	4.93	5.53	4.34	5.86	4.15	5.34
Brown-headed Cowbird	7.23	8.16	7.82	9.55	6.81	6.21				0.05		
Ruby-crowned Kinglet	0.72	0.84	0.51	0.44	0.21	0.10	10.10	7.55	7.44	4.12	5.39	5.08
Great-tailed Grackle	0.60	1.98	5.15	5.92	7.27	4.24	1.17	1.22	2.60	2.84	1.23	3.20
Gambel's Quail	3.16	1.76	1.48	1.68	4.58	9.70	0.63	0.75	0.59	1.79	1.60	9.54
Lucy's Warbler	10.81	6.99	5.22	6.16	3.94	3.28						
Mourning Dove	10.74	3.48	3.12	2.77	4.36	4.66	0.29		0.32	0.09	0.23	
Yellow-breasted Chat	6.89	6.11	4.56	6.91	2.41	3.24			0.05			
House Finch	1.28	1.06	0.89	1.06	4.43	1.76	0.34	1.83	2.65	1.88	1.19	4.56
Orange-crowned Warbler	0.34	0.37	0.38	0.14	0.35	0.48	2.88	1.92	3.15	4.03	2.56	4.93
Yellow Warbler	2.30	2.05	2.78	5.58	4.89	4.28						
Blue Grosbeak	4.52	3.48	3.29	3.49	2.27	2.07						0.05
Gadwall	0.08	0.04	0.27	0.48	0.67	0.17	1.71	2.53	2.10	1.74	2.74	3.67
Crissal Thrasher	1.51	1.68	0.55	1.03	1.70	1.55	2.44	0.84	0.96	1.51	2.01	2.36
Brewer's Sparrow		0.66	1.68	0.31	0.64	1.17	0.29			0.46	0.41	
Lesser Goldfinch	0.08	0.44	0.24	0.14	0.50	1.76	0.20	0.09	0.23	0.82	0.64	4.03
Say's Phoebe	0.41	0.73	0.48	1.10	1.13	0.69	0.59	0.47	0.23	1.19	2.33	1.05
Killdeer	2.30	0.99	0.38	0.44	1.56	0.59	1.07	0.38	0.23	1.01	0.18	0.10
Dark-eyed Junco	0.11			0.31			0.10	0.52	4.65	1.37	2.46	0.68
Northern Flicker			0.07	0.10		0.03	0.93	1.08	2.10	1.88	1.05	1.73
Wilson's Warbler	2.07	1.68	1.27	0.55	0.96	0.38	0.34					
Greater Roadrunner	0.87	0.95	0.96	0.65	0.71	1.04	0.44	0.09	0.18	0.37	0.18	0.10
Bushtit	0.08					0.07	1.61	0.94	0.14		3.33	
Western Kingbird	0.45	0.70	1.20	0.75	0.92	0.55						
Lincoln's Sparrow	0.11	0.07	0.34	0.07	0.07	0.03	1.85	0.19	0.91	0.69	0.55	0.79
N. Rough-winged Swallow	0.23	0.40	0.27	1.99	0.74							
Great Blue Heron	0.19	0.11	0.27	0.14	0.74	0.35	0.20	0.38	0.27	0.18	0.64	0.42
Spotted Sandpiper	0.45	0.88	0.14	0.51	0.60	0.21	0.20	0.23		0.14	0.18	0.16
Yellow-headed Blackbird	2.00	0.18	0.10	0.41	0.71	0.21	0.05			0.32		

	Breeding Season						Non-breeding Season					
SPECIES	**YR 1**	**YR 2**	**YR 3**	**YR 4**	**YR 5**	**YR 6**	**YR 1**	**YR 2**	**YR 3**	**YR 4**	**YR 5**	**YR 6**
Ring-billed Gull								1.88	3.06		0.09	
Blue-gray Gnatcatcher	0.60	0.33	0.34	0.86			0.34			0.05	0.23	0.42
Loggerhead Shrike	0.57	0.29	0.07	0.27	0.53	0.10	0.24	0.14	0.14	0.14	0.59	0.37
Green Heron	0.45	0.84	0.45	0.51	0.35	0.38	0.10	0.23	0.09		0.05	0.10
White-winged Dove	0.64	0.40	0.72	0.68	0.78	0.48	0.05					
Black-chinned Hummingbird	0.34	0.66	0.72	0.55	0.71	0.66				0.05		
Least Sandpiper					1.24	0.72					1.55	0.05
Savannah Sparrow	0.23		0.38	0.21	0.04	0.10			0.23	0.64	0.46	0.47
American Wigeon			0.07	0.27					0.27	0.09	0.32	0.05
Barn Swallow			2.57									
Greater Yellowlegs		0.07		0.03	0.14	0.45	0.68	0.23	0.27	0.27	0.18	0.10
Chipping Sparrow	0.08		0.24		1.03	0.21				0.14	0.50	
Belted Kingfisher	0.04	0.07	0.03		0.04	0.07	0.54	0.23	0.41	0.32	0.14	0.16
Double-crested Cormorant	0.04	0.07	0.24	0.14	0.18	0.03		0.14	1.28	0.14	0.09	
Pied-billed Grebe		0.04	0.45	0.27	0.18	0.07	0.20	0.23	0.68		0.09	0.31
Rock Wren	0.04	0.11	0.03	0.21	0.25	0.14	0.20	0.19	0.09	0.14	0.50	0.63
Brewer's Blackbird					0.18					1.28	0.14	1.31
Cliff Swallow			0.21	1.47	0.04						0.05	
Common Moorhen	0.15	0.22	0.21	0.10	0.28	0.24	0.15	0.19		0.09	0.14	0.16
Northern Mockingbird	0.08	0.26	0.21	0.03	0.25	0.17		0.23	0.05	0.09	0.32	0.21
Spotted Towhee	0.08		0.03	0.07		0.03	0.15	0.19	0.46	0.60	0.14	0.16
Phainopepla						0.03	0.49	0.52	0.09	0.46	0.32	0.05
Costa's Hummingbird	0.15	0.22	0.34	0.17	0.18	0.21				0.05		0.05
Green-winged Teal		0.04		0.10		0.07		0.28	0.32	0.09	0.18	0.10
Snowy Egret	0.26		0.24	0.03	0.07			0.14	0.50		0.05	0.05
Western Sandpiper	0.79				0.53	0.21						
Horned Lark	0.11		0.58	0.34	0.04				0.09	0.37		0.05
Bufflehead			0.03						0.46		0.09	0.26
Western Wood-Pewee	0.15	0.15	0.10	0.21	0.04	0.35						
Pine Siskin							0.29		0.73			0.73
Northern Harrier		0.04	0.07		0.04		0.10	0.23	0.59	0.09	0.09	
Great Egret	0.04			0.03	0.21	0.10	0.15	0.05	0.23	0.05	0.14	0.10
Cooper's Hawk	0.04		0.03	0.07	0.04			0.14	0.23	0.05	0.14	0.26
Sharp-shinned Hawk					0.04		0.44	0.05	0.09	0.23	0.23	0.10
Warbling Vireo	0.19	0.11	0.07	0.07	0.28	0.10						
Virginia Rail	0.04	0.04	0.03	0.03		0.14	0.10	0.09	0.14	0.09	0.09	0.26
Lazuli Bunting	0.11	0.18	0.10	0.03	0.04							
Bullock's Oriole	0.04	0.29	0.17		0.11	0.17						0.05
Black-crowned Night-Heron	0.11	0.07	0.03	0.03		0.03		0.19	0.14	0.05		0.31
White-faced Ibis	0.15	0.51		0.03	0.04	0.10						
Anna's Hummingbird	0.23	0.07		0.07	0.11	0.03	0.05			0.05	0.09	
Red-tailed Hawk		0.04		0.03			0.20		0.18	0.14	0.09	0.31
Hermit Thrush	0.04	0.04					0.29	0.23	0.05	0.05		
Canada Goose			0.21			0.14			0.37		0.09	
American Kestrel	0.15	0.07	0.07		0.07	0.10						0.26

	Breeding Season						Non-breeding Season					
SPECIES	**YR 1**	**YR 2**	**YR 3**	**YR 4**	**YR 5**	**YR 6**	**YR 1**	**YR 2**	**YR 3**	**YR 4**	**YR 5**	**YR 6**
Black-headed Grosbeak	0.23	0.11			0.07	0.07						
American Robin							0.10	0.05	0.27	0.23	0.09	
Bell's Vireo	0.38		0.17			0.14						
Cinnamon Teal	0.19			0.07	0.14						0.09	
Common Merganser	0.08			0.03				0.05	0.14	0.05		0.05
Eared Grebe	0.04		0.48		0.07							
Western Meadowlark		0.04								0.05	0.27	0.10
Ash-throated Flycatcher	0.11		0.17	0.03		0.17						
Ladder-backed Woodpecker	0.04			0.03		0.07					0.09	0.37
Sora		0.04	0.03	0.03		0.10	0.10	0.09	0.05	0.09	0.05	0.10
American Avocet	0.45				0.07							
Least Bittern	0.04		0.07	0.14		0.07		0.05	0.09			
Western Tanager	0.11	0.04	0.07		0.11	0.10						
Dusky Flycatcher	0.04	0.04	0.27									
Golden-crowned Kinglet							0.05		0.27	0.09	0.09	0.05
Great Horned Owl			0.03		0.07	0.10					0.05	0.05
Osprey		0.07	0.03		0.07	0.03				0.05		
Common Goldeneye									0.14		0.09	
Gray Flycatcher	0.04		0.17		0.07							
Indigo Bunting					0.21	0.14						
Nashville Warbler			0.10			0.03						0.05
“Western” Flycatcher		0.04	0.17	0.03								
Lark Sparrow			0.07	0.07	0.04	0.14						
Northern Shoveler					0.07		0.20					
Barn Owl	0.11	0.07			0.04				0.05			
Black-necked Stilt	0.15				0.14							
“Solitary” Vireo		0.04	0.03	0.21								
Black-throated Sparrow		0.04				0.21						
Common Raven									0.27			
MacGillivray's Warbler	0.04		0.03			0.03						
Red-naped Sapsucker	0.04						0.05	0.14	0.05			
Violet-green Swallow			0.07	0.10								
Northern Pintail												0.21
Pacific Wren							0.10					0.10
Townsend's Warbler						0.17						
Tree Swallow				0.10					0.09			
Vesper Sparrow					0.07	0.03						
Cedar Waxwing							0.05					
House Wren		0.04					0.05				0.05	
Long-billed Dowitcher		0.07										
Semipalmated Sandpiper		0.15										
American Goldfinch					0.04						0.09	
American White Pelican				0.07		0.03						
Hooded Oriole			0.10									
Olive-sided Flycatcher	0.04		0.03			0.03						
Rock Pigeon									0.09	0.05		

	Breeding Season						Non-breeding Season					
SPECIES	**YR 1**	**YR 2**	**YR 3**	**YR 4**	**YR 5**	**YR 6**	**YR 1**	**YR 2**	**YR 3**	**YR 4**	**YR 5**	**YR 6**
Western Bluebird							0.15					
Willow Flycatcher				0.07		0.03						
American Bittern		0.04										
Brown-crested Flycatcher	0.08											
Canyon Wren	0.04							0.05				
Green-tailed Towhee				0.03								
Lesser Nighthawk		0.04			0.04							
Merlin								0.05			0.05	
Peregrine Falcon				0.03							0.05	
Red-breasted Nuthatch										0.05		
Redhead												
Rufous Hummingbird						0.07						
Black-throated Gray Warbler											0.05	
Broad-tailed Hummingbird												
Canyon Towhee		0.04										
Eastern Kingbird						0.03						
Eurasian Collared-Dove					0.04							
European Starling												
Hairy Woodpecker								0.05				
House Sparrow							0.05					
Lesser Yellowlegs												
Mountain Bluebird										0.05		
Ovenbird												0.05
Pectoral Sandpiper												
Prairie Falcon											0.05	
Red-shouldered Hawk												
Rufous-crowned Sparrow			0.03									
Scissor-tailed Flycatcher												
Semipalmated Plover	0.04											
Turkey Vulture												
Virginia's Warbler												
Western Grebe									0.05			
Wilson's Snipe					0.04							
Wood Duck										0.05		

Table 2a. Relative abundance (percent of total bird abundance) by species for all 6 years (overall), among seasons, and by year. Species listed are those that represent at least 1% of the overall bird community in one or more periods (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
Abert's Towhee	8.64	9.28	7.15	12.50	11.21	7.47	7.47	7.21	7.27
Song Sparrow	7.24	8.98	5.31	9.63	10.00	7.69	6.48	4.72	6.10
Yellow-rumped Warbler	7.14	0.64	16.00	5.06	2.48	8.43	7.32	8.67	9.66
Red-winged Blackbird	6.30	8.66	4.96	5.69	5.74	7.08	6.85	7.52	4.60
Marsh Wren	5.36	3.97	6.07	3.53	4.33	5.49	6.81	5.76	5.66
Bewick's Wren	4.58	4.66	3.85	5.89	6.24	3.61	4.70	4.15	3.42
White-crowned Sparrow	4.40	0.44	9.34	3.40	3.36	4.04	4.01	5.23	5.89
American Coot	4.15	1.68	5.51	1.81	7.05	7.33	3.71	3.00	2.25
Common Yellowthroat	3.40	6.99	0.05	3.29	3.61	3.38	4.13	2.93	3.14
Black-tailed Gnatcatcher	3.33	3.57	2.84	3.63	4.26	2.38	2.95	3.44	3.47
Verdin	3.33	3.80	2.61	2.83	3.47	2.87	3.41	3.53	3.73
Mallard	3.09	1.62	4.22	0.79	1.76	3.35	2.75	5.24	3.78
American Pipit	2.72	0.60	5.14	1.09	2.16	1.54	4.01	3.80	3.11
Black Phoebe	2.70	1.70	3.22	3.09	3.45	2.47	2.65	2.32	2.43
Brown-headed Cowbird	2.51	5.63	0.01	2.65	2.94	2.64	3.06	1.93	1.99
Ruby-crowned Kinglet	2.24	0.34	4.24	3.71	3.28	2.45	1.55	1.43	1.61
Great-tailed Grackle	2.11	3.14	1.30	0.58	1.17	2.69	2.85	2.65	2.20
Gambel's Quail	2.06	2.76	1.51	1.36	0.87	0.72	1.14	2.08	5.84
Lucy's Warbler	1.98	4.42		3.96	2.52	1.79	2.02	1.13	1.05
Mourning Dove	1.69	3.52	0.10	4.12	1.38	1.25	0.94	1.40	1.53
Yellow-breasted Chat	1.68	3.68	0.01	2.56	2.22	1.61	2.33	0.68	1.06
House Finch	1.42	1.29	1.31	0.74	1.05	1.02	0.88	2.52	1.96
Orange-crowned Warbler	1.31	0.25	2.06	1.36	0.85	1.33	1.41	1.08	1.81
Yellow Warbler	1.27	2.71		0.84	0.76	0.97	1.90	1.49	1.43
Blue Grosbeak	1.10	2.34	0.01	1.89	1.28	1.14	1.16	0.64	0.69
Gadwall	1.09	0.21	1.54	0.57	0.88	1.18	1.05	1.29	1.42
Crissal Thrasher	1.07	0.98	1.07	1.52	1.11	0.60	0.83	1.14	1.30
Brewer's Sparrow	0.69	0.56	0.13	0.22	0.39	0.74	0.71	1.27	0.62
Lesser Goldfinch	0.69	0.39	0.61	0.29	0.51	0.18	0.41	0.70	1.88
Say's Phoebe	0.63	0.56	0.63	0.44	0.50	0.25	0.69	1.05	0.74
Killdeer	0.58	0.75	0.32	1.38	0.67	0.25	0.54	0.55	0.24
Dark-eyed Junco	0.51	0.05	1.08	0.11	0.17	1.20	0.61	0.56	0.30

Table 2b. Breeding and non-breeding relative abundances (percent of total abundance) by species for each of six survey years (2005-2011). Species listed are those that represent at least 1% of the overall bird community in one or more periods (in descending order of overall relative abundance). No entry means that the species was not detected.

	Breeding Season						Non-breeding Season					
SPECIES	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6
Abert's Towhee	12.96	11.97	7.80	7.73	7.57	8.23	9.95	9.96	6.69	6.15	6.43	5.20
Song Sparrow	10.43	11.50	9.56	8.38	6.14	8.45	7.76	7.68	6.05	3.88	3.90	3.89
Yellow-rumped Warbler	0.19	0.83	1.35	0.50	0.65	0.29	12.81	4.72	16.13	17.81	18.62	21.84
Red-winged Blackbird	3.95	6.62	9.29	10.52	10.38	10.54	9.80	6.82	7.06	2.91	4.74	0.34
Marsh Wren	1.42	2.19	3.74	5.73	5.18	5.07	5.42	6.07	6.19	7.24	6.09	5.38
Bewick's Wren	5.23	6.79	3.77	4.89	4.51	2.84	5.20	4.79	2.97	4.60	2.90	3.31
White-crowned Sparrow	0.42	1.05	0.22	0.12	0.41	0.51	7.91	5.06	8.60	9.90	11.01	11.87
American Coot	0.86	1.02	4.31	2.29	0.84	0.78	3.41	13.63	6.13	4.00	4.45	3.10
Common Yellowthroat	5.95	6.70	7.37	7.87	6.88	7.05	0.04		0.03	0.15		0.08
Black-tailed Gnatcatcher	3.67	5.12	2.55	2.91	3.57	3.70	2.71	3.67	2.01	2.91	3.27	2.63
Verdin	2.87	4.49	3.36	3.48	4.12	4.48	2.26	1.84	2.41	3.12	3.19	2.55
Mallard	0.33	0.33	1.57	1.67	3.21	2.31	0.97	4.23	4.19	3.12	6.53	5.17
American Pipit		0.08	0.30		2.64	0.35	2.90	5.28	2.30	8.54	5.01	6.38
Black Phoebe	1.72	2.02	1.65	1.60	1.61	1.64	3.75	4.42	2.76	3.88	2.40	2.68
Brown-headed Cowbird	5.34	6.18	6.18	6.66	4.60	4.83				0.03		
Ruby-crowned Kinglet	0.53	0.64	0.41	0.31	0.14	0.08	7.68	6.03	4.74	2.73	3.11	2.55
Great-tailed Grackle	0.45	1.50	4.06	4.13	4.91	3.30	0.89	0.97	1.66	1.88	0.71	1.60
Gambel's Quail	2.34	1.33	1.16	1.17	3.09	7.54	0.48	0.60	0.38	1.18	0.92	4.78
Lucy's Warbler	7.98	5.29	4.12	4.29	2.66	2.55						
Mourning Dove	7.93	2.63	2.47	1.93	2.95	3.62	0.22		0.20	0.06	0.13	
Yellow-breasted Chat	5.09	4.63	3.60	4.82	1.63	2.52			0.03			
House Finch	0.95	0.80	0.70	0.74	3.00	1.37	0.26	1.46	1.69	1.24	0.68	2.28
Orange-crowned Warbler	0.25	0.28	0.30	0.10	0.24	0.38	2.19	1.54	2.01	2.67	1.48	2.47
Yellow Warbler	1.70	1.55	2.19	3.89	3.31	3.33						
Blue Grosbeak	3.34	2.63	2.60	2.43	1.53	1.61						0.03
Gadwall	0.06	0.03	0.22	0.33	0.46	0.13	1.30	2.02	1.34	1.15	1.58	1.84
Crissal Thrasher	1.11	1.27	0.43	0.72	1.15	1.21	1.86	0.67	0.61	1.00	1.16	1.18
Brewer's Sparrow		0.50	1.33	0.21	0.43	0.91	0.22			0.30	0.24	
Lesser Goldfinch	0.06	0.33	0.19	0.10	0.34	1.37	0.15	0.07	0.15	0.55	0.37	2.02
Say's Phoebe	0.31	0.55	0.38	0.76	0.77	0.54	0.45	0.37	0.15	0.79	1.34	0.53
Killdeer	1.70	0.75	0.30	0.31	1.05	0.46	0.82	0.30	0.15	0.67	0.11	0.05
Dark-eyed Junco	0.08			0.21			0.07	0.41	2.97	0.91	1.42	0.34
Northern Flicker			0.05	0.07		0.03	0.71	0.86	1.34	1.24	0.61	0.87
Wilson's Warbler	1.53	1.27	1.00	0.38	0.65	0.29	0.26					
Greater Roadrunner	0.64	0.72	0.76	0.45	0.48	0.80	0.33	0.07	0.12	0.24	0.11	0.05
Bushtit	0.06					0.05	1.22	0.75	0.09		1.92	
Lincoln's Sparrow	0.08	0.06	0.27	0.05	0.05	0.03	1.41	0.15	0.58	0.45	0.32	0.39
N. Rough-winged Swallow	0.17	0.30	0.22	1.38	0.50							
Ring-billed Gull								1.50	1.95		0.05	
Yellow-headed Blackbird	1.47	0.14	0.08	0.29	0.48	0.16	0.04			0.21		
Barn Swallow			2.03									
Cliff Swallow			0.16	1.03	0.02						0.03	

Table 3. Overall relative frequencies (percent of points with detections on any of 26 surveys) of bird species in each of the six years of surveys in the Las Vegas Wash (February 2009 – January 2011). The number of points increased from 29 to 31 after the second year*. Birds that flew over or were > 100 m from the census stations are excluded. Species listed in descending order of average frequency.

SPECIES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Red-winged Blackbird	100	100	100	100	100	94
Abert's Towhee	100	100	97	100	97	97
Black Phoebe	100	100	100	97	100	94
Song Sparrow	100	97	100	100	100	94
Yellow-rumped Warbler	100	97	100	97	100	97
Brown-headed Cowbird	97	100	100	97	100	94
Bewick's Wren	97	100	94	100	97	97
Common Yellowthroat	100	93	97	97	97	94
White-crowned Sparrow	93	100	97	97	100	87
N. Rough-winged Swallow	93	86	97	100	97	100
Verdin	93	97	90	97	100	87
Black-tailed Gnatcatcher	93	97	94	94	100	81
Ruby-crowned Kinglet	100	97	97	87	90	74
Mourning Dove	93	86	90	81	90	97
Crissal Thrasher	93	86	87	87	94	81
American Pipit	97	90	90	84	77	77
Mallard	66	69	94	94	100	94
House Finch	79	90	87	81	87	90
Marsh Wren	93	83	84	90	81	81
Blue Grosbeak	97	90	84	84	74	68
Lucy's Warbler	93	90	81	84	81	68
Orange-crowned Warbler	93	83	77	87	74	81
Great-tailed Grackle	69	69	81	87	97	84
Yellow-breasted Chat	93	93	81	90	61	68
Northern Flicker	72	76	77	90	77	77
American Coot	66	76	77	74	81	77
Gambel's Quail	83	59	58	74	77	87
Greater Roadrunner	66	72	68	74	77	61
Say's Phoebe	59	52	39	71	100	87
Double-crested Cormorant	66	55	61	61	71	74
Yellow Warbler	59	48	55	61	84	74
Killdeer	69	66	55	55	61	52
Great Blue Heron	45	69	42	45	68	61
Gadwall	45	41	52	61	61	65
Wilson's Warbler	76	66	65	48	35	29
Belted Kingfisher	66	59	55	55	35	39
Cliff Swallow	34	24	45	45	94	52
Loggerhead Shrike	55	38	19	45	71	42
Brewer's Sparrow	21	28	42	58	65	55
Ring-billed Gull	52	45	52	35	32	42
Green Heron	28	62	45	35	29	55
Western Kingbird	31	17	58	35	52	58

SPECIES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Lincoln's Sparrow	66	28	61	39	29	29
Lesser Goldfinch	28	41	35	39	48	58
Red-tailed Hawk	34	24	23	39	65	65
Northern Harrier	21	34	52	39	39	52
Blue-gray Gnatcatcher	52	62	29	58	10	19
Dark-eyed Junco	21	24	61	45	39	29
White-winged Dove	55	28	42	32	26	29
Barn Swallow	21	10	45	39	68	26
Spotted Sandpiper	41	38	16	35	35	32
Black-chinned Hummingbird	21	38	39	32	32	32
Osprey	41	21	29	19	42	39
Greater Yellowlegs	52	24	16	26	32	35
Sharp-shinned Hawk	34	17	19	26	48	35
Cooper's Hawk	21	28	26	29	32	35
Great Egret	28	17	32	16	26	45
Snowy Egret	31	21	35	16	19	29
Common Raven	41	28	10	19	26	23
Northern Mockingbird	7	38	32	19	29	19
Rock Wren	24	24	13	19	26	35
Phainopepla	21	31	6	23	32	13
American Kestrel	17	14	10	13	39	29
Pied-billed Grebe	7	21	29	23	19	23
Yellow-headed Blackbird	24	31	16	16	23	6
White-faced Ibis	21	21	10	6	29	29
Western Wood-Pewee	10	17	13	29	6	39
Black-crowned Night-Heron	24	24	23	6	16	19
Costa's Hummingbird	14	21	26	16	6	26
Spotted Towhee	17	14	16	39	13	10
Common Moorhen	10	14	16	13	29	26
Savannah Sparrow	14	0	19	16	19	32
American Wigeon	3	7	19	16	26	29
Common Merganser	24	28	13	6	13	13
Bushtit	31	21	6	3	16	10
Warbling Vireo	17	17	10	10	26	6
Chipping Sparrow	17	7	16	10	23	10
Peregrine Falcon	10	3	13	6	26	23
Lazuli Bunting	17	24	6	29	3	0
Bullock's Oriole	3	21	16	0	13	23
Violet-green Swallow	0	14	26	16	13	6
Turkey Vulture	3	3	13	13	23	19
Virginia Rail	14	7	6	10	6	23
Anna's Hummingbird	24	3	3	10	16	6
Green-winged Teal	0	17	19	6	6	13
Lesser Nighthawk	7	17	10	3	13	10
White-throated Swift	7	14	16	3	10	10
Black-headed Grosbeak	14	14	6	0	6	16
Ash-throated Flycatcher	14	7	16	6	0	13

SPECIES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Sora	3	7	6	10	19	10
American Robin	7	3	19	13	6	3
Hermit Thrush	14	28	3	3	3	0
Western Tanager	10	7	6	3	10	13
Canada Goose	0	3	13	0	13	19
Pine Siskin	17	0	16	0	0	13
Western Meadowlark	3	7	0	6	10	16
Great Horned Owl	0	3	3	0	13	19
Ladder-backed Woodpecker	3	0	0	3	6	26
Bell's Vireo	21	0	10	0	0	6
Rock Pigeon	3	7	10	10	3	3
Dusky Flycatcher	3	7	23	0	3	0
Brewer's Blackbird	0	3	0	3	26	3
Tree Swallow	0	0	16	10	3	6
Western Sandpiper	14	7	0	0	6	6
American Avocet	14	0	0	0	6	13
Least Bittern	3	3	6	6	3	10
Horned Lark	3	0	10	10	6	3
Solitary Vireo	3	3	3	19	0	0
Bufflehead	0	0	10	6	6	6
“Western” Flycatcher	3	7	13	3	0	0
California Gull	0	0	0	0	10	16
Indigo Bunting	0	0	0	0	16	10
Barn Owl	10	7	3	0	3	0
Northern Pintail	3	7	0	6	3	3
Cinnamon Teal	3	3	3	3	10	0
Golden-crowned Kinglet	3	0	10	3	3	3
Red-naped Sapsucker	7	10	3	0	0	0
Black-necked Stilt	7	3	0	0	3	6
MacGillivray's Warbler	3	3	3	0	0	10
Gray Flycatcher	3	0	6	0	6	3
Lark Sparrow	0	0	6	3	3	6
Nashville Warbler	0	0	3	6	3	6
Cedar Waxwing	10	3	0	0	3	0
Northern Shoveler	3	3	0	0	6	3
Eared Grebe	3	0	3	0	6	3
Merlin	0	3	0	0	6	6
Common Goldeneye	0	0	6	6	3	0
European Starling	0	0	0	3	6	6
Blue-winged Teal	14	0	0	0	0	0
House Wren	7	3	0	0	3	0
Pacific Wren	7	3	0	0	0	3
Canyon Wren	3	3	3	3	0	0
Black-throated Sparrow	0	3	0	0	0	10
Snow Goose	3	0	0	0	0	10
American White Pelican	0	0	0	3	3	6
Least Sandpiper	0	0	0	0	3	10

SPECIES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Townsend's Warbler	0	0	0	0	0	13
Vaux's Swift	0	0	6	0	6	0
Brown-crested Flycatcher	10	0	0	0	0	0
Prairie Falcon	3	3	0	0	3	0
Olive-sided Flycatcher	3	0	3	0	0	3
Eurasian Collared-Dove	0	0	0	0	10	0
Hooded Oriole	0	0	10	0	0	0
Vesper Sparrow	0	0	0	0	3	6
Willow Flycatcher	0	0	0	6	0	3
Western Bluebird	3	3	0	0	0	0
American Bittern	0	3	0	0	3	0
House Sparrow	3	0	3	0	0	0
Western Grebe	3	0	3	0	0	0
American Goldfinch	0	0	0	0	6	0
Green-tailed Towhee	0	0	0	3	3	0
Lesser Yellowlegs	0	0	0	0	6	0
Red-breasted Nuthatch	0	0	3	3	0	0
Redhead	0	0	0	3	0	3
Rufous Hummingbird	0	0	0	0	0	6
Sandhill Crane	0	0	0	0	0	6
Swainson's Hawk	0	0	6	0	0	0
Wilson's Snipe	0	0	0	0	3	3
Canyon Towhee	0	3	0	0	0	0
Hairy Woodpecker	0	3	0	0	0	0
Long-billed Dowitcher	0	3	0	0	0	0
Semipalmated Plover	3	0	0	0	0	0
Semipalmated Sandpiper	0	3	0	0	0	0
Summer Tanager	3	0	0	0	0	0
Bank Swallow	0	0	0	0	3	0
Black-throated Gray Warbler	0	0	0	0	3	0
Broad-tailed Hummingbird	0	0	0	0	0	3
Caspian Tern	0	0	0	3	0	0
Clark's Grebe	0	0	0	3	0	0
Eastern Kingbird	0	0	0	0	0	3
Mountain Bluebird	0	0	0	3	0	0
Ovenbird	0	0	0	0	0	3
Pectoral Sandpiper	0	0	0	0	3	0
Red-shouldered Hawk	0	0	0	0	0	3
Ring-necked Duck	0	0	0	3	0	0
Ross's Goose	0	0	0	0	3	0
Rufous-crowned Sparrow	0	0	3	0	0	0
Scissor-tailed Flycatcher	0	0	0	0	0	3
Virginia's Warbler	0	0	3	0	0	0
Wood Duck	0	0	0	3	0	0

*Four surveys at the 3 new points at the end of the second year were not included.

Table 4. Abundances in # birds per 40 ha **and abundance ranks** (for 50 most abundant species) for Nevada Bird Count (NBC) Mojave lowland riparian transects from 2005-2010 compared to Las Vegas Wash breeding season data for the same time period. Species are listed in ascending abundance ranks from the NBC data.

SPECIES	NBC		Wash	
	Abund	Rank	Abund	Rank
Gambel's Quail	8.60	1	3.74	14
Lucy's Warbler	6.67	2	6.00	7
Mourning Dove	6.60	3	4.70	12
Song Sparrow	5.60	4	12.19	2
Yellow Warbler	5.12	5	3.68	15
House Finch	5.01	6	1.75	20
Cliff Swallow	4.85	7	0.30	45
Bewick's Wren	4.45	8	6.32	6
Abert's Towhee	4.37	9	12.59	1
Brown-headed Cowbird	3.96	10	7.64	5
Yellow-breasted Chat	3.89	11	5.00	10
Verdin	3.58	12	5.16	9
Bell's Vireo	3.57	13	0.11	
Common Yellowthroat	2.23	14	9.49	4
Phainopepla	2.20	15	0.01	
Ash-throated Flycatcher	2.18	16	0.08	
Red-winged Blackbird	2.13	17	11.75	3
N. Rough-winged Swallow	2.06	18	0.61	31
Rock Wren	2.04	19	0.13	
Black-tailed Gnatcatcher	1.84	20	4.84	11
Black-throated Sparrow	1.67	21	0.04	
Blue-gray Gnatcatcher	1.63	22	0.35	40
Say's Phoebe	1.55	23	0.76	28
American Coot	1.46	24	2.28	18
Blue Grosbeak	1.43	25	3.17	16
Wilson's Warbler	1.22	26	1.13	22
Great-tailed Grackle	1.15	27	4.26	13
Mallard	0.87	28	2.20	19
House Sparrow	0.83	29		
Yellow-rumped Warbler	0.83	30	0.86	25
Lesser Goldfinch	0.81	31	0.53	35
Killdeer	0.78	32	1.02	23
Northern Mockingbird	0.70	33	0.17	
White-winged Dove	0.66	34	0.62	30
European Starling	0.62	35		
Bullock's Oriole	0.58	36	0.13	
Black-chinned Hummingbird	0.57	37	0.61	32
Canyon Wren	0.57	38	0.01	
Brewer's Sparrow	0.47	39	0.76	29
Black Phoebe	0.47	40	2.31	17
Western Meadowlark	0.46	41	0.01	

SPECIES	NBC		Wash	
	Abund	Rank	Abund	Rank
Orange-crowned Warbler	0.44	42	0.34	41
Eurasian Collared-Dove	0.42	43	0.01	
Western Kingbird	0.40	44	0.77	27
Virginia's Warbler	0.39	45		
Brewer's Blackbird	0.34	46	0.03	
Loggerhead Shrike	0.33	47	0.30	44
Crissal Thrasher	0.30	48	1.33	21
Ladder-backed Woodpecker	0.29	49	0.02	
Western Wood-Pewee	0.28	50	0.17	
Marsh Wren	0.26		5.39	8
Spotted Sandpiper	0.25		0.46	38
White-crowned Sparrow	0.25		0.60	33
Yellow-headed Blackbird	0.25		0.58	34
Costa's Hummingbird	0.22		0.21	49
Turkey Vulture	0.22			
Ring-necked Pheasant	0.22			
Violet-green Swallow	0.21		0.03	
Greater Roadrunner	0.20		0.86	24
White-throated Swift	0.20			
Red-tailed Hawk	0.18		0.01	
Lazuli Bunting	0.17		0.08	
Warbling Vireo	0.17		0.14	
Chipping Sparrow	0.16		0.26	47
Western Tanager	0.15		0.07	
Horned Lark	0.15		0.18	
Vermilion Flycatcher	0.14			
Long-billed Dowitcher	0.14		0.01	
Pied-billed Grebe	0.14		0.17	
Cactus Wren	0.13			
Black-headed Grosbeak	0.12		0.08	
MacGillivray's Warbler	0.12		0.02	
Ruddy Duck	0.10			
Lesser Nighthawk	0.10		0.01	
Eared Grebe	0.10		0.10	
Indigo Bunting	0.09		0.06	
Common Raven	0.09			
Dark-eyed Junco	0.08		0.07	
Western Flycatcher	0.08		0.04	
Brown-crested Flycatcher	0.07		0.01	
Wild Turkey	0.07			
American Avocet	0.07		0.08	
Gray Vireo	0.06			
Green Heron	0.06		0.50	36
Cinnamon Teal	0.06		0.06	
Redhead	0.06			
Ruby-crowned Kinglet	0.05		0.47	37

SPECIES	NBC		Wash	
	Abund	Rank	Abund	Rank
House Wren	0.05		0.01	
Summer Tanager	0.05			
Canada Goose	0.05		0.06	
Rock Pigeon	0.05			
Anna's Hummingbird	0.04		0.08	
Spotted Towhee	0.04		0.04	
Green-tailed Towhee	0.04		0.01	
Gray Flycatcher	0.04		0.05	
American Robin	0.04			
Willow Flycatcher	0.04		0.02	
Townsend's Warbler	0.04		0.03	
Peregrine Falcon	0.03		0.01	
Snowy Egret	0.03		0.10	
Great Egret	0.03		0.06	
Great Horned Owl	0.03		0.04	
Dusky Flycatcher	0.03		0.06	
Hooded Oriole	0.03		0.02	
Northern Shoveler	0.03		0.01	
Black-throated Gray Warbler	0.02			
Great Blue Heron	0.02		0.30	43
Barn Swallow	0.02		0.44	39
Lesser Scaup	0.02			
Cedar Waxwing	0.02			
Solitary Vireo	0.02		0.05	
Cassin's Finch	0.02			
Olive-sided Flycatcher	0.02		0.02	
Wilson's Phalarope	0.02			
American Kestrel	0.02		0.08	
Sora	0.02		0.04	
Common Goldeneye	0.02			
Tree Swallow	0.02		0.02	
Band-tailed Pigeon	0.02			
Virginia Rail	0.02		0.05	
Lark Sparrow	0.01		0.05	
Common Nighthawk	0.01			
Scott's Oriole	0.01			
Greater Yellowlegs	0.01		0.12	
Broad-tailed Hummingbird	0.01			
Least Sandpiper	0.01		0.33	42
Bufflehead	0.01		0.01	
Nashville Warbler	0.01		0.02	
Hairy Woodpecker	0.01			
Western Grebe	0.01			
Bendire's Thrasher	0.01			
Le Conte's Thrasher	0.01			
Lewis's Woodpecker	0.01			

SPECIES	NBC		Wash	
	Abund	Rank	Abund	Rank
Cooper's Hawk	0.01		0.03	
Sharp-shinned Hawk	0.01		0.01	
Hammond's Flycatcher	0.01			
Calliope Hummingbird	0.01			
American Pipit			0.81	26
Gadwall			0.29	46
Western Sandpiper			0.25	48
Common Moorhen			0.20	50
Savannah Sparrow			0.16	
White-faced Ibis			0.14	
Lincoln's Sparrow			0.12	
Double-crested Cormorant			0.12	
American Wigeon			0.06	
Least Bittern			0.05	
Black-crowned Night-heron			0.05	
Black-necked Stilt			0.05	
Belted Kingfisher			0.04	
Barn Owl			0.04	
Green-winged Teal			0.04	
Osprey			0.04	
Northern Flicker			0.04	
Northern Harrier			0.02	
Semipalmated Sandpiper			0.02	
Bushtit			0.02	
American White Pelican			0.02	
Common Merganser			0.02	
Vesper Sparrow			0.02	
Hermit Thrush			0.01	
Rufous Hummingbird			0.01	
American Bittern			0.01	
American Goldfinch			0.01	
Canyon Towhee			0.01	
Eastern Kingbird			0.01	
Red-naped Sapsucker			0.01	
Rufous-crowned Sparrow			0.01	
Semipalmated Plover			0.01	
Wilson's Snipe			0.01	

Table 5. Summary regression statistics for all 47 species that were detected at the Las Vegas Wash during at least 40 (of a total of 156) survey events between February 2005 and January 2011. Species listed in descending order of detections. Dark gray shading indicates significantly negative trends (9 species), and light gray shading indicates significantly positive trends (15 species).

SPECIES	No. of Events with Detection	Total No. of Birds Detected	Overall Density Estimate (birds/40 ha)	R^2	Regression Coefficient	P
Abert's Towhee	156	4473	12.21	0.06	-0.82	<0.01
Song Sparrow	156	3746	10.23	0.16	-1.02	<0.01
Bewick's Wren	156	2371	6.47	0.06	-0.44	<0.01
Verdin	156	1722	4.70	0.10	0.43	<0.01
Black-tailed Gnatcatcher	155	1723	4.70	0.01	0.13	0.27
Marsh Wren	154	2775	7.58	0.10	0.90	<0.01
Black Phoebe	154	1397	3.81	0.00	-0.02	0.87
Red-winged Blackbird	143	3260	8.90	0.00	0.28	0.56
Crissal Thrasher	140	555	1.52	0.01	0.07	0.17
American Coot	128	2147	5.86	0.00	-0.30	0.48
Mallard	122	1600	4.37	0.15	1.23	<0.01
Great-tailed Grackle	118	1090	2.98	0.06	0.58	<0.01
Gambel's Quail	117	1069	2.92	0.25	1.22	<0.01
Say's Phoebe	111	327	0.89	0.12	0.19	<0.01
Orange-crowned Warbler	102	680	1.86	0.04	0.28	0.02
House Finch	100	733	2.00	0.05	0.57	<0.01
Yellow-rumped Warbler	99	3699	10.10	0.06	2.68	<0.01
Mourning Dove	99	877	2.39	0.03	-0.45	0.04
Killdeer	98	299	0.82	0.07	-0.18	<0.01
Greater Roadrunner	97	217	0.59	0.00	-0.01	0.70
Ruby-crowned Kinglet	94	1162	3.17	0.03	-0.38	0.04
Common Yellowthroat	93	1762	4.81	0.00	-0.04	0.88
White-crowned Sparrow	92	2277	6.22	0.07	1.40	<0.01
Lucy's Warbler	75	1027	2.80	0.09	-0.75	<0.01
American Pipit	73	1406	3.84	0.05	0.97	<0.01
Great Blue Heron	72	125	0.34	0.06	0.07	<0.01
Spotted Sandpiper	71	124	0.34	0.00	-0.01	0.69
Northern Flicker	70	240	0.66	0.01	0.07	0.14
Brown-headed Cowbird	69	1298	3.54	0.01	-0.25	0.34
Yellow-breasted Chat	65	871	2.38	0.04	-0.41	0.02
Yellow Warbler	65	656	1.79	0.02	0.25	0.07
Gadwall	61	564	1.54	0.03	0.28	0.03
Loggerhead Shrike	61	111	0.30	0.00	0.02	0.44
Green Heron	61	108	0.29	0.02	-0.04	0.06

SPECIES	No. of Events with Detection	Total No. of Birds Detected	Overall Density Estimate (birds/40 ha)	R^2	Regression Coefficient	P
Lincoln's Sparrow	60	151	0.41	0.02	-0.06	0.08
Blue Grosbeak	59	567	1.55	0.03	-0.25	0.04
Lesser Goldfinch	50	355	0.97	0.07	0.42	<0.01
White-winged Dove	46	107	0.29	0.00	-0.00	0.88
Greater Yellowlegs	46	78	0.21	0.00	0.01	0.56
Rock Wren	46	65	0.18	0.08	0.05	<0.01
Belted Kingfisher	45	70	0.19	0.00	-0.00	0.95
Western Kingbird	42	159	0.43	0.01	0.04	0.29
Black-chinned Hummingbird	41	106	0.29	0.00	0.02	0.41
Dark-eyed Junco	40	264	0.72	0.01	0.12	0.20
N. Rough-winged Swallow	40	128	0.35	0.00	0.01	0.93
Pied-billed Grebe	40	67	0.18	0.00	0.00	0.89
Common Moorhen	40	55	0.15	0.00	0.01	0.66

Table 6. Comparison of species richness, total abundance and species abundance (birds per 40 ha) in four revegetation treatments. Species abundances were calculated for the 34 species that were detected at the Las Vegas Wash on at least 15 of the 30 points in the 6th year (2010). Species listed in descending order of statistical significance. Dark gray shading indicates high values in comparisons that showed statistically significant treatment effects and possible treatment effects ($p < 0.2$).

	Treatment				ANOVA	
SPECIES	No Treatm.	Cleared	New Reveg.	Old Reveg.	R^2-Value	p-value
Bird Species Richness	***34.0***	***26.0***	***37.2***	***39.9***	***0.29***	***0.03***
Total Abundance	***121.5***	***104.3***	***154.0***	***183.7***	***0.28***	***0.03***
Say's Phoebe	1.05	0.73	2.94	0.60	0.71	<0.01
Yellow Warbler	0.59	0.50	0.97	4.03	0.39	<0.01
Ruby-crowned Kinglet	1.44	0.85	1.18	4.07	0.38	<0.01
Crissal Thrasher	2.22	0.64	1.35	2.75	0.22	0.09
Yellow-rumped Warbler	17.97	7.46	10.53	18.72	0.22	0.09
Brown-headed Cowbird	2.42	2.58	1.47	4.03	0.20	0.12
Northern Flicker	0.10	0.51	0.39	0.98	0.20	0.11
Abert's Towhee	8.05	7.52	8.85	14.43	0.19	0.13
American Coot	1.95	1.19	7.20	3.62	0.19	0.13
Black Phoebe	6.04	4.58	3.08	2.52	0.19	0.13
Mourning Dove	5.04	2.84	1.55	1.21	0.19	0.13
Orange-crowned Warbler	1.34	0.91	3.80	3.77	0.18	0.16
Verdin	6.21	3.02	4.09	7.23	0.18	0.16
Great-tailed Grackle	0.78	0.55	3.75	5.54	0.13	0.31
Lesser Goldfinch	0.59	1.07	2.26	4.75	0.12	0.36
Black-chinned Hummingbird	0.39	0.15	0.09	0.49	0.10	0.44
Yellow-breasted Chat	0.61	0.85	1.80	2.22	0.10	0.14
Gambel's Quail	6.68	5.06	5.88	12.36	0.09	0.46
Greater Roadrunner	0.59	0.94	0.29	0.75	0.09	0.47
Lucy's Warbler	1.88	0.56	0.69	2.30	0.09	0.49
White-crowned Sparrow	6.64	7.37	13.73	8.51	0.09	0.46
Red-winged Blackbird	3.28	5.75	7.61	8.59	0.08	0.52
Bewick's Wren	6.24	4.87	2.79	5.65	0.07	0.56
Black-tailed Gnatcatcher	7.61	4.87	3.69	4.97	0.07	0.57
Blue Grosbeak	1.08	1.28	0.48	1.09	0.07	0.61
House Finch	1.03	2.29	5.51	3.01	0.07	0.62
Marsh Wren	5.44	4.87	8.58	11.60	0.07	0.58
American Pipit	0.78	6.73	5.07	5.31	0.06	0.69
Common Yellowthroat	4.01	3.70	3.79	5.88	0.06	0.66
Mallard	1.15	2.43	10.17	7.42	0.05	0.70
Song Sparrow	8.36	7.20	10.15	10.10	0.03	0.82

Appendices

Appendix 1. All bird species detected at Las Vegas Wash, February 2005 through April 2011 during breeding, non-breeding, and transitional seasons. Bolded species are conservation priorities (Clark County 2000, Bureau of Reclamation 2006, GBBO 2010). X denotes at least one detection in that season (for season definitions, see Methods). Asterisks indicate species that were not recorded within 100 m during a survey, which are not included in the rest of the analyses. Species listed in taxonomic order.

Bird Species	Scientific Name	Breeding Season	Non-Breeding Season	Transi-tional
Snow Goose	*Chen caerulescens*	X	X	X
Ross's Goose *	*Chen rossii*		X	
Canada Goose	*Branta canadensis*	X	X	X
Wood Duck	*Aix sponsa*		X	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	X	X
Cinnamon Teal	***Anas cyanoptera***	**X**	**X**	**X**
Northern Shoveler	*Anas clypeata*	X	X	X
Northern Pintail	***Anas acuta***		**X**	**X**
Green-winged Teal	*Anas crecca*	X	X	X
Redhead	***Aythya americana***		**X**	**X**
Ring-necked Duck *	*Aythya collaris*		X	
Bufflehead	*Bucephala albeola*	X	X	X
Common Goldeneye	*Bucephala clangula*		X	X
Common Merganser	*Mergus merganser*	X	X	X
Ruddy Duck *	*Oxyura jamaicensis*		X	
Gambel's Quail	***Callipepla gambelii***	**X**	**X**	**X**
Pied-billed Grebe	*Podilymbus podiceps*	X	X	X
Eared Grebe	***Podiceps nigricollis***	**X**	**X**	**X**
Western Grebe	***Aechmophorus occidentalis***		**X**	
Clark's Grebe *	***Aechmophorus clarkii***	**X**		
American White Pelican	***Pelecanus erythrorhynchos***	**X**	**X**	**X**
Double-crested Cormorant	*Phalacrocorax auritus*	X	X	X
American Bittern	*Botaurus lentiginosus*	X		X
Least Bittern	***Ixobrychus exilis***	**X**	**X**	**X**
Great Blue Heron	*Ardea herodias*	X	X	X
Great Egret	*Ardea alba*	X	X	X
Snowy Egret	***Egretta thula***	**X**	**X**	**X**
Green Heron	*Butorides virescens*	X	X	X

Bird Species	Scientific Name	Breeding Season	Non-Breeding Season	Transi-tional
Black-crowned Night-Heron	*Nycticorax nycticorax*	X	X	X
White-faced Ibis	***Plegadis chihi***	**X**	**X**	**X**
Turkey Vulture	*Cathartes aura*	X		X
Osprey	*Pandion haliaetus*	X	X	X
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***		**X**	
Red-shouldered Hawk	*Buteo lineatus*		X	X
Swainson's Hawk *	***Buteo swainsoni***	**X**		
Red-tailed Hawk	*Buteo jamaicensis*	X	X	X
American Kestrel	*Falco sparverius*	X	X	X
Merlin	*Falco columbarius*		X	
Peregrine Falcon	***Falco peregrinus***	**X**	**X**	**X**
Prairie Falcon	***Falco mexicanus***		**X**	**X**
Virginia Rail	*Rallus limicola*	X	X	X
Sora	*Porzana carolina*	X	X	X
Common Moorhen	*Gallinula galeata*	X	X	X
American Coot	*Fulica americana*	X	X	X
Sandhill Crane *	***Grus canadensis***		**X**	
Semipalmated Plover	*Charadrius semipalmatus*	X		
Killdeer	*Charadrius vociferus*	X	X	X
Black-necked Stilt	***Himantopus mexicanus***	**X**		
American Avocet	***Recurvirostra americana***	**X**		**X**
Spotted Sandpiper	*Actitis macularius*	X	X	X
Greater Yellowlegs	*Tringa melanoleuca*	X	X	X
Lesser Yellowlegs	*Tringa flavipes*		X	X
Semipalmated Sandpiper	*Calidris pusilla*	X		
Western Sandpiper	***Calidris mauri***	**X**	**X**	**X**
Least Sandpiper	***Calidris minutilla***	**X**	**X**	**X**
Pectoral Sandpiper	*Calidris melanotos*			X
Long-billed Dowitcher	***Limnodromus scolopaceus***	**X**		**X**
Wilson's Snipe	*Gallinago delicata*	X		
Ring-billed Gull	*Larus delawarensis*	X	X	X
California Gull *	*Larus californicus*	X	X	X
Caspian Tern *	*Hydroprogne caspia*	X		
Rock Pigeon	*Columba livia*	X	X	X
Eurasian Collared-Dove	*Streptopelia decaocto*	X		
White-winged Dove	*Zenaida asiatica*	X	X	X
Mourning Dove	*Zenaida macroura*	X	X	X
Greater Roadrunner	*Geococcyx californianus*	X	X	X

Bird Species	**Scientific Name**	**Breeding Season**	**Non-Breeding Season**	**Transi-tional**
Barn Owl	*Tyto alba*	X	X	X
Great Horned Owl	*Bubo virginianus*	X	X	X
Long-eared Owl	*Asio otus*	X		
Lesser Nighthawk	*Chordeiles acutipennis*	X		
Vaux's Swift *	*Chaetura vauxi*	X	X	X
White-throated Swift *	***Aeronautes saxatalis***	**X**	**X**	**X**
Black-chinned Hummingbird	*Archilocus alexandri*	X	X	X
Anna's Hummingbird	*Calypte anna*	X	X	X
Costa's Hummingbird	***Calypte costae***	**X**	**X**	**X**
Broad-tailed Hummingbird	*Selasphorus platycercus*			X
Rufous Hummingbird	***Selasphorus rufus***	**X**		**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
Olive-sided Flycatcher	***Contopus cooperi***	**X**		
Western Wood-Pewee	*Contopus sordidulus*	X		X
Willow Flycatcher	***Empidonax traillii***	**X**		
Gray Flycatcher	***Empidonax wrightii***	**X**		**X**
Dusky Flycatcher	*Empidonax oberholseri*	X		X
“Western” Flycatcher	*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*	X	X	X
Bell's Vireo	***Vireo bellii***	**X**		
“Solitary” Vireo	*Vireo cassinii/plumbeus*	X		
Warbling Vireo	*Vireo gilvus*	X		X
Common Raven	*Corvus corax*	X	X	X
Horned Lark	*Eremophila alpestris*	X	X	X
Tree Swallow	*Tachycineta bicolor*	X	X	X
Violet-green Swallow	*Tachycineta thalassina*	X	X	X
N. Rough-winged Swallow	*Stelgidopteryx serripennis*	X	X	X
Bank Swallow*	*Riparia riparia*	X		
Cliff Swallow	*Petrochelidon pyrrhonota*	X	X	X
Barn Swallow	*Hirundo rustica*	X	X	X

Bird Species	Scientific Name	Breeding Season	Non-Breeding Season	Transi-tional
Verdin	*Auriparus flaviceps*	X	X	X
Bushtit	*Psaltriparus minimus*	X	X	X
Red-breasted Nuthatch	*Sitta canadensis*		X	X
Cactus Wren *	*Campylorhynchus brunneicapillus*		X	
Rock Wren	*Salpinctes obsoletus*	X	X	X
Canyon Wren	*Catherpes mexicanus*	X	X	X
Bewick's Wren	*Thryomanes bewickii*	X	X	X
House Wren	*Troglodytes aedon*	X	X	X
Pacific Wren	*Troglodytes pacificus*		X	X
Marsh Wren	*Cistothorus palustris*	X	X	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	
Mountain Bluebird	*Sialia currucoides*		X	
Hermit Thrush	*Catharus guttatus*	X	X	X
American Robin	*Turdus migratorius*		X	X
Northern Mockingbird	*Mimus polyglottos*	X	X	X
Crissal Thrasher	*Toxostoma crissale*	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***	**X**	**X**	**X**
Ovenbird	*Seiurus aurocapilla*		X	
Orange-crowned Warbler	*Oreothlypis celata*	X	X	X
Lucy's Warbler	***Oreothlypis luciae***	**X**		**X**
Nashville Warbler	*Oreothlypis ruficapilla*	X	X	X
Virginia's Warbler	***Oreothlypis virginiae***			**X**
MacGillivray's Warbler	*Geothlypis tolmiei*	X		X
Common Yellowthroat	*Geothlypis trichas*	X	X	X
Yellow Warbler	***Setophaga petechia***	**X**		**X**
Yellow-rumped Warbler	*Setophaga coronata*	X	X	X
Black-throated Gray Warbler	*Setophaga nigrescens*		X	
Townsend's Warbler	*Setophaga townsendi*	X		
Wilson's Warbler	*Cardellina pusilla*	X	X	X
Yellow-breasted Chat	*Icteria virens*	X	X	X
Green-tailed Towhee	*Pipilo chlorurus*	X		X
Spotted Towhee	*Pipilo maculatus*	X	X	X
Rufous-crowned Sparrow	*Aimophila ruficeps*	X		
Canyon Towhee	*Pipilo fusca*	X		

Bird Species	**Scientific Name**	**Breeding Season**	**Non-Breeding Season**	**Transi-tional**
Abert's Towhee	***Melazone aberti***	**X**	**X**	**X**
Chipping Sparrow	*Spizella passerina*	X	X	X
Brewer's Sparrow	***Spizella breweri***	**X**	**X**	**X**
Vesper Sparrow	*Pooecetes gramineus*	X		X
Lark Sparrow	*Chondestes grammacus*	X		
Black-throated Sparrow	*Amphispiza bilineata*	X	X	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
Dark-eyed Junco	*Junco hyemalis*	X	X	X
Summer Tanager *	***Piranga rubra***			**X**
Western Tanager	*Piranga ludoviciana*	X		X
Black-headed Grosbeak	*Pheucticus melanocephalus*	X		X
Blue Grosbeak	***Passerina caerulea***	**X**	**X**	**X**
Lazuli Bunting	*Passerina amoena*	X	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*	X	X	X
Great-tailed Grackle	*Quiscalus mexicanus*	X	X	X
Brown-headed Cowbird	*Molothrus ater*	X	X	X
Hooded Oriole	*Icterus cucullatus*	X	X	
Bullock's Oriole	*Icterus bullockii*	X	X	X
House Finch	*Carpodacus mexicanus*	X	X	X
Pine Siskin	*Spinus pinus*	X	X	X
Lesser Goldfinch	*Spinus psaltria*	X	X	X
American Goldfinch	*Spinus tristis*	X	X	
House Sparrow	*Passer domesticus*		X	X