Las Vegas Wash Aquatic Bird Counts, 2009-2016

Las Vegas Wash Coordination Committee

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SOUTHERN NEVADA WATER AUTHORITY
Las Vegas Wash Project Coordination Team

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Las Vegas Wash Coordination Committee

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May 2019

ABSTRACT

The Las Vegas Wash (Wash) is the primary drainage for the Las Vegas Valley watershed, carrying treated wastewater, urban runoff, shallow groundwater and storm water from the valley to Lake Mead at Las Vegas Bay. The Las Vegas Wash Coordination Committee (LVWCC) is charged with stabilizing the Wash and restoring its ecological function and has constructed erosion control structures along the channel's length. The aquatic habitat created in the process is home to a variety of birds. To increase knowledge of the richness, abundance, and distribution of aquatic birds, the Las Vegas Wash Project Coordination Team initiated aquatic bird counts in October 2009. The counts began at the Wash and expanded to include Clark County's in-lieu fee Mitigation Wetlands (Mitigation Wetlands) in January 2010. This report summarizes the data collected from the Wash study area from October 2009 through December 2014, and the Mitigation Wetlands study area from January 2010 through December 2016. Surveys were conducted at the two study areas up to 14 times per year (typically monthly with an extra survey in spring and late summer/early fall). The Wash included eight sites originally and then a few others were added as construction was completed, with results summarized separately. The Mitigation Wetlands included all six cells.

Results were summarized for three periods: overall, non-breeding (October through March), and breeding/migration (April through September). For the Wash, 55, 46, and 44 species were detected in these periods, respectively. Average richness and abundance did not change significantly overall but increased for the non-breeding season from 16.7 species and 378.2 individuals per survey to 19.5 species and 564.3 individuals per survey and decreased in the breeding/migration period from 16.9 species and 139.4 birds per survey to 13.3 species and 108.0 birds per survey. For the Mitigation Wetlands, 68, 51, and 63 species were detected in the overall, non-breeding, and breeding/migration periods in 2010-2014, and 75, 57, and 66 species were detected in these periods, respectively, by the end of 2016. One federally endangered species, the Yuma Ridgway's rail, was detected. Average richness and abundance trended significantly downward for all periods with the exception of abundance in the non-breeding season, and even this changed with the addition of the 2015-2016 data. A total of 80 species were identified across all sites. Average abundance at the eight original Wash sites and at the Mitigation Wetlands was significantly higher in the non-breeding season than in the breeding season/migration period. Average richness was significantly higher at the Mitigation Wetlands than at the original eight Wash sites and average abundance was significantly higher in the breeding/migration period. The largest factor likely leading to the declines at the Mitigation Wetlands is the increase in the amount of aquatic habitat elsewhere in the project area over the course of the study.

ACKNOWLEDGEMENTS

I thank the Bureau of Reclamation for providing partial funding to the Southern Nevada Water Authority for this project under cooperative agreement R09AC30017. I also extend my thanks to Keiba Crear, Jason Eckberg, Marissa Foster, Signa Gundlach, Carol Lane, Zane Marshall, Nicholas Rice, and Timothy Ricks for assisting with surveys. Finally, I thank the Las Vegas Wash Coordination Committee for their continued support for wildlife monitoring and the implementation of the Las Vegas Wash Comprehensive Adaptive Management Plan and the Las Vegas Wash Wildlife Management Plan.

Las Vegas Wash Aquatic Bird Counts, 2009-2016

Table of Contents

Page No.

List of Tables

Page No.

List of Tables (cont.)

List of Figures

List of Appendices

1.0 INTRODUCTION

1.1 Background

The Las Vegas Wash (Wash) is the primary drainage for the Las Vegas Valley watershed, carrying treated wastewater, urban runoff, shallow groundwater and storm water from the valley to Lake Mead at Las Vegas Bay (Figure 1). Once an ephemeral stream, the Wash became perennial in the 1950s with the first discharge of treated wastewater into the channel. With year-round water, wetlands formed and expanded. However, increasing flows from an increasing population and runoff from large storms began eroding the channel bed and banks, depositing thousands of tons of sediment into Las Vegas Bay. By the late 1990s, the wetlands along the Wash had eroded to a fraction of their former extent and the channel was deeply incised.

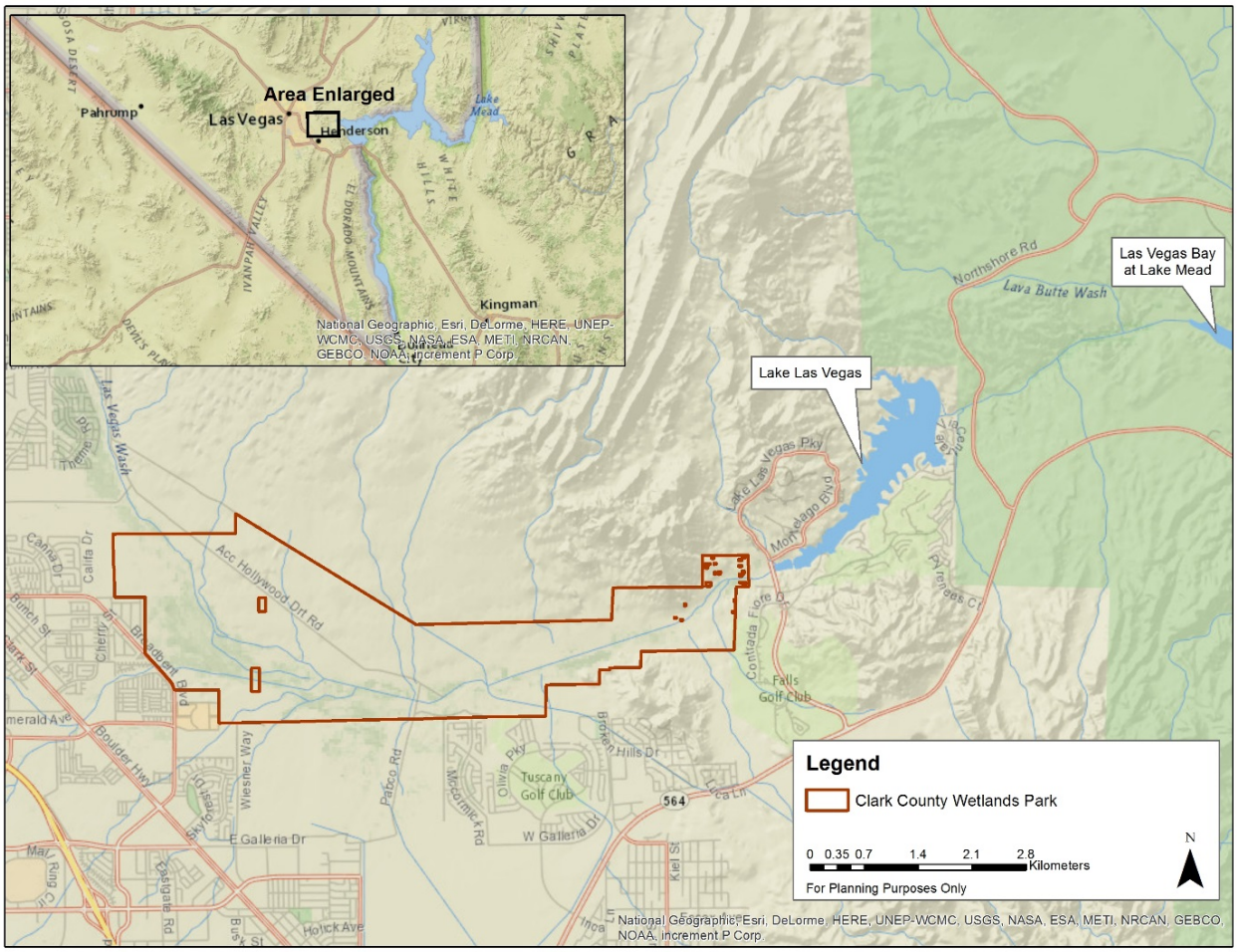

Figure 1. Las Vegas Wash location and general study area map.

The Las Vegas Wash Coordination Committee (LVWCC), a 28-member stakeholder group, was formed in 1998 and charged with stabilizing the Wash and restoring its ecological function. The LVWCC developed the Las Vegas Wash Comprehensive Adaptive Management Plan (CAMP; LVWCC 2000) in order to achieve its goals. The document includes 44 action items, one of which is constructing erosion control structures, or weirs, along the channel's length. These weirs, of

which all 21 planned structures are now complete, increased aquatic habitat. During weir construction, the channel was widened at each site, and when finished the weirs slowed the flow of the Wash, creating impoundments upstream of the structures. Aquatic habitat was also created along the face and apron of the weirs. Following construction, areas around the weirs were actively revegetated with wetland plants such as bulrush (*Schoenoplectus* spp.); emergent species, primarily cattails (*Typha domingensis*) and common reed (*Phragmites australis*), passively established. The Wash flows through the Clark County Wetlands Park (Figure 1). The county has also increased aquatic habitat in the area with the development of the in-lieu fee mitigation wetlands (Mitigation Wetlands). The site functions primarily as mitigation for Clark County Regional Flood Control District's implementation of its master plan.

The aquatic habitat created through the efforts of the LVWCC and Clark County is home to a variety of birds. As a result, the Las Vegas Wash Wildlife Management Plan (Shanahan et al. 2008), which was created to partially fulfill a CAMP action item, recommended that aquatic bird counts be conducted in the project area. Consequently, on October 28, 2009, the Las Vegas Wash Project Coordination Team (Wash Team) initiated aquatic bird counts with funding provided by the Bureau of Reclamation under cooperative agreement R09AC30017. The counts began at the Wash and were expanded to include the Mitigation Wetlands in January 2010. Monitoring of the Wash concluded in December 2014 (with the exception of the Duck Creek Confluence Weir). Monitoring of the Mitigation Wetlands concluded in December 2016. This report summarizes the data collected through the life of the study.

1.2 Goals

The goals of the project were to: (1) increase knowledge of the richness, abundance and distribution of waterfowl, waterbirds, shorebirds, and marsh birds and (2) provide data to the statewide aquatic bird count monitoring program managed by the Great Basin Bird Observatory (GBBO). GBBO started the statewide program in 2004 (GBBO et al. 2004) and assisted in the development of the monitoring methods used for the counts summarized in this report. Although the statewide program was put on hold, the Wash Team submitted data from the counts to GBBO.

2.0 METHODS

2.1 Study Areas

Two study areas were surveyed in the project area: the Wash and the Mitigation Wetlands. They differed in their flow regimes, age composition, and size.

2.1.1 Wash

The Wash study area included most of the weirs present along the main Wash when the counts began in 2009 (Figure 2; Table 1). Weirs that were to be replaced or undergo significant additional construction were not surveyed. Initially, counts were conducted at eight weir sites, comprised of 10 weirs; the Lower Narrows/Homestead weirs were added as a site (Figure 2) once construction was complete in October 2011, bringing the total to nine weir sites comprised of 11 weirs. Weir sites typically included the impoundment, face, and apron of the weir. However, for some sites only the impoundment was sufficiently accessible to be surveyed. The weirs differed in age and the size of the habitat they offered (Table 1).

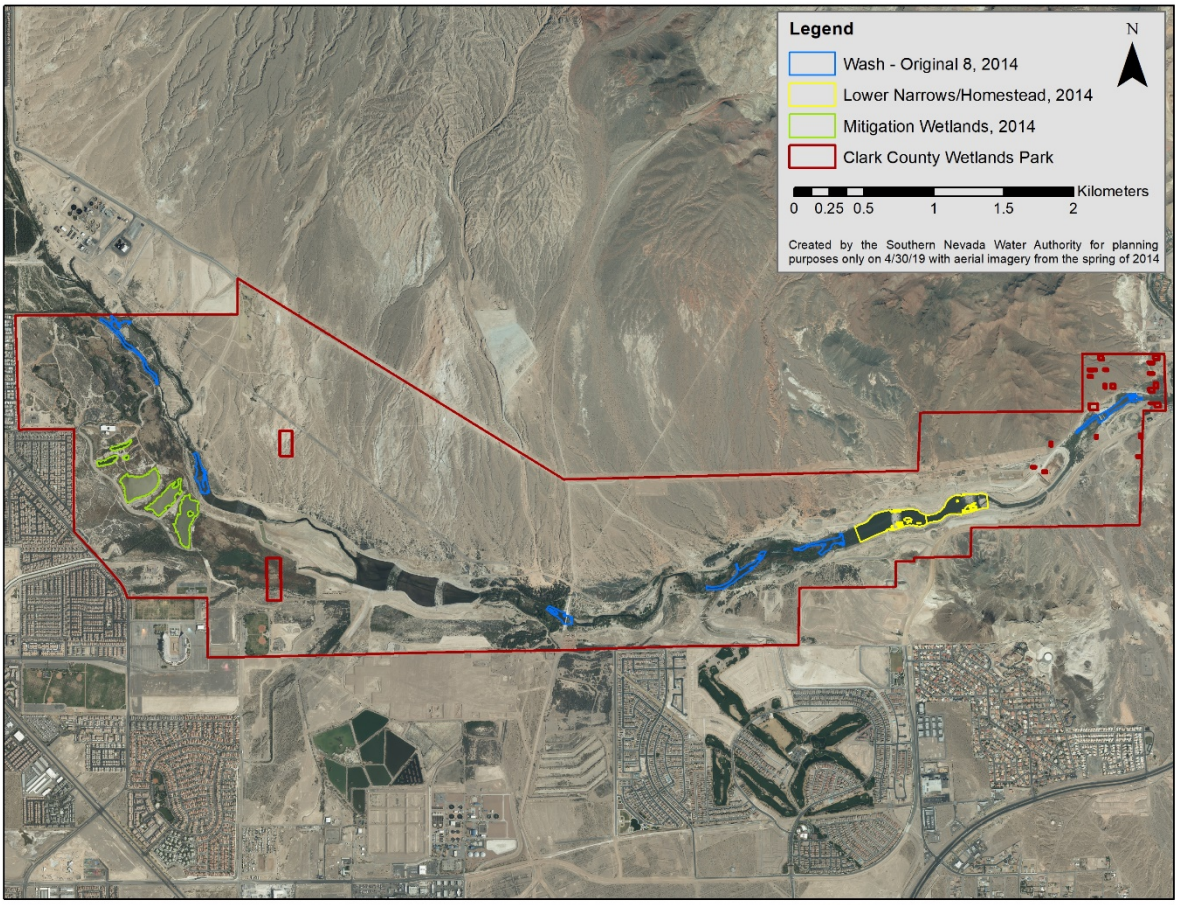

Figure 2. Aquatic bird count sites as delineated in spring 2014.

Site	Year Built	Bank Surveyed	2009	2010	2011	2012	2013	2014
Upper Diversion Weir	2008	Both	0.8	0.8	0.7	0.5	0.6	0.5
Monson & Visitor Center Weirs	2002	North	0.8	0.8	0.9	0.8	0.9	0.9
DU Wetlands No. 2 Weir	2009	North	1.8	1.8	1.8	1.6	1.7	1.3
Pabco Road Weir	2000	Both	0.6	0.6	0.7	0.8	0.9	0.9
Calico Ridge Weir	2004	North	1.6	1.6	1.6	1.5	1.6	1.3
Rainbow Gardens Weir	2004	North	0.7	0.7	0.7	0.7	0.7	0.7
Powerline Crossing Weir	2006	Both	1.2	1.2	1.1	1.0	1.0	0.9
Bostick Weir	2003	South	2.0	2.0	1.8	1.7	1.6	1.5
Total Area (ha) - 8 Original Sites			9.5	9.5	9.2	8.6	8.9	7.9
Lower Narrows & Homestead Weirs	2011	North	n/a	n/a	11.1	11.1	11.0	10.1
Total Area (ha)					20.3	19.7	19.9	18.0

Table 1. Wash sites, listed in survey order, with annual non-marsh area, 2009-2014.

The original weir sites and Lower Narrows/Homestead weirs site were surveyed through December 2014 when project funding from Reclamation ended. Other weirs were constructed during the study but were not added to the counts. However, Duck Creek Confluence Weir,

completed in 2013, was surveyed each February from 2014 through 2016 to provide additional reference for aquatic birds that may have shifted to habitat at newly completed weirs.

2.1.2 Mitigation Wetlands

The Mitigation Wetlands study area included all six cells that comprise it (Figure 2; Table 2). Clark County constructed the wetland cells to provide off-site wetland mitigation within the county. While construction finished in July 2009, the cells were not planted with wetland vegetation for several months, so surveys did not begin until January 2010. There are three small cells (< 1 ha, cells 1-3) and three large cells (> 4 ha, cells 5-7) at the site (note: Cell 4 was planned but not constructed, however, the naming convention in the study area follows the original site design). Open water is generally deep in the small cells (> 1 m). The large cells include both shallow and deeper water zones. Over time, marsh habitat filled in around the perimeters of the cells. In Cell 3, very little open water was left by 2011. Emergent islands formed in the interiors of cells 6 and 7 (Table 2). Marsh and other vegetation was then augmented in the interiors of cells 5 and 6 in the fall of 2016 to meet U.S. Army Corps of Engineers' (Corps') permit requirements. Aquatic bird counts continued at the Mitigation Wetlands through the end of 2016 to provide wildlife data for Corps' permit compliance for the study area.

Site	2010	2011	2012	2013	2014	2015	2016
Cell 1	0.8	0.5	0.4	0.4	0.4	0.4	0.4
Cell 2	0.6	0.6	0.5	0.5	0.5	0.5	0.5
Cell 3	0.4	0.1	0.1	0.1	0.1	0.1	0.1
Cell 4	4.9	4.5	4.3	4.0	3.9	3.8	3.4
Cell 5	4.1	3.6	3.2	2.7	2.5	2.4	2.3
Cell 6	5.2	4.3	3.9	3.6	3.5	3.4	3.4
Total Area (ha)	16.0	13.7	12.4	11.4	10.8	10.6	10.1

Table 2. Mitigation Wetlands sites with annual non-marsh area, 2010-2016.

2.2 Aquatic Bird Counts

The sites within each study area were surveyed monthly year-round with the exception of spring and late summer/early fall (April/May and August/September, respectively), when an extra count was conducted between the regularly scheduled surveys to better capture shorebird migration (GBBO et al. 2004). A field crew typically consisting of two people (rarely one) surveyed each site. Counts were generally, but not always, carried out on consecutive days, with the Mitigation Wetlands surveyed on one day and the Wash the next day. Surveys began at or near sunrise. Counts at the Mitigation Wetlands generally concluded within 2-4 hours and counts at the Wash generally concluded within 4-6 hours. Staff recorded detections of waterfowl, waterbirds, shorebirds and marsh birds, listing the species, number of individuals, location (impoundment, weir or apron) within the weir site (for the Wash site only) and habitat (water, marsh edge, marsh interior and bare). Birds that could not be identified to species were identified to family or genus or were noted as XXXX. Staff also noted if the bird was heard and not seen. Aural detections from poorly surveyed areas, primarily the marsh interior, could then be disregarded during quantitative analysis. Flyovers were also noted, as were birds in adjacent habitats. Surveys were not time-limited but were instead area-limited. Field staff remained on-site until they were confident they

had counted all birds present. While surveys were not time-limited, a minimum of 15 minutes was initially spent at each site; this decreased to 10 minutes in August 2011 after determining it would have little to no impact on results.

2.3 Data Analysis

Data were analyzed and summarized for three time periods for each study area—overall, non-breeding season, and breeding season/migration (Table 3)—for the five-year period when monitoring occurred at both (with the three months of data from 2009 collected at the Wash). Data from the Lower Narrows/Homestead weirs site and the Duck Creek Confluence Weir site were analyzed and reported separately from the other Wash sites. The former was only surveyed for three of the five years (44 surveys overall, 21 in the non-breeding season and 23 in the breeding season/migration period with the same exceptions as the Wash from 2012 forward [Table 3]), and the latter was just surveyed the three times, all but two of which were outside the period the other Wash sites were surveyed. Data collected at the Mitigation Wetlands in 2015 and 2016 were also analyzed and summarized for the three periods along with final totals for the seven-year period.

Period/ Season	Months	Actual Survey Date Range	Yearly/ Seasonal n	Wash n, Mitigation Wetlands n (Shared)	Exceptions
Overall	January - December	January 12 - December 31	14	71, 98 (68)	Wash - 2009, n=3; 2010/12, n=13 (no April Two 2010 or July 2012)
Non-Breeding	October - March	October 12 - March 18	6	33, 42 (30)	Mitigation Wetlands – 2010/14, n=3; Wash – 2014, n=3
Breeding/ Migration	April - September	April 8 - September 27	8	38, 56 (38)	Wash - 2010/12, n=7

Table 3. Defined periods and the numbers of surveys conducted at each site within those periods.

Aural detections from the marsh interior were excluded from the analyses. This impacted results for marsh obligates, specifically least bittern, Virginia rail, sora, and to a lesser extent, common gallinule. Flyovers and birds detected in adjacent areas were also excluded from the analyses.

Data reported for each period include the total number of species identified (i.e., richness), the total number of individuals detected (i.e., detections or abundance), and average richness and abundance per survey each year and for the length of the study. Charts of monthly richness and abundance (with the extra spring survey listed as April Two for the Wash and April/May Two for the Mitigation Wetlands and the extra late August/early September survey shown as Aug/Sept Two) were also generated to help illustrate within season variations in both metrics. For each study area, all surveys conducted at that site were included in the average for the given period (Table 3). Additionally, average species-specific abundances were generated for each year and for the length of time surveys were conducted at the given area. Species-specific abundances were calculated for Duck Creek Confluence Weir for the February 2014-2016 visits and a three-year average for that month was generated. All species-specific abundance tables are provided as appendices. Species are presented in taxonomic order, with average abundances calculated for each family, in addition to the individual species. Families and species that contributed

substantially to abundance are referenced in the text, as are species that were only rarely detected. The distribution of each species is also provided in the abundance tables and was calculated as the percentage of the sites within each study area at which the species was detected over the life of the study. Species confirmed breeding (dependent young or eggs) are highlighted, and Conservation Priority Species from the Nevada Comprehensive Bird Conservation Plan (GBBO 2010) are noted.

SigmaStat 3.5 and SigmaPlot 14.0 were used to run a variety of statistical tests to determine whether there were significant differences in the data (note: the Lower Narrows and Homestead weirs site was excluded from these analyses, as was Duck Creek Confluence Weir). The significance level was set at $p < 0.05$. To compare changes in richness and abundance within each study area, one-way repeated measures analysis of variance (RM ANOVA) and linear regressions were conducted; data used to run the RM ANOVA were adjusted to include only surveys conducted every year (e.g., all April Two and July surveys were removed from Wash tests since surveys were not conducted in those months in all years). RM ANOVA was used to identify significant differences between years. When significant differences were identified, the Holm-Sidak or Bonferroni method was used for the pairwise comparisons. Linear regressions were used to identify significant trends. To test for differences between the two study areas and between seasons within study areas, t-tests were performed. Comparisons between the 2009-2014 surveys at the original Wash sites and the 2010-2014 surveys at the Mitigation Wetlands include only shared surveys for statistical analyses but otherwise include all survey data. When testing for differences between non-breeding and breeding season/migration richness and abundance within each study area, all surveys were used, as with linear regressions.

Data periodically needed to be transformed to meet parametric test requirements. This was done using a natural log (ln) transformation. When data still did not meet parametric test requirements, the Mann-Whitney rank sum test was used in place of the t-test and the Friedman RM ANOVA on ranks test was used in place of the one-way RM ANOVA (with the Tukey test used for pairwise comparisons). Linear regressions were not used when data failed tests for normality or constant variance even after transformation.

3.0 RESULTS

3.1 Wash

3.1.1 Original Eight Sites

3.1.1.1 Overall

From October 2009 through December 2014, we detected 55 species and 21,965 birds from 11 families (Table 4; Appendix A). From year to year, total richness varied by just over 10%, from 35 to 39 species (disregarding 2009 surveys as only three months of data were collected). Total detections varied by a wider margin, from 3,330 to 4,883 with the low occurring in 2010 (when no survey was conducted in April Two) and the high in 2013. Average species richness remained in a tight range (15.4 to 16.5) over the course of the study, not changing significantly (linear regression: $p = 0.459$; RM ANOVA on ranks: $p = 0.770$). Average abundance increased from 256.2 birds per survey in 2010 to 348.8 in 2013, then declined to 280.4 birds per survey in 2014; the differences between years 2011 and 2014 were found to be significant in pairwise comparisons ($p < 0.05$). Linear regression could not be performed.

Overall	2009 (3 mo.)	2010	2011	2012	2013	2014	Total
Total Richness	21	39	38	35	38	37	55
Total Abundance	911	3,330	4,504	4,411	4,883	3,926	21,965
Average Richness	14.7	16.5	15.6	15.5	16.4	15.4	15.8
Average Abundance	303.7	256.2	321.7	339.3	348.8	280.4	309.4

Table 4. Overall richness and abundance metrics for the original eight Wash sites.

The ducks and rails families accounted for 90% of average abundance overall (Appendix A). The five most abundant species (in descending order) were American coot, mallard, gadwall, American wigeon and common gallinule; these accounted for 80% of average abundance (Appendix A). The species comprising the top five only varied by one from 2010 to 2014, but the order of most to least abundant changed more substantially. In 2010, it was mallard, American coot, gadwall, American wigeon, and common gallinule, while in 2014, it was American coot, mallard, American wigeon, ring-necked duck, and gadwall. Interestingly, ring-necked duck was not detected until 2011 but then increased every year until it was one of the most abundant species in the study area.

Species that were only detected once include tundra swan, canvasback, greater scaup, lesser scaup, hooded merganser, ruddy duck, western grebe, black-bellied plover, ruddy turnstone, and American white pelican. Eight species were distributed across 100% of the sites: gadwall, American wigeon, mallard, pied-billed grebe, common gallinule, American coot, spotted sandpiper, and great blue heron (Appendix A). Nineteen Conservation Priority Species were identified (Appendix A).

3.1.1.2 Non-Breeding Season

A total of 46 species and 17,214 individuals from 10 families were detected during the non-breeding season from October 2009 through December 2014 (Table 5; Appendix A). Total richness varied annually from 27 to 33 species and total detections ranged from a low of 2,269 in the first year to a peak of 4,144 in the 2012/13 season (disregarding late 2014 which only had three months of data). Average richness and abundance both trended significantly upwards (Adj. R^2 = 0.114, $p = 0.039$; Adj. R^2 = 0.103, $p = 0.047$) over the course of the study, with richness increasing from 16.7 species per survey in 2009/10 to a high of 19.5 species per survey in both the 2012/13 and 2013/14 non-breeding seasons, while average abundance increased from a low of 378.2 in the first year to 564.3 birds per survey in 2013/14 (although the peak occurred in 2012/13). The RM ANOVA identified a significant difference between the richness means ($p = 0.024$) but did not identify any particular years in pairwise comparisons; the average abundance of all later non-breeding seasons was significantly higher than the first ($p < 0.05$).

Non-Breeding	2009/10	2010/11	2011/12	2012/13	2013/14	2014 (3 mo.)	Total
Total Richness	30	28	27	33	32	23	46
Total Abundance	2,269	3,112	3,490	4,144	3,386	813	17,214
Average Richness	16.7	16.3	17.2	19.5	19.5	15.0	17.6
Average Abundance	378.2	518.7	581.7	690.7	564.3	271.0	521.6

Table 5. Non-breeding season richness and abundance metrics for the original eight Wash sites.

There was a noticeable within season pattern in abundance (Figure 3). It was lowest in October (typically at or substantially below 200 birds), rose in November, then rose again in December to ~520-780 birds and remained similar through March. January and February 2013 exhibited the highest abundances with 1,033 and 946 birds, respectively, while January and February 2010 had abundances that were hundreds of birds below their peers. The number of species detected from month to month (Figure 4) mimicked the abundance pattern, with the lowest richness recorded in October and November and higher numbers from December through March. Of note, October richness in both 2012 and 2013 was 4-8 species higher than in any other year.

The ducks and rails families accounted for 94% of average abundance in the non-breeding season (Appendix A). The four most abundant birds were the same as in the overall period: American coot, mallard, gadwall, and American wigeon; ring-necked duck replaced common gallinule as the fifth most abundant (Appendix A). These species accounted for 84% of average abundance in this period. Again, the species comprising the top five only differed by one from 2010 to 2014, and even the order of most to least abundant changed only slightly. In 2010, it was American coot, mallard, gadwall, American wigeon, and least sandpiper, while in 2014, it was American coot, mallard, American wigeon, gadwall, and ring-necked duck. Of note is that ring-necked duck and least sandpiper basically swapped, with the duck not detected in the first breeding season and the sandpiper not identified in the last. Also of interest is the increase in American wigeon over the five-year period. Even if all the unidentified ducks were American wigeon in 2010 but none in 2014, there would still be a substantial increase in abundance for the species over the five years (Appendix A).

Fourteen Conservation Priority Species were identified (Appendix A). Interestingly, one species was confirmed breeding in this period. A pied-billed grebe was observed with a new chick at the Monson/Visitor Center weirs site in late October 2009.

3.1.1.3 Breeding Season/Migration Period

From April 2010 through September 2014, we detected 44 species and 4,751 birds from 10 families (Table 6; Appendix A). Total richness varied by 10 species, ranging from a low of 23 species in 2012 to a high of 33 the very next year. It should be noted again that in both 2010 and 2012, field crews only conducted seven of the eight surveys normally conducted in the period. The second low for total richness was 26 species in 2014. Total individuals varied, with the high of 1,154 reported in 2011 and the low of 789 in 2012 (with 2014's 864 individuals the low with all eight surveys). Conversely to the non-breeding season, average species richness and abundance both showed slight but significant downward trends (Adj. $R^2 = 0.084$, $p = 0.043$; Adj. $R^2 = 0.082$, $p = 0.045$) falling from 16.9 to 13.3 species and 139.4 to 108.0 birds per survey; RM ANOVA identified no significant differences between years ($p = 0.113$, 0.444). Average richness and abundance were significantly lower in the breeding season/migration period than in the non-breeding season ($p \leq 0.001$).

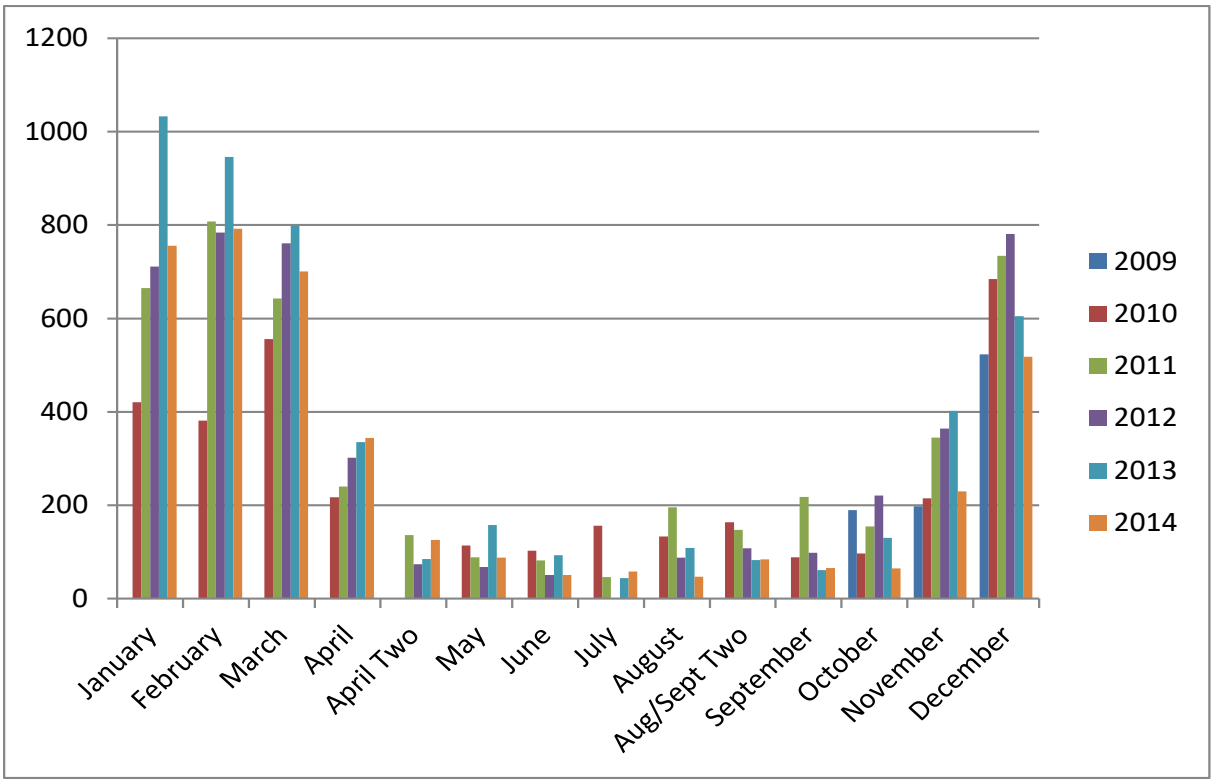

Figure 3. Number of birds (abundance) detected at the original eight Wash sites each survey by month and year.

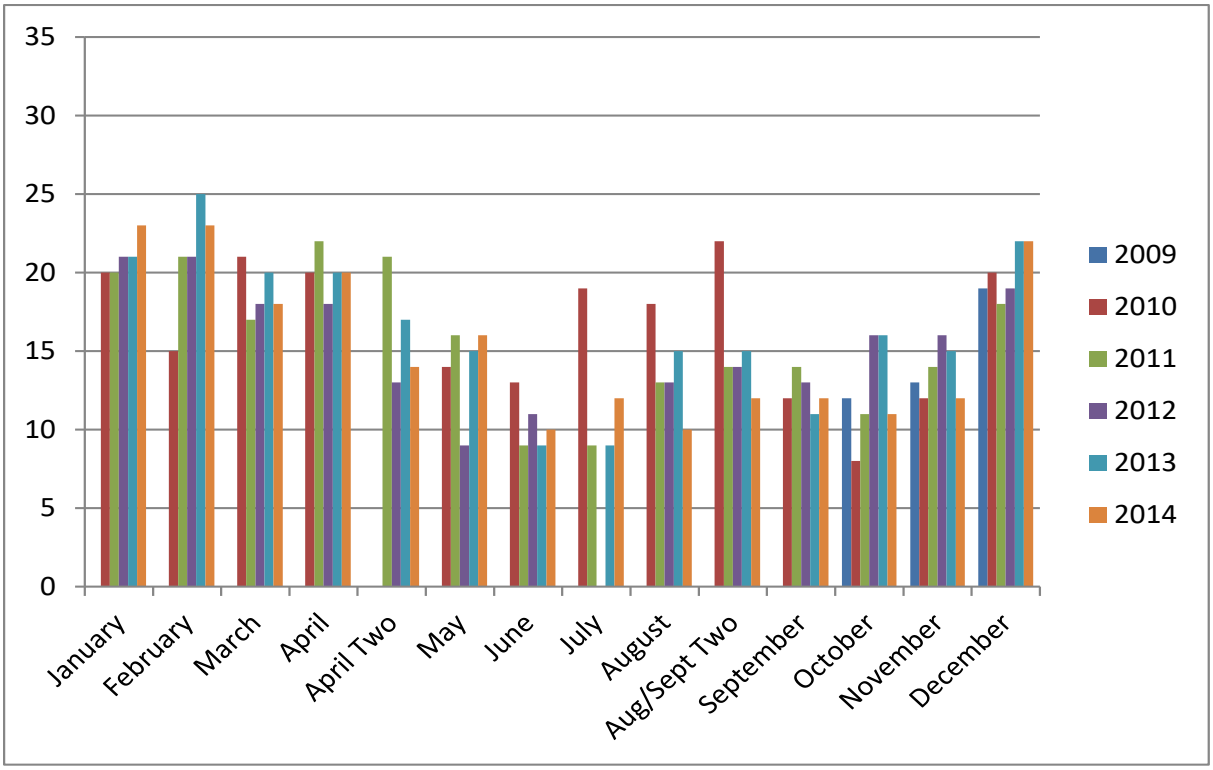

Figure 4. Number of species (richness) detected at the original eight Wash sites each survey by month and year.

Breeding/Migration	2010	2011	2012	2013	2014	Total
Total Richness	32	31	23	33	26	44
Total Abundance	976	1,154	789	968	864	4,751
Average Richness	16.9	14.8	13.0	13.9	13.3	14.3
Average Abundance	139.4	144.3	112.7	121.0	108.0	125.0

Table 6. Breeding season/migration period richness and abundance metrics for the original eight Wash sites.

As with the non-breeding season, there was a strong within season pattern in abundance (Figure 3); it was highest in the first April survey (~215-345 birds), then typically fell to ~45-160 birds for the remainder of the period. There were a few scattered exceptions in 2010 and 2011 where abundance exceeded 160 birds. Species richness was highest in April, descended gradually to a low in June and (typically) July, and then rose somewhat in the remaining months of the period (Figure 4). April Two 2011 and July through Aug/Sept Two 2010 showed exceptionally high richness relative to other years, particularly July and Aug/Sept Two 2010, in which seven more species were identified per survey than in any other year. May 2012 was notable for low richness, having five fewer species detected than in any other year.

The dominance of the ducks and rails families declined in the breeding season/migration period, falling to 72% of average abundance (Appendix A). Three other families gained in importance, the bitterns, ibises, and sandpipers, totaling 21% of average abundance in the period. Changes occurred to the five most abundant species as well, becoming mallard, American coot, white-faced ibis, common gallinule, and spotted sandpiper. Together, the five species represented 74% of average abundance (Appendix A). As with the other periods, the species comprising the top five only differed by one from 2010 to 2014, and there was some change to order of most to least abundant. In 2010, it was mallard, American coot, least sandpiper, white-faced ibis and common gallinule, and in 2014, it was American coot, mallard, long-billed dowitcher, common gallinule, and white-faced ibis. While they do not generally nest on the Wash, American coot abundance more than doubled over the five-year period, largely due to increases in detections in the first April survey.

Fifteen Conservation Priority Species were identified, of which one, American avocet, likely nested but could not be confirmed (Appendix A). Only four species were confirmed breeding during the season (Canada goose, mallard, common gallinule, and killdeer).

3.1.2 Lower Narrows/Homestead Weirs Site

3.1.2.1 Overall

From October 2011 through December 2014, we detected 43 species and 14,187 birds from 10 families (Table 7; Appendix B). Total richness varied from 31 to 35 (disregarding 2011 surveys as only three months of data were collected). Total detections varied by a wider margin, from 3,692 to 5,244 with the high recorded in 2013 and the low in 2014. Average richness remained in a tight range of 10.2 to 12.1 species per survey. Average abundance varied from a low of 263.7 (2014) to a high of 374.6 birds per survey (2013).

Overall	2011 (3 mo.)	2012	2013	2014	Total
Total Richness	17	31	34	35	43
Total Abundance	1,326	3,925	5,244	3,692	14,187
Average Richness	10.3	10.2	12.1	11.9	11.3
Average Abundance	442.0	301.9	374.6	263.7	322.4

Table 7. Overall richness and abundance metrics for the Lower Narrows/Homestead weirs site.

The ducks and rails families accounted for 95% of average abundance overall (Appendix B). The five most abundant species (in descending order) were American coot, mallard, gadwall, American wigeon, and green-winged teal; these accounted for more than 90% of average abundance (Appendix B). Species that were only detected once include lesser scaup, American white pelican, hooded merganser, Virginia rail, Wilson's snipe, and least bittern. Fifteen Conservation Priority Species were identified (Appendix B).

3.1.2.2 Non-Breeding Season

A total of 34 species and 11,431 individuals from eight families were detected during the non-breeding season from October 2011 through December 2014 (Table 8; Appendix B). Total richness varied slightly from 25 to 27 and total detections ranged from 2,822 to 4,088 (disregarding late 2014 in which only three months of data were collected). Average richness and abundance increased from 11.7 species and 470.3 birds per survey in the 2011/12 season to 14.3 species and 628.5 birds per survey in the 2013/14 season.

Non-Breeding	2011/12	2012/13	2013/14	2014 (3 mo.)	Total
Total Richness	26	25	27	18	34
Total Abundance	2,822	4,088	3,771	750	11,431
Average Richness	11.7	12.8	14.3	11.7	12.8
Average Abundance	470.3	681.3	628.5	250.0	544.3

Table 8. Non-breeding season richness and abundance metrics for the Lower Narrows/Homestead weirs site.

The Lower Narrows/Homestead weirs site showed a similar within season pattern as the rest of the Wash sites, with abundance lowest in October (Figure 5), averaging below 200 birds per survey, then rising in November and remaining higher through March. Notable peaks, where abundance swelled to more than 900 birds, occurred in March 2013 and in December and January of the 2013/14 season. Richness was somewhat lower in October through December and higher from January through March (Figure 6).

The ducks and rails families accounted for 98% of average abundance in the non-breeding season (Appendix B). The five most abundant species were the same as overall, with just a slight change in order, with gadwall and mallard trading places (Appendix B). These species accounted for 94% of average abundance in the period.

Ten Conservation Priority Species were identified (Appendix B).

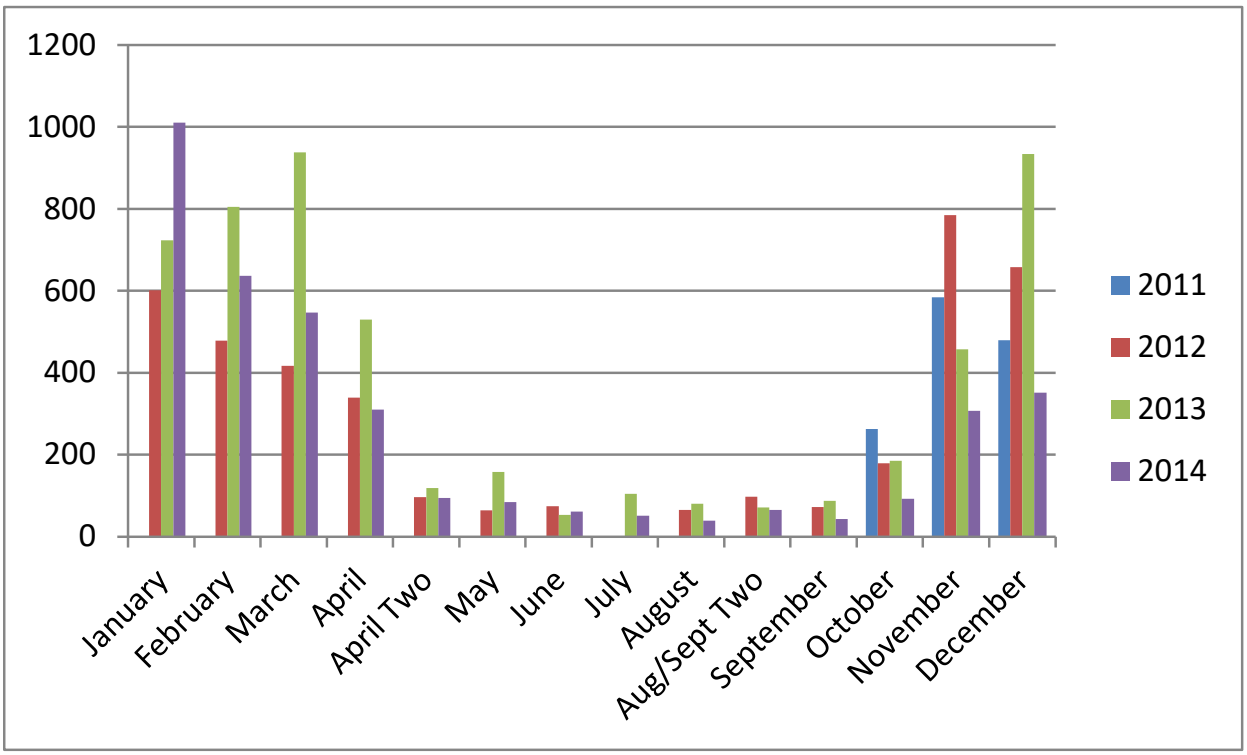

Figure 5. Number of birds (abundance) detected at the Lower Narrows/Homestead weirs site each survey by month and year.

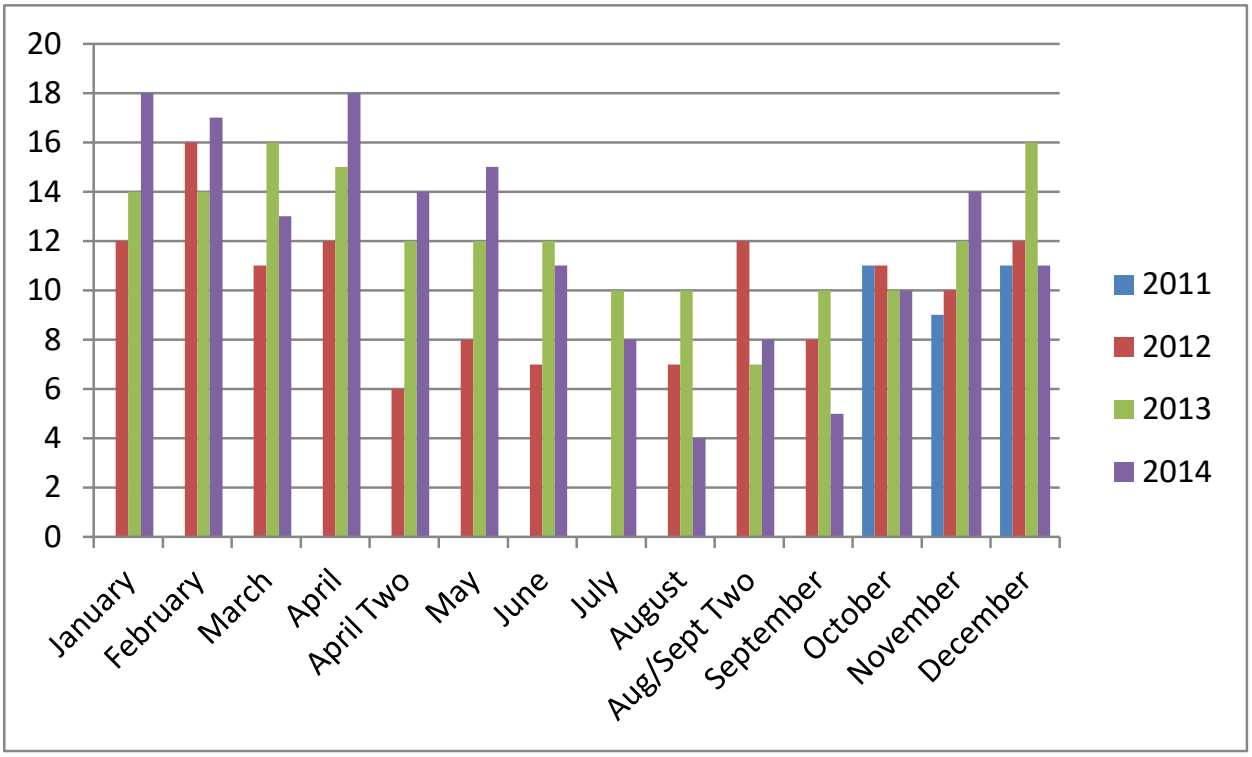

Figure 6. Number of species (richness) at the Lower Narrows/Homestead weirs site survey by month and year.

3.1.2.3 Breeding Season/Migration Period

From April 2012 through September 2014, we detected 40 species and 2,756 individuals from 10 families (Table 9; Appendix B). Total richness varied from a low of 24 species in 2012 to 29 species in both 2013 and 2014. It should be noted once again though, that in 2012 field crews only conducted seven of the eight surveys normally conducted in the period. Despite this, the lowest number of total detections, 747 individuals, was recorded in 2014 (the highest, 1,202, was recorded in 2013). Average species richness ranged from 8.6 to 11.0 species per survey, while average abundance ranged from 93.4 to 150.3 birds per survey; the highest values were recorded in 2013.

Breeding/Migration	2012	2013	2014	Total
Total Richness	24	29	29	40
Total Abundance	807	1,202	747	2,756
Average Richness	8.6	11.0	10.4	10.0
Average Abundance	115.3	150.3	93.4	119.8

Table 9. Breeding season/migration period richness and abundance metrics for the Lower Narrows/ Homestead weirs site.

As with the non-breeding season, there was a strong within season pattern in abundance (Figure 5). Again, it was similar to the pattern for the other Wash sites; highest in the first April survey (310-530 birds), then typically falling to less than 100 birds per survey for the remainder of the period. The sole exceptions were April Two, May and July of 2013. Species richness was highest in April, declined in April Two, rose slightly in May and then descended to a low in July through the remaining months of the period, with 10 species or fewer detected (Figure 6). Aug/Sept Two provided the only exception, with 12 species.

The dominance of the ducks and rails families declined in the breeding season/migration period to 84% of average abundance (Appendix B). Two other families gained in importance, the bitterns and ibises, totaling 8% of average abundance in the period. Some changes occurred to the five most abundant species as well, primarily in order but also with the addition of a new species. In the breeding season/migration period, the five most abundant species were mallard, American coot, gadwall, American wigeon, and white-faced ibis (the latter replacing green-winged teal); together, the five species represented 83% of average abundance (Appendix B).

Thirteen Conservation Priority Species were identified (Appendix B). Only two species were confirmed breeding during the season (mallard and common gallinule).

3.1.3 Duck Creek Confluence Weir

In the February surveys of this site in 2014-2016, we detected 29 species and 1,712 birds from nine families, counting 577, 516, and 619 birds per visit, respectively, as well as 16, 22, and 18 species per visit (Appendix C). For the three-year period, this yielded an average of 570.7 birds and 18.7 species.

The ducks and rails families comprised 90% of the total abundance detected in February 2014-16 (Appendix C). For the same period, the five most abundant species (in descending order) were gadwall, northern shoveler, American coot, least sandpiper, and American wigeon (Appendix C).

These accounted for 83% of the abundance detected over the three years of February visits. Gadwall was by far the most abundant, comprising 47% of all detections made at the site. It increased from 239 birds in 2014 and to 339 birds in 2016 (with a slight dip to 226 in 2015). Six Conservation Priority Species were confirmed at the site (Appendix C).

3.2 Mitigation Wetlands

3.2.1 Overall

From 2010 through 2014, we detected 68 species and 24,625 birds from 12 families (Table 10; Appendix D). Total richness varied from a high of 57 in 2010 to a low of 46 in 2013. Total detections also peaked in 2010, at 6,629, then declined by more than 25%, to 4,790 in 2011, ultimately falling to a low of 4,123 in 2014. Average richness and abundance likewise trended downward (Adj. $R^2 = 0.163$, $p < 0.001$; Adj. $R^2 = 0.057$, $p = 0.026$) from 24.7 to 18.4 species and from 473.5 to 294.5 birds per visit.

Including data through 2016, we detected 75 species and 29,072 birds from 12 families (Table 10; Appendix D). Total richness established a new low of 43 in 2015. Total detections continued to decline, bottoming out at 1,705 birds in 2015, with 2,742 detected in 2016. Average richness and abundance trended downward more significantly (Adj. $R^2 = 0.231$, $p < 0.001$; Adj. $R^2 = 0.210$, $p < 0.001$ for the seven years of data) to just 18.1 species and 195.9 birds per visit in 2016. RM ANOVA found a significant difference between years ($p < 0.001$), with pairwise comparisons showing that most years but 2011 had significantly lower average richness and abundance than 2010, except 2013 for richness and 2012 for abundance.

Overall	2010	2011	2012	2013	2014	5Y Total	2015	2016	7Y Total
Total Richness	57	53	49	46	50	68	43	50	75
Total Abundance	6,629	4,790	4,855	4,228	4,123	24,625	1,705	2,742	29,072
Avg. Richness	24.7	23.1	19.2	19.6	18.4	21.0	14.1	18.1	19.6
Avg. Abundance	473.5	342.1	346.8	302.0	294.5	351.8	121.8	195.9	296.7

Table 10. Overall richness and abundance metrics for the Mitigation Wetlands.

For the 2010-2014 period, the ducks and rails families accounted for 75% of average abundance, and the five most abundant species (in descending order)—American coot, green-winged teal, northern shoveler, ruddy duck, and gadwall—accounted for 56% of average abundance (Appendix D). This remained largely unchanged by the end of 2016, with the only notable difference being a change in the fifth most abundant species to ring-necked duck. While averaging across the multi-year periods did not cause noticeable changes, looking at individual years provides more nuance. Other than American coot (always the most abundant) and green-winged teal, the top five species varied from the first to the fifth and seventh years. Mallard, cinnamon teal, and gadwall rounded out the five most abundant species in 2010, while in 2014 and 2016, least sandpiper and ring-necked duck stepped into the top five, with American avocet and ring-billed gull comprising the final member in 2014 and 2016, respectively.

Species that were only detected once include greater white-fronted goose, horned grebe, black-bellied plover, snowy plover, whimbrel, long-billed curlew, sanderling, Baird's sandpiper, pectoral sandpiper, semipalmated sandpiper, Franklin's gull, least tern, and red-throated loon (Appendix

D). Fourteen species were distributed across 100% of the cells (Appendix D): Canada goose, cinnamon teal, mallard, green-winged teal, ruddy duck, pied-billed grebe, sora, common gallinule, American coot, killdeer, least bittern, great blue heron, green heron, and white-faced ibis; all but the goose had reached this extent by the end of 2014. Twenty-three Conservation Priority Species were identified in the first five years and a total of 25 reported by the end of the seven-year period (Appendix D).

3.2.2 Non-Breeding Season

A total of 51 species and 15,207 individuals from 12 families were detected during the non-breeding season from 2010 through 2014 (Table 11; Appendix D). Total richness varied annually from 35 to 43 species and total detections ranged from 2,603 to 3,391 individuals, disregarding years with only partial data. Average richness exhibited a significant downward trend, declining from 25.8 to 19.2 species per survey (Adj. $R^2 = 0.234$, $p = 0.004$) and pairwise comparisons showed average richness as significantly lower in the 2013/14 non-breeding season than in the 2010/11 season. Average abundance also declined, falling from 523.0 to 433.8 individuals per survey, but these changes were not statistically significant (linear regression: $p = 0.141$; RM ANOVA: $p = 0.619$).

Non-Breeding	2010 (3 mo.)	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2014 (3 mo.)	5Y Total	2014/ 2015	2015/ 2016	2016 (3 mo.)	7Y Total
Total Richness	28	43	37	41	35	31	51	31	37	27	57
Total Abundance	1,822	3,138	3,391	2,960	2,603	1,293	15,207	1,907	1,592	662	18,075
Avg. Richness	21.3	25.8	22.0	21.7	19.2	17.3	21.6	15.3	17.5	15.7	21.6
Avg. Abundance	607.3	523.0	565.2	493.3	433.8	431.0	506.9	317.8	265.3	220.7	430.4

Table 11. Non-breeding season richness and abundance metrics for the Mitigation Wetlands.

Including 2015-2016 data, we detected 57 species and 18,075 birds from 12 families (Table 11; Appendix D). Total richness was low but largely similar to the first five years. Total detections declined substantially, to just 1,592 birds for the 2015/16 season. Both average richness and abundance had declined significantly by the end of the 2015/16 season (Adj. $R^2 = 0.277$, $p < 0.001$; Adj. $R^2 = 0.305$, $p < 0.001$), down to just 17.5 species and 265.3 birds per visit. RM ANOVA on Ranks identified a significant difference between richness means ($p = 0.012$), with 2014/15 richness significantly lower than 2010/11, while the RM ANOVA for average abundance identified a significant difference ($p = 0.044$) but did not identify any particular years in pairwise comparisons.

Abundance was typically lowest in October and then became more variable, peaking in all months except January at least once, but generally high in December and January (Figure 7). There were some notable peaks, with abundance in November 2010 (826 birds) and February 2012 (833 birds) being higher than their peers. The three-month period of October-December 2015 represents the lowest such stretch of any non-breeding season, averaging just 115 birds per survey and the absolute low for the season, just 69 birds, was recorded in November 2016.

Species richness was variable, with higher values tending to occur in November, December and March (Figure 8). November 2016 had the lowest richness of the study with just nine, but all other

monthly lows were established in 2015. At 10.7 species per survey, the 2015/16 non-breeding season started off well below the study average for the season of 20.0, but it then increased to 24.3 in the last three months and a high value of 28 species was established for February.

The ducks and rails families accounted for 88% of average abundance in the non-breeding season (Appendix D) from 2010 through 2014. The five most abundant species were American coot, green-winged teal, northern shoveler, gadwall and ring-necked duck, accounting for 68% of average abundance (Appendix D). By the end of 2016, ducks and rails abundance dipped just slightly, comprising 84% of average abundance for the seven-year period. Ring-necked duck moved into fourth, as gadwall dropped out of the top five, and ring-billed gull became the fifth most abundant species. Again, looking at individual years reveals more dramatic changes. In the 2010/11 non-breeding season, American coot, green-winged teal, northern pintail, gadwall, and ruddy duck were the most abundant. In the 2013/2014 season, green-winged teal moved into the top spot, relegating the coot to second, with ring-necked duck, northern shoveler, and Canada goose rounding out the five most abundant species. Finally, in the 2015/2016 season, ring-billed gull moved into third, with ring-necked duck and now least sandpiper completing the top five.

Sixteen Conservation Priority Species were identified in 2010-2014 and 17 by the end of 2016 (Appendix D).

3.2.3 Breeding Season/Migration Period

Over the five-year period, we detected 63 species and 9,418 individuals from 11 families in the breeding season/migration period (Table 12; Appendix D). Total richness varied from 40 to 54 species and was highest in 2010. Total abundance ranged from 1,322 to 2,876 and was also highest in the first year. Average richness showed a statistically significant downward trend, from 24.8 species per visit in 2010 to 19.3 in 2014 (Adj. $R^2 = 0.113$, $p = 0.02$); in pairwise comparisons, average richness was found to be significantly higher in 2010 than in 2013, when average richness dropped to a low of 17.4 ($p < 0.05$). Average abundance also declined over the five-year period, from 359.5 to 196.1 individuals per visit, with a low of 165.3 recorded in 2013. Linear regression could not be performed as the data would not meet test assumptions; however, pairwise comparisons identified all years but 2011 as being significantly lower in average abundance than 2010. Average abundance was also significantly lower in the breeding season/migration period than in the non-breeding season ($p < 0.001$), but average richness was not significantly different ($p = 0.567$).

Including 2015-2016 data, we detected 66 species and 10,997 birds from 11 families (Table 12; Appendix D). Total richness decreased to a low of 38 in 2015 but increased to 40 species in 2016. Total detections decreased to just triple digits, well below what they had been in the first five years. These low numbers led to a significant downward trend for both average richness and abundance for the seven-year period (Adj. $R^2 = 0.196$, $p < 0.001$; Adj. $R^2 = 0.290$, $p < 0.001$), which decreased to just 16.6 species and 104.4 birds per visit in 2016, following a low of 15.8 species and 93.0 birds per visit in 2015. RM ANOVA found significant differences in richness means among years ($p = 0.004$) with 2010 richness significantly higher than 2015 and 2016. Significant differences between years ($p < 0.001$) were even more extensive for abundance, with comparisons identifying 2010 abundance as significantly higher than all other years but 2011, and 2011 abundance as significantly higher than both 2015 and 2016.

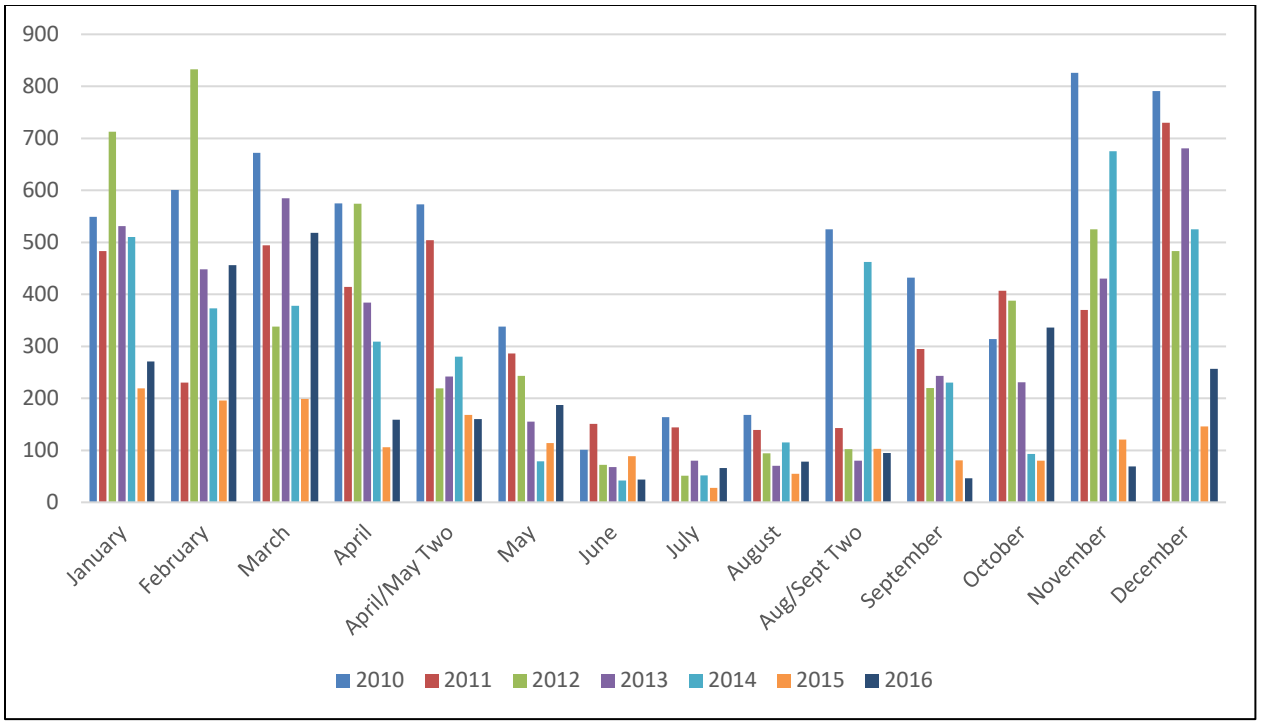

Figure 7. Number of birds (abundance) detected at the Mitigation Wetlands site each survey by month and year, 2010-2016.

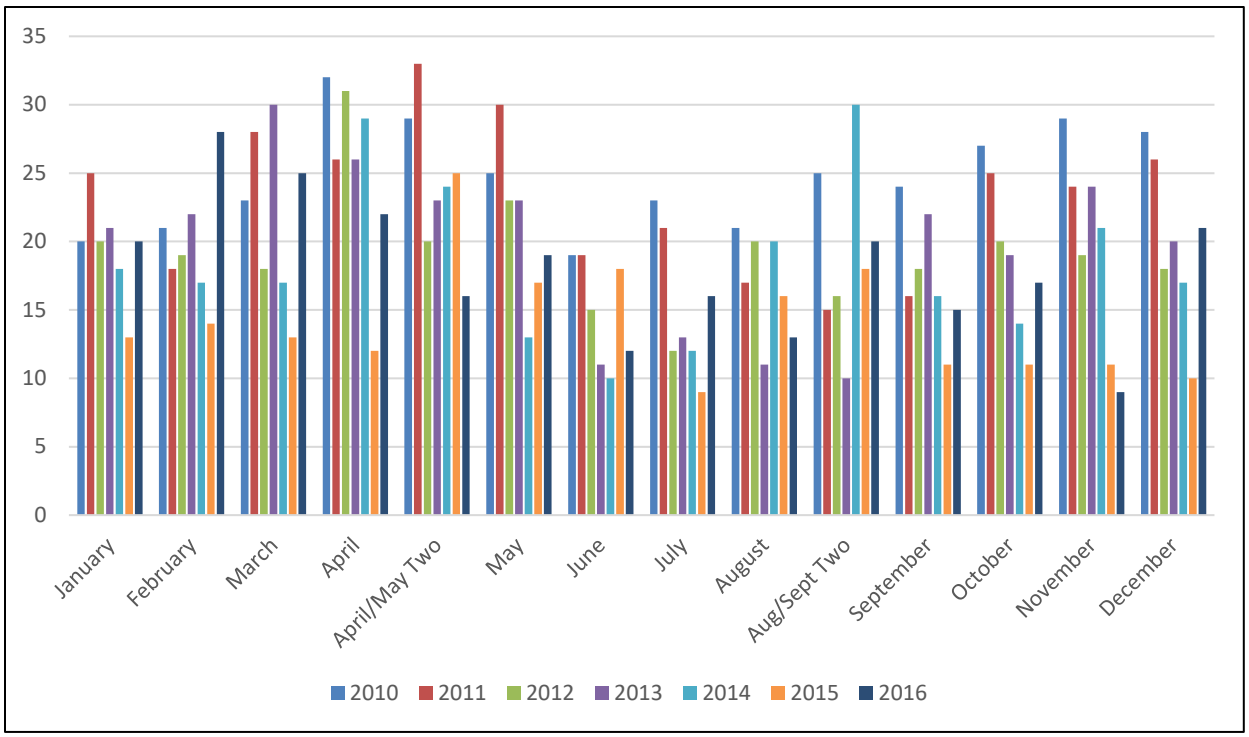

Figure 8. Number of species (richness) detected at the Mitigation Wetlands site each survey by month and year, 2010-2016.

Breeding/Migration	2010	2011	2012	2013	2014	5Y Total	2015	2016	7Y Total
Total Richness	54	45	43	40	43	63	38	40	66
Total Abundance	2,876	2,076	1,575	1,322	1,569	9,418	744	835	10,997
Avg. Richness	24.8	22.1	19.4	17.4	19.3	20.6	15.8	16.6	19.3
Avg. Abundance	359.5	259.5	196.9	165.3	196.1	235.5	93.0	104.4	196.4

Table 12. Breeding season/migration period richness and abundance metrics for the Mitigation Wetlands.

There was a stronger within season pattern in abundance for the breeding/migration period (Figure 7) than for the non-breeding season. Abundance was generally highest at the beginning of the season, then declined to a low in June through August, and then started rising again. Peaks are apparent in April/May Two 2010 and 2011 and in Aug/Sept Two 2010 and 2014. The 28 birds observed in July 2015 represents the low for the study.

Species richness followed a similar pattern to abundance (Figure 8) although not as strongly. Several peaks occur where richness is well above others for the month. Examples include April/May Two 2011, May 2011, July 2010 and 2011, and Aug/Sept Two 2010 and 2014. The nine species detected in July 2015 ties the low from November 2016.

The dominance of the ducks and rails families declined in the breeding season/migration period, falling to approximately 55% of average abundance in both the five- and seven-year periods (Appendix D). Two other families gained in importance, the sandpipers and stilts, together contributing more than 25% of average abundance in both periods (Appendix D). In 2010-2014, the five most abundant species were American coot, American avocet, cinnamon teal, long-billed dowitcher, and ruddy duck. Adding in 2015-2016 data, the top three remain the same, ruddy duck shifts to fourth and mallard enters as fifth. In both the five- and seven-year periods, they comprised just 51% of average abundance (Appendix D). Examining individual years again provides more nuance. In the 2010/11 season, American coot, cinnamon teal, mallard, American avocet, and ruddy duck were the most abundant. In the 2013/2014 season, American avocet became the most abundant, then least and western sandpipers, long-billed dowitcher, and American coot. Finally, in the 2015/2016 season, American coot rebounded to the top spot, followed by eared grebe, cinnamon teal, western sandpiper, and American avocet.

Field crews detected 22 Conservation Priority Species in 2010-2014 and 24 by the end of 2016 (Appendix D), including the federally endangered Yuma Ridgway's rail. The rail was detected during the August 19 and September 3, 2015 surveys. It was the first detection of the species in the project area since 2006 despite annual targeted surveys, highlighting the value of the aquatic bird counts. Twelve species were confirmed breeding, including three Conservation Priority Species: American avocet, black-necked stilt, and least bittern (Appendix D).

3.3 Summary of Species Detected, 2009-2016

Including all data summarized in this report, we identified 80 species, including 27 Conservation Priority Species (note: one additional species, Forster's tern, was observed after counts concluded at the Mitigation Wetlands on May 8, 2013, and a gadwall/mallard hybrid, known as a Brewer's duck, was observed along the Wash on other dates but was not included in the species totals). We detected 61 species in the non-breeding season and 72 species in the breeding season/migration period, including 20 and 26 Conservation Priority Species, respectively.

3.4 Comparison of Wash (Original Eight Sites) and Mitigation Wetlands Sites, 2009-2014

3.4.1 Overall

The Mitigation Wetlands hosted higher diversity than the original eight Wash sites. We detected 68 of the total 74 species at the cells, or 92%, versus 55 (74%) at the Wash. The two sites shared 50 species (68%). The Mitigation Wetlands had nearly four times the number of unique species, at 19, than the original eight Wash sites, which only had five. Average richness was significantly higher at the Mitigation Wetlands ($p < 0.001$), but average abundance was not significantly different ($p = 0.469$).

The greater diversity of the Mitigation Wetlands bird community over the five-year period is further indicated by comparisons of family and species composition. We identified one more family, the loons, at the site. While the ducks and rails families accounted for 90% of average abundance at the Wash, they accounted for only 75% at the Mitigation Wetlands. To achieve similar average abundance, the grebes (4%), stilts (5%) and sandpipers (7%) families need to be added, bringing the total to 91%. Similarly, only two of the five most abundant species were shared between the sites, and at the Wash, the five most abundant species accounted for 80% of average abundance, while at the Mitigation Wetlands, they accounted for just 56%. To achieve the same percentage of average abundance at the cells, the next eight most abundant species would need to be added (Appendix D). We also identified four, or approximately 20%, more Conservation Priority Species at the Mitigation Wetlands than at the Wash.

Interestingly, despite the higher overall diversity, average richness and abundance at the Mitigation Wetlands trended significantly downward over the five-year period. However, at the Wash, there was no significant change in average richness, and average abundance actually increased, although the change was not statistically significant.

3.4.2 Non-Breeding Season

The Mitigation Wetlands hosted a higher diversity of birds in the non-breeding season, as well. We detected 51 species at the cells of the total 58, or 88%, versus 46 (79%) at the Wash. Of the 58 species detected, the two sites shared 39, or 67%. The Mitigation Wetlands had fewer unique species in this period, with 12, while the original eight Wash sites had seven. This higher values at the Mitigation Wetlands are still somewhat surprising, since three additional surveys were conducted in the non-breeding season at the Wash, giving more opportunities to identify species. As with the overall period, average richness was significantly higher at the Mitigation Wetlands ($p < 0.001$), but average abundance was not significantly different ($p = 0.057$).

We identified two more families, the loons and the pelicans, at the Mitigation Wetlands than at the Wash in this period. The ducks and rails families accounted for 94% of average abundance at the Wash and 88% of average abundance at the Mitigation Wetlands. Including the grebes (3%) and gulls (4%) families at the latter site brings the total to 95% of average abundance for the four families. Three of the five most abundant species were shared. At the Wash, the five most abundant species accounted for 84% of average abundance. At the Mitigation Wetlands, they comprised 68%. To achieve a similar percentage of average abundance at the cells, the next five most abundant species would need to be added (Appendix D). We identified two, or approximately 15%, more Conservation Priority Species at the Mitigation Wetlands than at the Wash.

As with the overall period, there were differences related to average richness and abundance. Both showed significant upward trends at the Wash. However, at the Mitigation Wetlands, average richness exhibited a significant downward trend. Average abundance also declined at the cells over the course of the study, but these changes were not statistically significant until 2015-2016 data were added.

Both sites hosted significantly higher numbers of birds in the non-breeding season versus the breeding/migration period, highlighting the value of the project area to overwintering waterfowl and coots, which make up the majority of the detections. Average richness was also significantly higher at the Wash in the non-breeding season versus the breeding/migration period but was not significantly different at the Mitigation Wetlands.

3.4.3 Breeding Season/Migration Period

The breeding season/migration period showed the greatest differences between the bird community at the Wash and the Mitigation Wetlands. We detected 69 species in this period, of which 63, or 91%, were identified at the Mitigation Wetlands compared to just 44 of the species at the Wash, representing only 64% of the total. Only 38 (55%) of the species were shared by the two sites. Six species were unique to the Wash; the Mitigation Wetlands had more than four times as many unique species, with 25 (note: the two additional surveys conducted at the latter site provided more opportunities to detect species, but only two of the species unique to the site occurred during those). Both average richness and average abundance were significantly higher at the Mitigation Wetlands than at the Wash ($p \leq 0.001$) in the breeding season/migration period.

At the Mitigation Wetlands, one more family, the gulls, was detected than at the Wash, and the dominance of the ducks and rails families declined at both sites to different degrees. At the Wash, it fell to 72% of average abundance and three other families gained in importance, the bitterns, ibises, and sandpipers, totaling 21%, equaling 93% of average abundance in the period. At the Mitigation Wetlands, the ducks and rails families declined to 55% of average abundance and the stilts and sandpipers families contributed 29%. To achieve 93%, the bitterns, ibises, and plovers families would also need to be added (Appendix D). Substantial changes occurred to the five most abundant species at both sites from the non-breeding to the breeding/migration period, as well; following these, only American coot was shared between them. At the Wash, they comprised 74% of average abundance, while at the cells, they accounted for just 51% of average abundance. Six more species would be needed to achieve 74% of average abundance (Appendix D).

We identified seven, or nearly 50%, more Conservation Priority Species at the Mitigation Wetlands than at the Wash, including the federally endangered Yuma Ridgway's rail. Twelve species were confirmed breeding during the season at the Mitigation Wetlands, including three Conservation Priority Species. Only a third as many species were confirmed breeding at the Wash in this season (Canada goose, mallard, common gallinule, and killdeer) with American avocet (a Conservation Priority Species), likely nesting, but not confirmed. Pied-billed grebe was confirmed nesting at the Wash in October 2009.

This is the only period in which both sites showed statistically significant declines in average richness and abundance.

4.0 DISCUSSION

The project area hosts a wide diversity of aquatic birds year-round but with significantly higher numbers in the non-breeding months, particularly of waterfowl and coots. Although the Mitigation Wetlands had higher species richness for all periods and significantly higher bird numbers in the breeding/migration period for the five-year period, differences between results for the two study areas should be interpreted cautiously. The two study areas differ in flow regime, with the Wash being in-channel aquatic habitat and the Mitigation Wetlands being off-channel aquatic habitat. The weir sites that comprised the Wash study area varied in age, with most already several years old at the onset of surveys, while the Mitigation Wetlands were brand new at the beginning of the study. The cells offered extensive open water habitat, both shallower and deeper, with emergent marsh vegetation bordering each cell. The latter is important for nesting for many species and more species nested at the cells than at the Wash. The broad expanses between the large cells also provided nesting habitat for species, such as killdeer. As for the aquatic habitats, when water levels were lower during migration, emphasizing the large shallow zones, those areas were covered with migrating shorebirds, as in Aug/Sept Two 2014, highlighting the site's importance as migration stopover habitat. Shorebirds would also take to the mudflats when levels were low in the non-breeding season. When the level was low in Cell 7 in October 2016, more than 200 least sandpipers, 26 long-billed dowitchers, and the only pectoral sandpiper were counted there. At other times, hundreds of ducks would cover the two small sandbars that would get exposed, taking advantage of the loafing habitat while still having access to open water. Birds did not respond as well when water levels were very low. For example, in the fall of 2016, the water level in Cell 5 was lowered until there was only a thin trickle of water through the center so that emergents and other vegetation could be planted in the interior. Detections dropped to 0-3 birds per survey, contributing to the low abundances recorded at the site. Water level management was difficult over the years due to poorly functioning hydrology caused both by mechanical and beaver issues. The project manager for the site has since addressed the issues to the extent possible, and while still challenging, water levels are more responsive now and can be better managed.

The size of the area may have influenced the number of species and individuals detected at the Mitigation Wetlands. Although non-marsh area declined over the years (Table 2), the amount of surveyed area included in these analyses was always greater than at the original eight Wash sites. Another factor may have been the flow regime. The off-channel nature of the site may have appealed to more species. The Wash flows at more than 250 cubic feet per second, which may be dissuasive to some birds. As an example, the ruddy duck was one of the most common species at the Mitigation Wetlands but was rare along the Wash.

The difference in the age of the Mitigation Wetlands relative to the Wash sites could be a possible reason average richness and abundance declined overall at the cells but not at the Wash. The general maturity of the sites may mean that the bird communities at those areas were also more mature, and thus less subject to change. However, this is challenged by the increasing trend observed in richness and abundance in the non-breeding season at the Wash and decreasing trend in those same metrics observed at the Wash in the breeding season. Perhaps some food resource was present at the Mitigation Wetlands early on that declined over time, leading to the general decline in richness and abundance. It is also possible that the decline in non-marsh area over the years (Table 2) contributed to the decrease in these metrics.

The largest factor likely leading to the declines at the Mitigation Wetlands is that the amount of aquatic habitat increased elsewhere in the project area over the course of the study, as indicated by the addition of the Lower Narrows/Homestead weirs site to the Wash in October 2011. The Lower Narrows/Homestead weirs hosted more than 3,500 birds every year. It seems reasonable that at least some of these birds came from other sites, such as the Mitigation Wetlands and other sites on the Wash. And while most of the stabilized habitat available on the Wash was surveyed into 2012, from mid-2012 through mid-2013, three more large weirs—DU Wetlands No. 1, Duck Creek Confluence and Upper Narrows—were completed, on the stretch of the Wash just downstream from the Mitigation Wetlands. The Duck Creek Confluence Weir alone had an aquatic footprint of ~7.5 ha. Counts of the latter site in February 2014-2016 detected more than 500 birds from at least 16 species each count, and gadwall, a species that declined at all sites in the last few years of the study (Appendices A, B, and D), accounted for more than 40% of the detections in 2014-2015 and nearly 55% in 2016 (Appendix C).

The original Wash sites and Mitigation Wetlands together had more than 9,000 detections every year until 2014 when detections dropped to just over 8,000 birds. Detections at the Lower Narrows/Homestead weirs site declined by more than 1,500 birds from 2013 to 2014 as well. It is conceivable that some critical mass of new habitat was reached as the new weirs came online and those birds, rather than being lost from the system, simply moved to a different part of it. By the end of 2014, two more weirs had been completed (Silver Bowl and Archery), connecting the reach of the Wash stabilized by the DU Wetlands No. 2 (surveyed) and No. 1 weirs to the Duck Creek Confluence and Upper Narrows weirs, further adding to aquatic habitat.

5.0 LITERATURE CITED

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Appendix A

Wash Study Area
Original Eight Weir Sites:
Distribution and Five-Year and
Annual Overall Average Abundances for Species, 2009-2014

Family and Species	DIST	OA-5Y (n=71)	NB-5Y (n=33)	BM-5Y (n=38)	2009 (n=3)	2010 (n=13)	2011 (n=14)	2012 (n=13)	2013 (n=14)	2014 (n=14)
Ducks, Geese, and Swans		**166.89**	**300.85**	**50.55**	**187.33**	**136.00**	**198.64**	**169.69**	**179.00**	**144.71**
Domestic Goose	25%	0.11	0.03	0.18		0.62				
Canada Goose	75%	0.90	0.61	1.16		0.15	0.36	1.31	1.57	1.29
Tundra Swan*	13%	0.01	0.03		0.33					
Duck sp.		12.56	26.97	0.05	40.00	12.69	15.36	11.38	14.29	3.14
Wood Duck	50%	0.14	0.24	0.05			0.14	0.31		0.29
Blue-winged Teal	50%	0.30	0.42	0.18				0.92	0.43	0.21
Cinnamon Teal*	63%	0.68	0.79	0.58		0.38	0.43	1.23	1.50	
Northern Shoveler	75%	1.56	3.30	0.05		0.15	2.07	0.38	4.71	0.64
Gadwall	100%	29.63	60.94	2.45	40.00	24.77	42.36	35.77	31.36	11.79
American Wigeon	100%	26.06	54.06	1.74	5.00	14.38	24.07	27.77	34.71	33.14
Mallard	100%	82.15	127.61	42.68	93.00	76.92	106.71	77.85	70.29	76.00
Northern Pintail*	25%	2.21	4.67	0.08	1.00	0.38	2.07	4.77	3.36	0.79
Green-winged Teal	88%	1.49	3.18	0.03	4.00	1.77	1.07	0.92	2.29	0.86
Canvasback*	13%	0.01	0.03						0.07	
Redhead*	38%	0.14	0.27	0.03				0.31	0.21	0.21
Ring-necked Duck	63%	4.77	10.18	0.08			0.14	3.46	8.86	12.00
Greater Scaup	13%	0.03	0.06							0.14
Lesser Scaup*	13%	0.01	0.03							0.07
Bufflehead	50%	1.87	4.03		4.00	1.54	1.43	1.77	3.79	0.36
Common Goldeneye	38%	0.75	1.58	0.03		0.92	1.29	0.31	0.86	0.50
Hooded Merganser	13%	0.01	0.03							0.07
Common Merganser	88%	1.45	1.76	1.18		1.31	1.14	1.15	0.71	3.21
Ruddy Duck	13%	0.01	0.03					0.08		
Grebes		**3.37**	**6.03**	**1.05**	**4.00**	**2.38**	**3.07**	**3.46**	**3.29**	**4.43**
Pied-billed Grebe	100%	3.23	6.00	0.82	4.00	2.31	3.00	3.46	2.71	4.43
Eared Grebe*	38%	0.13		0.24		0.08	0.07		0.50	
Western Grebe*	13%	0.01	0.03						0.07	
Rails, Gallinules, and Coots		**110.06**	**191.36**	**39.45**	**68.67**	**77.77**	**89.14**	**146.46**	**136.07**	**110.00**
Virginia Rail	13%	0.01	0.03							0.07
Sora	75%	0.48	0.61	0.37		0.46	0.14	0.54	0.93	0.43
Common Gallinule	100%	5.96	6.33	5.63	3.33	5.77	6.57	6.92	6.36	4.79
American Coot	100%	103.61	184.39	33.45	65.33	71.54	82.43	139.00	128.79	104.71
Stilts and Avocets		**1.37**	**0.21**	**2.37**		**3.46**	**2.07**	**0.15**	**1.36**	**0.14**
Black-necked Stilt*	50%	0.99		1.84		2.77	2.00		0.43	
American Avocet*	50%	0.38	0.21	0.53		0.69	0.07	0.15	0.93	0.14
Lapwings and Plovers		**2.42**	**1.42**	**3.29**	**1.00**	**2.54**	**4.00**	**2.38**	**2.29**	**1.21**
Plover sp.		0.01		0.03					0.07	
Black-bellied Plover	13%	0.01		0.03			0.07			
Semipalmated Plover	25%	0.06		0.11			0.07		0.21	
Killdeer	88%	2.34	1.42	3.13	1.00	2.54	3.86	2.38	2.00	1.21

Family and Species (cont.)	DIST	OA-5Y (n=71)	NB-5Y (n=33)	BM-5Y (n=38)	2009 (n=3)	2010 (n=13)	2011 (n=14)	2012 (n=13)	2013 (n=14)	2014 (n=14)
Sandpipers, Phalaropes, and Allies		**8.87**	**7.45**	**10.11**	**32.67**	**16.54**	**7.86**	**5.08**	**4.79**	**5.29**
Sandpiper sp.		0.08	0.03	0.13		0.46				
Ruddy Turnstone	13%	0.01		0.03		0.08				
Calidris sp.		0.39	0.64	0.18		0.62	1.43			
Dunlin	13%	0.04	0.03	0.05			0.14	0.08		
Least Sandpiper*	13%	2.62	2.94	2.34	27.33	5.08	1.86	0.62	0.29	
Western Sandpiper*	13%	0.49		0.92		2.31	0.36			
Long-billed Dowitcher*	13%	1.83	1.00	2.55	2.67	4.23	0.36	0.62	1.43	2.43
Wilson's Snipe	25%	0.04	0.09			0.08				0.14
Spotted Sandpiper	100%	2.62	1.97	3.18	1.67	2.54	2.57	3.00	2.64	2.57
Lesser Yellowlegs	13%	0.07		0.13		0.08	0.29			
Willet*	13%	0.04	0.03	0.05		0.23				
Greater Yellowlegs	75%	0.59	0.73	0.47	1.00	0.77	0.86	0.77	0.36	0.14
Wilson's Phalarope*	25%	0.03		0.05		0.08			0.07	
Gulls, Terns, and Allies		**0.03**	**0.06**			**0.15**				
Ring-billed Gull	13%	0.03	0.06			0.15				
Cormorants		**2.45**	**3.24**	**1.76**	**0.67**	**2.23**	**1.71**	**1.54**	**2.57**	**4.50**
Double-crested Cormorant	75%	2.45	3.24	1.76	0.67	2.23	1.71	1.54	2.57	4.50
Pelicans		**0.01**		**0.03**						**0.07**
American White Pelican*	13%	0.01		0.03						0.07
Bitterns, Herons, and Allies		**9.45**	**10.85**	**8.24**	**9.33**	**10.46**	**9.57**	**9.23**	**9.57**	**8.50**
Least Bittern*	38%	0.21	0.06	0.34		0.08	0.21	0.23	0.21	0.36
Heron sp.		0.01		0.03					0.07	
Great Blue Heron	100%	2.51	2.82	2.24	4.67	3.54	1.64	2.38	2.14	2.43
Great Egret	63%	0.44	0.61	0.29	0.33	1.00	0.43	0.08	0.29	0.43
Snowy Egret*	88%	1.21	1.00	1.39	1.00	1.92	1.07	0.85	1.36	0.93
Green Heron	88%	1.23	0.61	1.76	0.67	1.00	0.71	0.69	2.14	1.64
Black-crowned Night-Heron	63%	3.85	5.76	2.18	2.67	2.92	5.50	5.00	3.36	2.71
Ibises and Spoonbills		**4.45**	**0.15**	**8.18**		**4.62**	**5.64**	**1.31**	**9.86**	**1.57**
White-faced Ibis*	75%	4.45	0.15	8.18		4.62	5.64	1.31	9.86	1.57
Grand Total		**309.37**	**521.64**	**125.03**	**303.67**	**256.15**	**321.71**	**339.31**	**348.79**	**280.43**

DIST = Distribution; OA = Overall; NB = Non-breeding season; BM = Breeding season/migration period; Confirmed breeding species; * Conservation Priority Species

Appendix B

Lower Narrows/Homestead Weirs Site:
Three-Year and Annual Overall Average Abundances
for Species, 2011-2014

Family and Species	OA-3Y (n=44)	NB-3Y (n=21)	BM-3Y (n=23)	2011 (n=3)	2012 (n=13)	2013 (n=14)	2014 (n=14)
Ducks, Geese, and Swans	**208.50**	**359.38**	**70.74**	**264.33**	**216.69**	**221.29**	**176.14**
Canada Goose	0.50	0.71	0.30	2.67	0.54	0.21	0.29
Duck sp.	2.16	4.52			1.00	5.86	
Wood Duck	0.07	0.05	0.09			0.21	
Blue-winged Teal	0.23	0.14	0.30		0.23		0.50
Cinnamon Teal*	1.66	0.90	2.35		2.46	1.93	1.00
Northern Shoveler	2.00	2.86	1.22	0.67	1.38	4.57	0.29
Gadwall	78.11	142.48	19.35	127.00	97.08	81.86	46.29
GadwallxMallard Hybrid	0.09	0.19				0.14	0.14
American Wigeon	32.89	59.38	8.70	37.33	21.00	30.36	45.50
Mallard	78.64	126.14	35.26	85.00	83.85	80.79	70.29
Northern Pintail*	1.30	2.57	0.13	1.00	2.85	0.57	0.64
Green-winged Teal	6.57	11.24	2.30	1.33	4.92	9.29	6.50
Redhead*	0.23	0.43	0.04	2.33		0.07	0.14
Ring-necked Duck	0.30	0.48	0.13			0.43	0.50
Lesser Scaup*	0.02	0.05			0.08		
Bufflehead	2.39	4.95	0.04	6.33	1.15	3.21	1.86
Common Goldeneye	0.36	0.48	0.26	0.67		0.21	0.79
Hooded Merganser	0.02	0.05					0.07
Mergus sp.	0.05		0.09			0.14	
Common Merganser	0.14	0.24	0.04		0.08	0.14	0.21
Ruddy Duck	0.80	1.52	0.13		0.08	1.29	1.14
Grebes	**3.59**	**1.14**	**5.83**	**0.33**	**0.77**	**8.43**	**2.07**
Pied-billed Grebe	0.48	0.71	0.26		0.38	0.43	0.71
Eared Grebe*	3.05	0.33	5.52	0.33	0.38	7.93	1.21
Western/Clark's Grebe*	0.02		0.04			0.07	
Western Grebe*	0.05	0.10					0.14
Rails, Gallinules, and Coots	**99.16**	**174.95**	**29.96**	**171.00**	**70.54**	**132.79**	**76.71**
Virginia Rail	0.02	0.05			0.08		
Sora	0.20	0.19	0.22		0.23	0.21	0.21
Common Gallinule	0.52	0.48	0.57		0.23	0.79	0.64
American Coot	98.41	174.24	29.17	171.00	70.00	131.79	75.86
Stilts and Avocets	**0.41**		**0.78**		**0.54**	**0.50**	**0.29**
Black-necked Stilt*	0.27		0.52		0.54	0.36	
American Avocet*	0.14		0.26			0.14	0.29
Lapwings and Plovers	**1.57**	**1.95**	**1.22**	**2.00**	**2.00**	**1.36**	**1.29**
Killdeer	1.57	1.95	1.22	2.00	2.00	1.36	1.29
Sandpipers, Phalaropes, and Allies	**3.11**	**5.29**	**1.13**	**2.00**	**6.62**	**1.43**	**1.79**
Sandpiper sp.	0.07	0.14		0.33	0.15		
Least Sandpiper*	1.86	3.81	0.09		5.31	0.64	0.29
Long-billed Dowitcher*	0.18	0.29	0.09	1.33	0.23		0.07
Wilson's Snipe	0.02		0.04				0.07
Spotted Sandpiper	0.75	0.71	0.78		0.38	0.64	1.36
Greater Yellowlegs	0.18	0.33	0.04	0.33	0.38	0.14	
Wilson's Phalarope*	0.05		0.09		0.15		

Family and Species (cont.)	OA-3Y (n=44)	NB-3Y (n=21)	BM-3Y (n=23)	2011 (n=3)	2012 (n=13)	2013 (n=14)	2014 (n=14)
Cormorants	**0.70**	**0.62**	**0.78**	**1.67**	**0.38**	**0.50**	**1.00**
Double-crested Cormorant	0.70	0.62	0.78	1.67	0.38	0.50	1.00
Pelicans	**0.02**		**0.04**			**0.07**	
American White Pelican*	0.02		0.04			0.07	
Bitterns, Herons, and Allies	**1.68**	**0.95**	**2.35**	**0.67**	**1.23**	**1.86**	**2.14**
Least Bittern*	0.02		0.04				0.07
Great Blue Heron	0.82	0.71	0.91	0.67	0.54	0.93	1.00
Great Egret	0.14		0.26			0.07	0.36
Snowy Egret*	0.52	0.24	0.78		0.38	0.71	0.57
Green Heron	0.18		0.35		0.31	0.14	0.14
Ibises and Spoonbills	**3.68**	**0.05**	**7.00**		**3.15**	**6.36**	**2.29**
White-faced Ibis*	3.68	0.05	7.00		3.15	6.36	2.29
Grand Total	**322.43**	**544.33**	**119.83**	**442.00**	**301.92**	**374.57**	**263.71**

OA = Overall; NB = Non-breeding season; BM = Breeding season/migration period; Confirmed breeding species; * Conservation Priority Species

Appendix C

Duck Creek Confluence Weir:
Three-Year Average and
Annual February Abundances for Species, 2014-2016

Family and Species	OA-3Y (n=3)	2014 (n=1)	2015 (n=1)	2016 (n=1)
Ducks, Geese, and Swans	**445.68**	**517**	**304**	**516**
Canada Goose	0.67		2	
Blue-winged Teal	0.67		2	
Northern Shoveler	82.33	175	9	63
Gadwall	268.00	239	226	339
American Wigeon	23.67	10	18	43
Mallard	21.00	22	27	14
Northern Pintail*	11.67	28		7
Green-winged Teal	18.00	40	12	2
Ring-necked Duck	12.67			38
Lesser Scaup*	2.33		7	
Bufflehead	0.67		1	1
Common Goldeneye	0.33	1		
Hooded Merganser	1.00			3
Common Merganser	2.67	2		6
Grebes	**4**	**1**	**7**	**4**
Pied-billed Grebe	3.33	1	5	4
Eared Grebe*/Horned Grebe	0.67		2	
Rails, Gallinules, and Coots	**68**	**46**	**73**	**85**
Common Gallinule	1.33		1	3
American Coot	66.67	46	72	82
Lapwings and Plovers	**3**	**4**	**4**	**1**
Killdeer	3.00	4	4	1
Sandpipers, Phalaropes, and Allies	**32.34**	**4**	**93**	
Least Sandpiper*	30.67	2	90	
Long-billed Dowitcher*	0.67		2	
Greater Yellowlegs	1.00	2	1	
Gulls, Terns, and Allies	**9.67**	**2**	**26**	**1**
Ring-billed Gull	9.67	2	26	1
Cormorants	**2.67**		**2**	**6**
Double-crested Cormorant	2.67		2	6
Bitterns, Herons, and Allies	**4.99**	**2**	**7**	**6**
Great Blue Heron	4.00	2	5	5
Great Egret	0.33		1	
Snowy Egret*	0.33		1	
Black-crowned Night-Heron	0.33			1
Ibises and Spoonbills	**0.33**	**1**		
White-faced Ibis*	0.33	1		
Grand Total	**570.67**	**577**	**516**	**619**

OA = Overall; * Conservation Priority Species

Appendix D

Mitigation Wetlands Study Area:
Distribution and Seven-Year, Five-Year, and
Annual Overall Average Abundances for Species, 2010-2016

Family and Species	DIST	OA-7Y (n=98)	NB-7Y (n=42)	BM-7Y (n=56)	OA-5Y (n=70)	NB-5Y (n=30)	BM-5Y (n=40)	2010 (n=14)	2011 (n=14)	2012 (n=14)	2013 (n=14)	2014 (n=14)	2015 (n=14)	2016 (n=14)
Ducks, Geese, and Swans		**140.79**	**255.12**	**55.04**	**172.43**	**311.87**	**67.85**	**203.07**	**167.79**	**176.21**	**179.71**	**135.36**	**60.15**	**62.92**
Snow Goose	33%	0.08	0.17	0.02	0.11	0.23	0.03	0.57						
Ross's Goose	17%	0.03	0.07		0.04	0.10		0.21						
Greater White-fronted Goose	17%	0.08	0.19											0.57
Canada Goose	100%	5.50	11.19	1.23	5.91	12.63	0.88	5.50	5.50	1.79	6.07	10.71	2.79	6.14
Duck sp.		1.92	4.43	0.04	2.69	6.20	0.05	0.07		4.50	4.57	4.29		
Wood Duck	33%	0.06	0.14		0.09	0.20			0.07	0.14	0.21			
Teal sp.		1.24	0.74	1.63	1.67	0.87	2.28		1.79	0.14	6.43		0.36	
Blue-winged Teal	33%	0.32	0.21	0.39	0.34	0.30	0.38	0.64	0.50		0.50	0.07	0.43	0.07
Cinnamon Teal*	100%	11.50	7.60	14.43	13.46	7.73	17.75	26.07	19.14	5.86	7.21	9.00	6.00	7.21
Northern Shoveler	83%	26.41	55.57	4.54	36.00	75.73	6.20	20.29	20.07	71.57	59.43	8.64	3.50	1.36
Gadwall	83%	10.83	22.52	2.05	14.63	30.57	2.68	26.00	19.21	16.36	8.57	3.00	0.71	1.93
American Wigeon	67%	4.15	8.98	0.54	5.64	12.17	0.75	4.71	6.07	4.86	7.36	5.21	0.07	0.79
Mallard	100%	11.00	12.00	10.25	13.00	14.17	12.13	28.00	16.64	6.21	7.71	6.43	7.86	4.14
Northern Pintail*	50%	4.05	8.71	0.55	5.66	12.20	0.75	16.07	10.14	0.57	1.36	0.14		0.07
Green-winged Teal	100%	32.84	67.17	7.09	39.49	80.70	8.58	38.86	31.00	34.64	42.36	50.57	10.36	22.07
Canvasback*	33%	0.03	0.05	0.02	0.04	0.07	0.03			0.21				
Redhead*	50%	0.50	0.62	0.41	0.64	0.87	0.48	1.43	0.71	0.50	0.50	0.07		
Ring-necked Duck	83%	12.87	28.93	0.82	12.63	28.20	0.95	7.21	7.36	13.00	11.36	24.21	12.43	14.50
Scaup sp.		0.01	0.02		0.01	0.03		0.07						
Lesser Scaup*	67%	0.47	0.62	0.36	0.66	0.87	0.50	0.86	1.43	0.29	0.71			
Bufflehead	67%	0.44	0.69	0.25	0.53	0.87	0.28	0.93	0.93	0.36	0.21	0.21	0.29	0.14
Common Goldeneye	33%	0.08	0.07	0.09	0.11	0.10	0.13	0.29	0.07			0.21		
Hooded Merganser	67%	0.28	0.62	0.02	0.23	0.50	0.03	0.64	0.07	0.21	0.21		0.14	0.64
Common Merganser	67%	0.80	1.83	0.02	0.93	2.13	0.03	0.14	0.43	1.36	2.21	0.50	0.07	0.86
Ruddy Duck	100%	15.31	21.98	10.30	17.91	24.43	13.03	24.50	26.64	13.64	12.71	12.07	15.14	2.43
Grebes		**11.69**	**13.05**	**10.68**	**13.19**	**15.77**	**11.25**	**14.93**	**13.43**	**13.57**	**17.71**	**6.29**	**6.78**	**9.14**
Pied-billed Grebe	100%	6.13	9.57	3.55	7.43	11.67	4.25	8.50	11.29	7.79	6.50	3.07	3.93	1.86
Horned Grebe	17%	0.01		0.02	0.01		0.03		0.07					
Eared Grebe*	67%	3.20	1.52	4.46	2.84	1.80	3.63	5.00	0.93	2.07	4.93	1.29	1.64	6.57
Western/Clark's Grebe*		0.11	0.26		0.16	0.37				0.64	0.14			
Western Grebe*	67%	1.96	1.40	2.38	2.39	1.53	3.03	1.36	0.86	2.43	5.43	1.86	1.21	0.57
Clark's Grebe*	67%	0.28	0.29	0.27	0.36	0.40	0.33	0.07	0.29	0.64	0.71	0.07		0.14

Family and Species (cont.)	DIST	OA-7Y (n=98)	NB-7Y (n=42)	BM-7Y (n=56)	OA-5Y (n=70)	NB-5Y (n=30)	BM-5Y (n=40)	2010 (n=14)	2011 (n=14)	2012 (n=14)	2013 (n=14)	2014 (n=14)	2015 (n=14)	2016 (n=14)
Rails, Gallinules, and Coots		**76.77**	**106.69**	**54.32**	**92.77**	**134.00**	**61.85**	**164.64**	**86.50**	**91.71**	**55.00**	**66.00**	**34.57**	**38.93**
Yuma Ridgway's Rail*(E)	17%	0.02		0.04									0.14	
Virginia Rail	33%	0.16	0.10	0.21	0.10	0.10	0.10		0.21		0.29		0.21	0.43
Sora	100%	0.94	0.29	1.43	0.81	0.37	1.15	1.14	0.71	0.50	0.71	1.00	1.43	1.07
Common Gallinule	100%	3.03	1.81	3.95	3.06	1.80	4.00	2.71	3.64	2.86	4.14	1.93	3.36	2.57
American Coot	100%	72.61	104.50	48.70	88.80	131.73	56.60	160.79	81.93	88.36	49.86	63.07	29.43	34.86
Stilts and Avocets		**14.04**	**2.38**	**22.79**	**17.39**	**2.67**	**28.43**	**21.29**	**22.00**	**13.29**	**13.43**	**16.93**	**6.08**	**5.29**
Black-necked Stilt*	50%	3.52	0.07	6.11	4.49	0.03	7.83	7.36	10.00	2.79	1.00	1.29	0.79	1.43
American Avocet*	83%	10.52	2.31	16.68	12.90	2.63	20.60	13.93	12.00	10.50	12.43	15.64	5.29	3.86
Lapwings and Plovers		**4.12**	**2.76**	**5.14**	**4.17**	**2.20**	**5.65**	**4.14**	**3.29**	**3.50**	**2.00**	**7.93**	**2.07**	**5.93**
Black-bellied Plover	17%	0.02	0.05		0.03	0.07		0.14						
Snowy Plover*	17%	0.01		0.02	0.01		0.03	0.07						
Semipalmated Plover	50%	0.09		0.16	0.13		0.23	0.14		0.07		0.43		
Killdeer	100%	4.00	2.71	4.96	4.00	2.13	5.40	3.79	3.29	3.43	2.00	7.50	2.07	5.93
Sandpipers, Phalaropes, and Allies		**23.82**	**14.76**	**30.61**	**24.81**	**5.37**	**39.40**	**29.29**	**17.43**	**26.93**	**8.79**	**41.64**	**4.22**	**38.41**
Sandpiper sp.		0.31		0.54	0.43		0.75	2.14						
Whimbrel	17%	0.03		0.05	0.04		0.08		0.21					
Long-billed Curlew*	17%	0.01		0.02										0.07
Marbled Godwit*	50%	0.10		0.18	0.13		0.23	0.21	0.21			0.21	0.07	
Calidris sp.		1.12	0.10	1.89	1.51	0.13	2.55	7.43	0.14					0.29
Sanderling	17%	0.01	0.02											0.07
Dunlin	33%	0.02	0.05											0.14
Baird's Sandpiper	17%	0.02		0.04	0.03		0.05					0.14		
Least Sandpiper*	67%	9.21	10.64	8.14	7.09	2.03	10.88	7.71	1.71	11.64	0.14	14.21	1.00	28.07
Pectoral Sandpiper	17%	0.01	0.02											0.07
Semipalmated Sandpiper	17%	0.01		0.02	0.01		0.03	0.07						
Western Sandpiper*	50%	3.46	0.05	6.02	4.01		7.03	5.57	0.14	0.50	0.14	13.71	0.93	3.21
Long-billed Dowitcher*	50%	6.84	2.83	9.84	8.46	2.27	13.10	1.43	11.14	12.43	6.57	10.71	0.93	4.64
Wilson's Snipe	50%	0.24	0.21	0.27	0.19		0.33	0.21		0.57		0.14	0.14	0.64
Spotted Sandpiper	83%	0.62		1.09	0.64		1.13	0.93	1.14	0.14	0.71	0.29	0.86	0.29
Solitary Sandpiper	50%	0.03		0.05	0.04		0.08	0.07		0.07		0.07		
Lesser Yellowlegs	50%	0.11		0.20	0.14		0.25	0.07	0.14	0.36		0.14		0.07
Greater Yellowlegs	67%	0.69	0.83	0.59	0.77	0.93	0.65	1.21	0.43	0.57	1.14	0.50	0.29	0.71

Family and Species (cont.)	DIST	OA-7Y (n=98)	NB-7Y (n=42)	BM-7Y (n=56)	OA-5Y (n=70)	NB-5Y (n=30)	BM-5Y (n=40)	2010 (n=14)	2011 (n=14)	2012 (n=14)	2013 (n=14)	2014 (n=14)	2015 (n=14)	2016 (n=14)
Wilson's Phalarope*	50%	0.77		1.34	1.04		1.83	2.21	2.14	0.64	0.07	0.14		0.14
Red-necked Phalarope*	17%	0.19		0.34	0.27		0.48					1.36		
Gulls, Terns, and Allies		**11.76**	**24.17**	**2.45**	**10.99**	**21.27**	**3.28**	**17.14**	**10.71**	**10.93**	**11.21**	**4.93**	**0.36**	**27.00**
Gull sp.		0.02	0.05		0.03	0.07			0.07	0.07				
Bonaparte's Gull	33%	0.04	0.05	0.04	0.04	0.07	0.03	0.07	0.14					0.07
Franklin's Gull*	17%	0.01	0.02		0.01	0.03					0.07			
Ring-billed Gull	50%	11.37	23.81	2.04	10.57	21.00	2.75	16.43	10.21	10.64	10.79	4.79	0.29	26.43
California Gull	50%	0.24	0.24	0.25	0.24	0.10	0.35	0.57	0.07	0.21	0.36			0.50
Least Tern	17%	0.01		0.02									0.07	
Caspian Tern	33%	0.04		0.07	0.06		0.10		0.21			0.07		
Black Tern*	33%	0.02		0.04	0.03		0.05	0.07				0.07		
Loons		**0.01**	**0.02**		**0.01**	**0.03**			**0.07**					
Red-throated Loon	17%	0.01	0.02		0.01	0.03			0.07					
Cormorants		**2.06**	**2.98**	**1.38**	**2.49**	**3.83**	**1.48**	**2.36**	**3.71**	**1.36**	**2.79**	**2.21**	**0.07**	**1.93**
Double-crested Cormorant	83%	2.06	2.98	1.38	2.49	3.83	1.48	2.36	3.71	1.36	2.79	2.21	0.07	1.93
Pelicans		**0.44**	**0.29**	**0.55**	**0.56**	**0.37**	**0.70**	**0.14**		**0.79**	**0.29**	**1.57**	**0.29**	
American White Pelican*	67%	0.44	0.29	0.55	0.56	0.37	0.70	0.14		0.79	0.29	1.57	0.29	
Bitterns, Herons, and Allies		**7.69**	**7.45**	**7.88**	**8.69**	**8.73**	**8.65**	**11.14**	**9.43**	**6.43**	**8.00**	**8.43**	**5.29**	**5.16**
American Bittern	50%	0.09	0.14	0.05	0.06	0.10	0.03		0.07	0.07		0.14		0.36
Least Bittern*	100%	0.87	0.05	1.48	0.70	0.07	1.18	0.36	0.21	0.50	1.71	0.71	1.79	0.79
Great Blue Heron	100%	2.14	2.36	1.98	2.23	2.70	1.88	2.14	2.57	2.36	2.07	2.00	2.43	1.43
Great Egret	83%	1.45	1.02	1.77	1.77	1.07	2.30	3.36	1.79	0.86	1.00	1.86	0.36	0.93
Snowy Egret*	83%	1.36	1.17	1.50	1.77	1.50	1.98	3.86	1.71	0.64	0.71	1.93	0.07	0.57
Cattle Egret	17%	0.05		0.09	0.07		0.13	0.36						
Green Heron	100%	0.31	0.19	0.39	0.34	0.23	0.43	0.57	0.79	0.29	0.07		0.14	0.29
Black-crowned Night-Heron	83%	1.43	2.52	0.61	1.74	3.07	0.75	0.50	2.29	1.71	2.43	1.79	0.50	0.79
Ibises and Spoonbills		**0.04**	**0.69**	**5.48**	**4.24**	**0.80**	**6.83**	**5.36**	**7.79**	**2.07**	**3.07**	**2.93**	**1.64**	**1.14**
White-faced Ibis*	100%	0.04	0.69	5.48	4.24	0.80	6.83	5.36	7.79	2.07	3.07	2.93	1.64	1.14
XXXX		0.04		0.07	0.06		0.10					0.29		
Grand Total		**296.65**	**430.36**	**196.38**	**351.79**	**506.90**	**235.45**	**473.50**	**342.14**	**346.79**	**302.00**	**294.50**	**121.79**	**195.86**

DIST = Distribution; OA = Overall; NB = Non-breeding season; BM = Breeding season/migration period; Confirmed breeding species; * Conservation Priority Species; (E) = Federally endangered