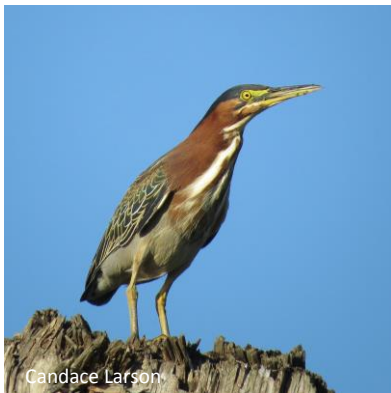


Avian response to habitat restoration at Fernhill Wetlands



Interim report to Clean Water Services from the Audubon Society of Portland

Joe Liebezeit, Candace Larson, Jay Withgott, and Jon Plissner



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Introduction

Since the summer of 2015 the Audubon Society of Portland (ASOP) has been working with Clean Water Services (CWS) to document the bird community response to the restoration effort at Fernhill Wetlands. This interim report provides an update on this project and includes another year's worth of data analysis (through the fall of 2017). This report builds on the previous report which covered effort through the fall of 2016. In the interest of brevity we do not repeat a description of the project background, goals/objectives, study design, and detailed methods in this report unless something has changed. Please refer to the 2017 interim report for in-depth project information¹.

Methodology

Community science avian surveys

Since last reporting, community science effort at Fernhill Wetland using the protocol developed by ASOP² in 2015 has continued at a steady level with at least several surveys conducted each month by experienced community scientists following the protocol methods. ASOP continues efforts to build the community science team at the site through social media promotion, occasional one-on-one trainings, and targeted bird walks at the site.

Formal avian surveys

ASOP has continued formal avian surveys at the site every fall and spring following the protocol originally developed in 2015. The formal bird survey protocol includes point count surveys, a line transect survey, and a separate survey of the large lake. We developed our protocol based on standard protocols developed by others (Ralph et al. 1995³, Lancia et al. 1996⁴, Huff et al. 2000⁵, Conway 2008⁶). Three skilled biologists (Candace Larson, Shawneen Finnegan, and Joe Liebezeit) conducted the formal surveys. Please contact Joe Liebezeit for a copy of the formal avian survey protocol if desired.

Data prep - eBird Data

All available eBird data for Fernhill Wetlands was downloaded from 2010 through October 2017 and criteria for data inclusion in the analysis were maintained as reported in the previous interim report. Pre-restoration data only included observations from 2010 through 2013 by known, experienced community scientists whom also contributed post-restoration protocol surveys. Post-restoration data included eBird data from mid-August 2015 through October 2017.

¹ Available here: <https://audubonportland.org/files/citizen-science/fernhill-preliminary-report-2017>

² Link to the protocol: <https://audubonportland.org/files/research/fernhill>

³ Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Albany, California: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 41 p.

⁴ Lancia, R.A., J.D. Nichols, and K.H. Pollock. 1996. Estimating the number of animals in wildlife populations. Pps. 215-253 *In* T.A. Bookhout, ed. Research and management techniques for wildlife and habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD.

⁵ Huff, M.H., K.A. Bettinger, H.L. Ferguson, M.J. Brown, and B. Altman. 2000. A habitat-based point count protocol for terrestrial birds, emphasizing Washington and Oregon. General Technical Report PNW-GTR-501. U.S. Department of Agriculture, US. Forest Service.

⁶ Conway, C. J. 2008. Standardized North American Marsh Bird Monitoring Protocols. Wildlife Research Report #2008-01. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ.

Data prep - Formal NTS survey data

Formal survey data from fall 2015 through fall 2017 were included in the analysis constituting five (three fall: 2015, 2016, and 2017 and two spring: 2016 and 2017) seasons. The point count sampling only included birds up to 50m out from each of the six point count stations; so we did not include analyses for that data set in this report.

Statistical analysis

We updated our statistical analysis for this interim report using multivariate methods and also including a detection probability estimate for abundance estimates.

To compare pre and post-restoration species richness we used general linear mixed model (GLMM), with species richness and Shannon-Weiner index as response variables, and treatment (pre- and post-restoration), and year as factors. Year post-restoration is included as a fixed effect.

To compare pre and post-restoration species abundance we used GLMM, assuming a Poisson distribution, with number of individuals/visit as response variables and season, treatment (pre- and post-restoration) and year as factors.

To compare post-restoration changes in abundance we first used contingency analysis of distribution of detections among distance bins for each species group and focal species to determine detection rates. We then used GLMM (Poisson distribution) for regression of abundance changes across years. For species diversity comparison we used GLMM with species richness and Shannon-Weiner indices as response variables and year as factor.

To compare eBird and formal survey methodologies we used pair-wise comparisons (paired t-test) for species richness and for abundance of all species groups.

Results

Species richness pre and post restoration

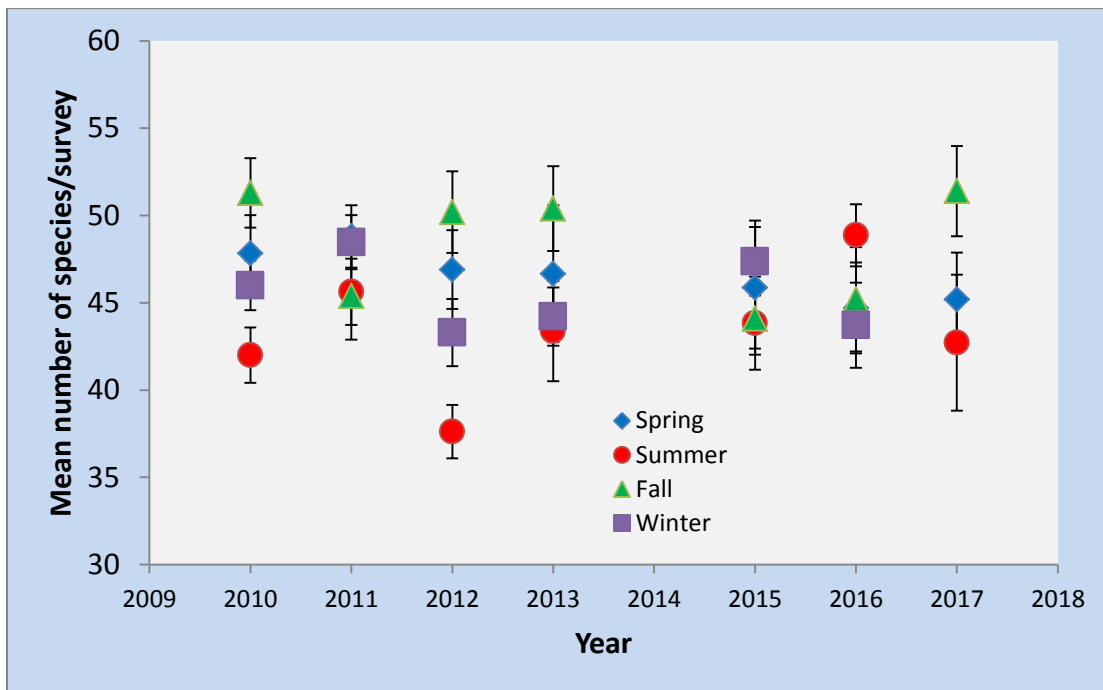


Figure 1. Species richness (# of species/survey) during the pre-restoration period (2010-2013) compared to the post-restoration period (2015-2017) by season at Fernhill Wetlands.

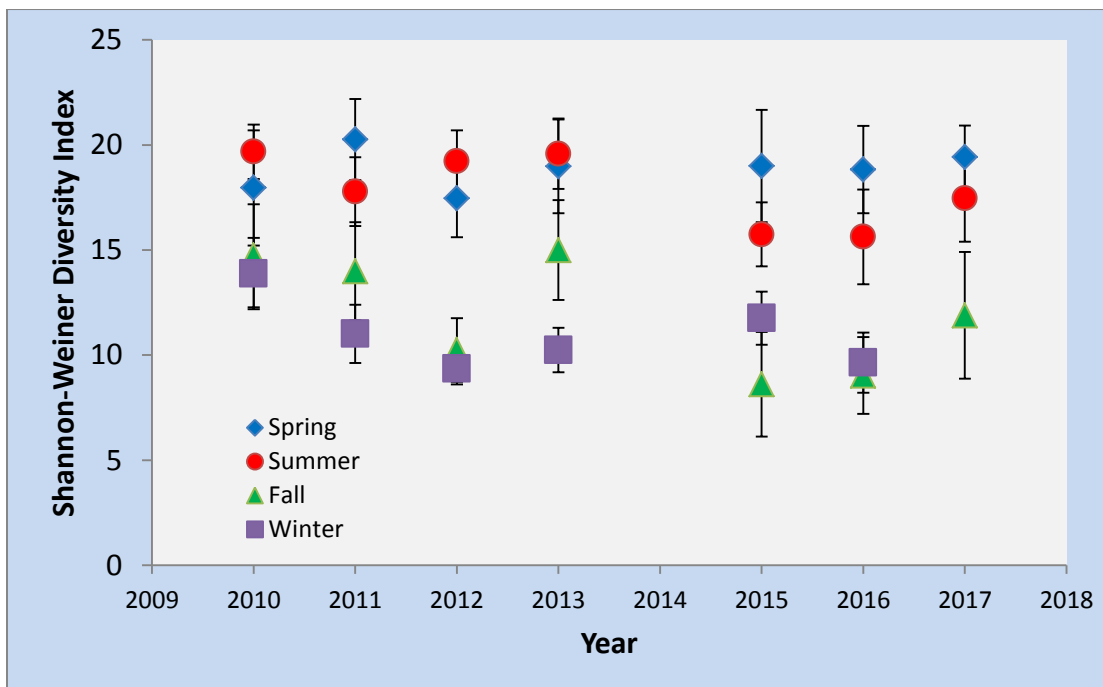


Figure 2. Species diversity (Shannon-Weiner index) during the pre-restoration period (2010-2013) compared to the post-restoration period (2015-2017) by season at Fernhill Wetlands.

Overall (seasons combined) species richness and diversity were not significantly different between pre and post restoration periods (Species richness: $Z = 0.650$, $P = 0.52$; diversity: $F_{1,289} = 1.098$, $p = 0.30$). Shannon-Weiner species diversity estimates

indicate that species diversity varied significantly across seasons ($F_{4, 287} = 423.3$, $p < 0.001$), and is generally lower during the winter and higher in the spring and summer. This trend held true across both the pre and post treatment period.

Results - Bird abundance pre and post restoration

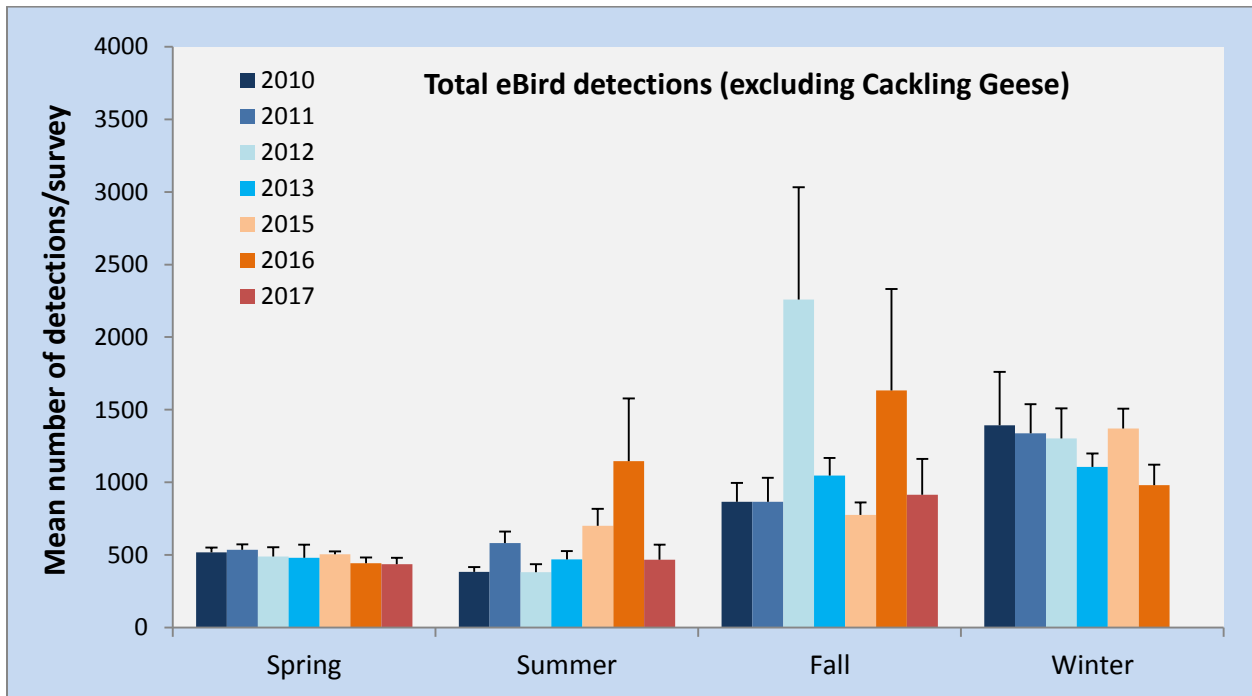


Figure 3. Total eBird detections of birds (not including Cackling Geese) at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-17) periods per season.

Overall bird abundance (seasons combined) was ~6% higher post restoration ($p < 0.001$) but was 8% lower post restoration excluding Cackling Geese.

There were significantly more bird detections in fall and winter during both pre and post restoration (mean abundance for fall and winter significantly greater than overall mean, spring and summer abundance significantly less than the overall mean; all $p < 0.001$). This suggests that regardless of the restoration effort, this site has supported a higher number of birds during fall migration and during the wintering season (this holds true with or without Cackling Geese included).

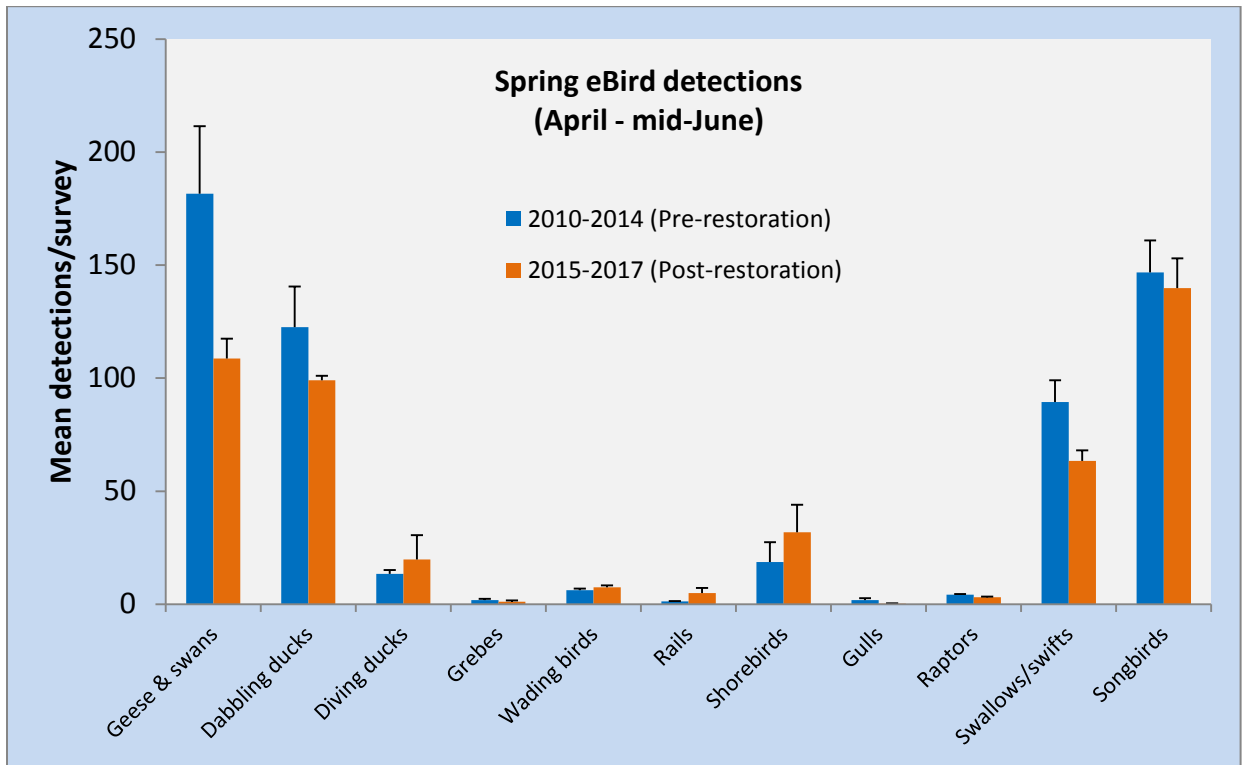


Figure 4. Total eBird detections of birds by guild at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-17) periods during the spring (April – mid-June).

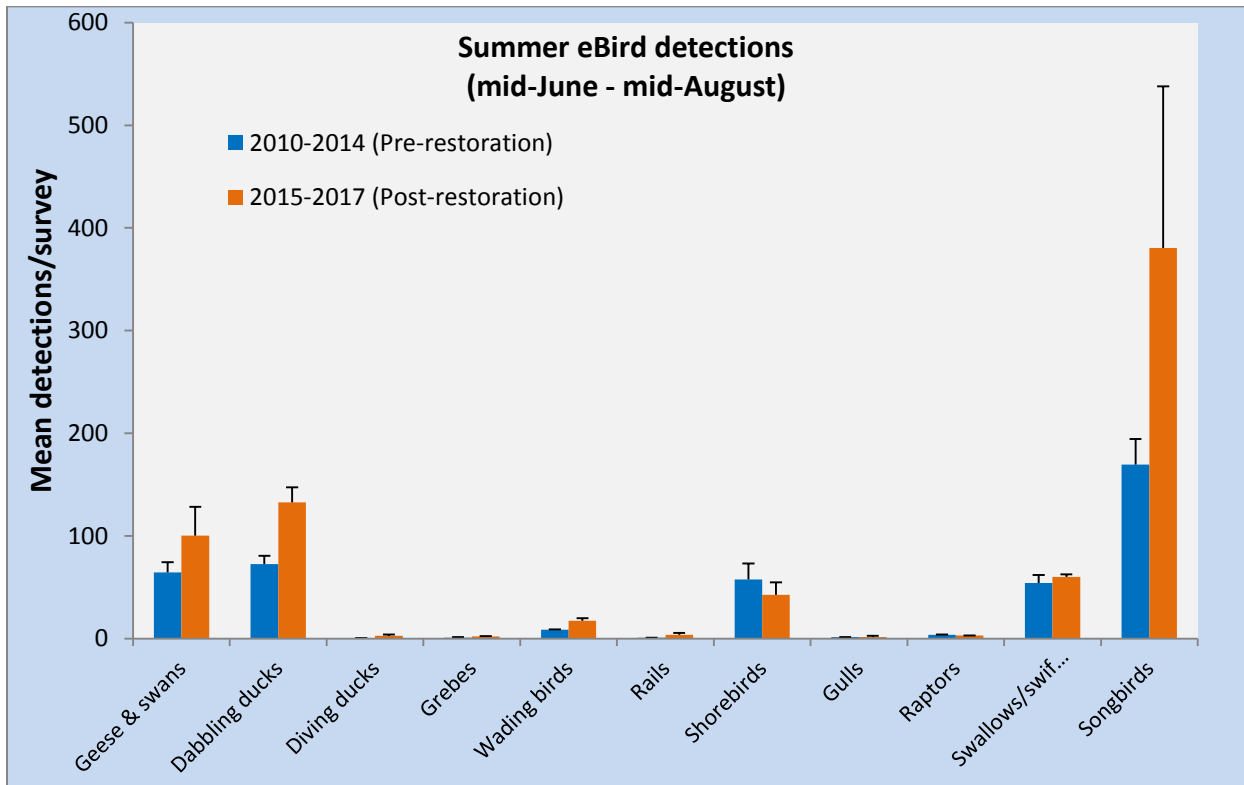


Figure 5. Total eBird detections of birds by guild at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-17) periods during the summer (mid-June through mid-August).

At the guild level, seasonal differences in abundance varied per species group. As an example, in the spring, abundances approached statistical significance for higher grebe abundance post-restoration ($p = 0.05$). For rails and post-restoration abundance was significantly higher ($p < 0.05$) while shorebird abundance was significantly lower post-restoration in the summer ($p < 0.05$). Wading birds (herons, egrets, etc.), dabblers and diving ducks all had significantly higher post-restoration abundances in the summer (all $p < 0.001$) (Figure 5).

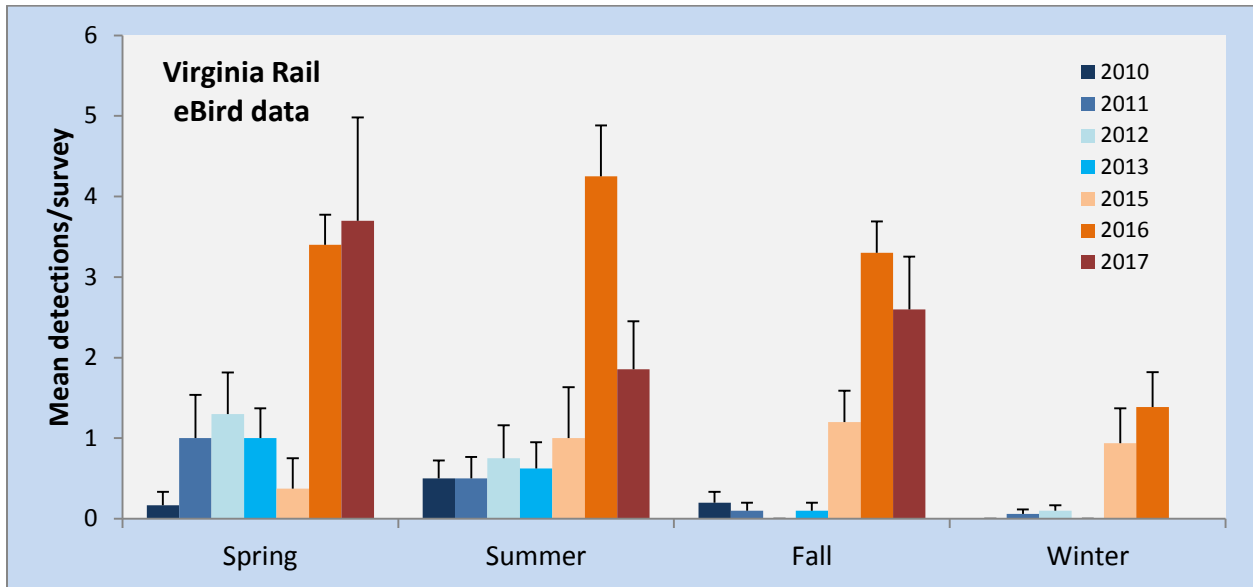


Figure 6. Virginia Rail eBird detections at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-17) periods by season.

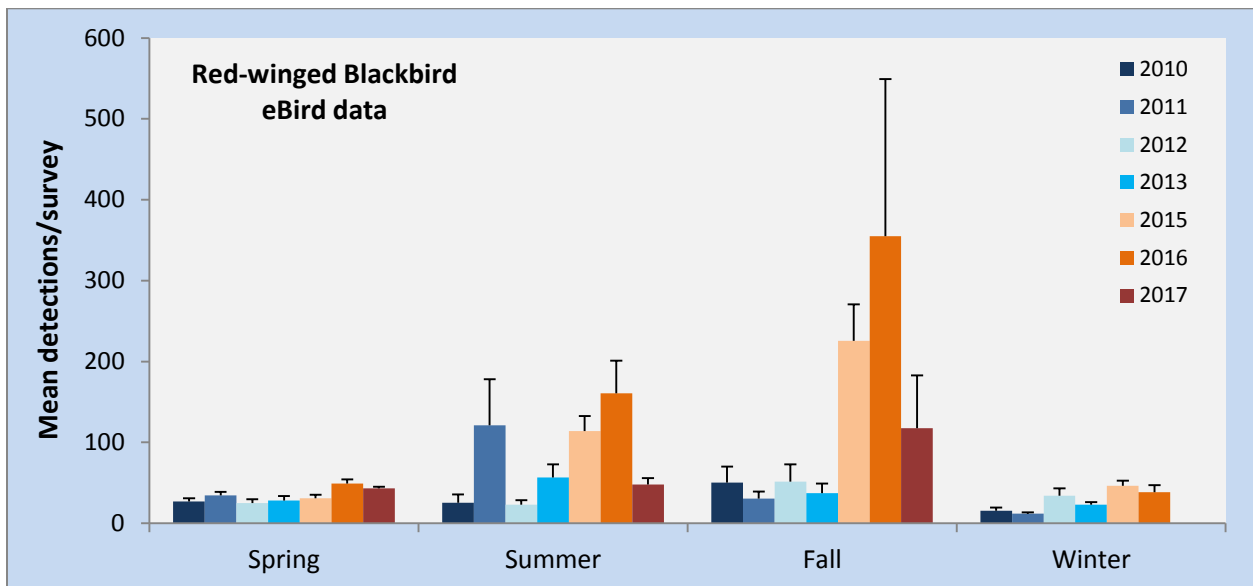


Figure 7. Red-winged Blackbird eBird detections at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-17) periods by season.

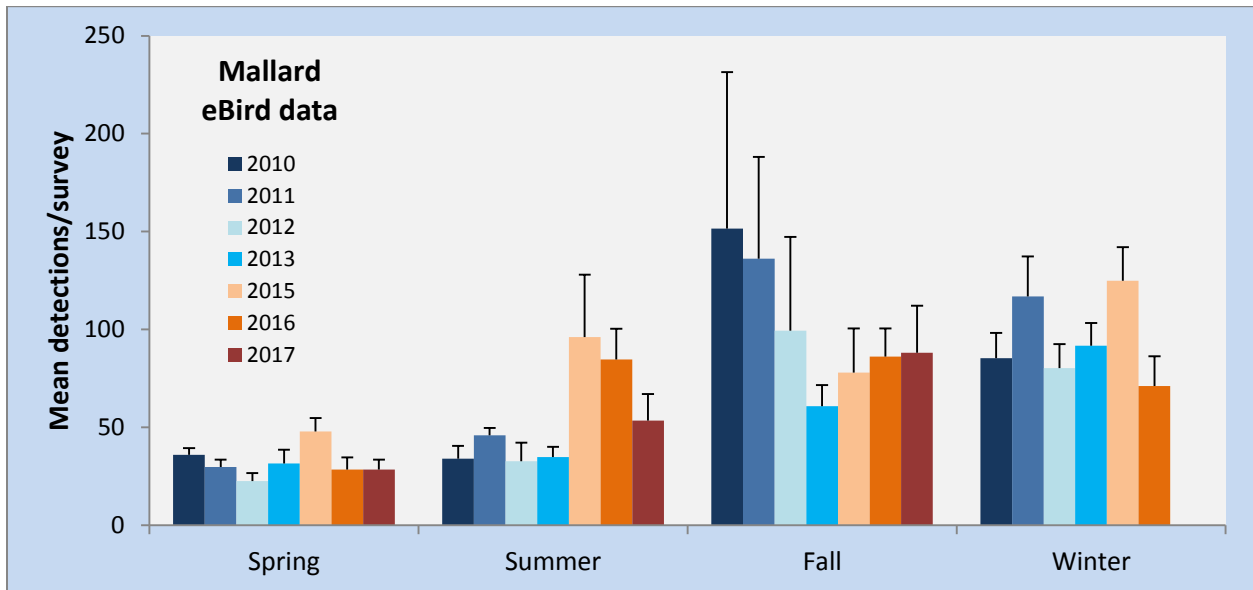


Figure 8. Mallard eBird detections at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-17) periods by season.

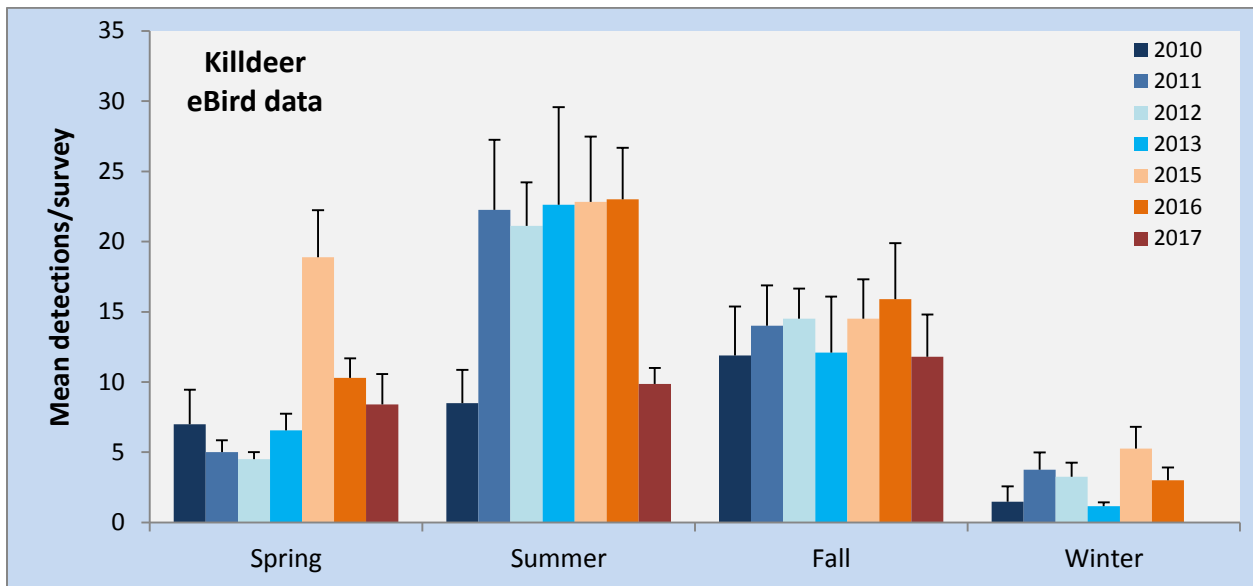


Figure 9. Killdeer eBird detections at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-17) periods by season.

At the individual species level, we see the most dramatic responses between pre and post restoration periods, and for many species, the patterns fit the predictions we made on species group response to the restoration (see Table 1 in the 2017 report). For example, Red-winged Blackbirds overall were detected significantly more post restoration versus pre-restoration ($Z = 56.74$, $p < 0.001$; Figure 7). Other species, like the Mallard, did not exhibit a clear overall (seasons combined) difference in abundance pre and post restoration ($Z = -1.68$; $p = 0.09$); although in the case of Mallards, summer abundances were higher post-restoration while fall abundances were higher pre-restoration (Figure 8). Similarly, for Killdeer, overall annual differences in pre and post-restoration abundances were not significantly different although

there do appear to be some seasonal differences (e.g. higher detections in spring post-restoration) (Figure 9). Virginia Rail abundances were also dramatically higher post-restoration however sample sizes are low so statistical test results to determine significance are not possible at this point.

Post-restoration changes in species richness

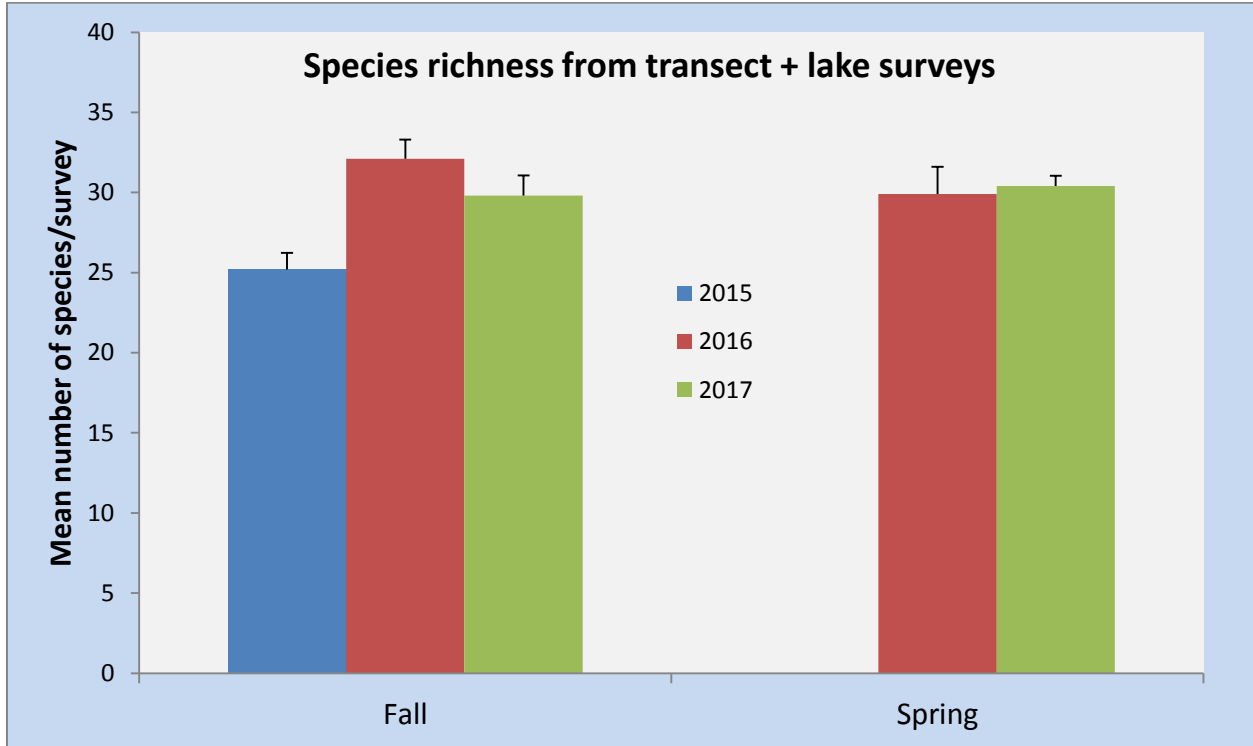


Figure 10. Species richness within the Natural Treatment System at Fernhill Wetlands post-restoration period during fall and spring seasons (no formal surveys conducted spring of 2015).

Species richness did not change significantly in the three years post restoration in the fall and the 2 years post restoration in the spring ($Z = -1.892$, $p = 0.06$; Figure 10). The slightly lower species richness in fall 2015 may reflect avian response to early stages of restoration when vegetation was just starting to become established. Species diversity (as measured by the Shannon-Weiner index) also showed no significant annual change post-restoration although fall diversity was significantly lower than spring diversity. This result could be explained by lack of species evenness (which is a component of species diversity). For example, large flocks of Cackling Geese and/or blackbirds in the spring would result in lower species evenness which could lower the overall species diversity estimate.

Post-restoration changes in bird abundance

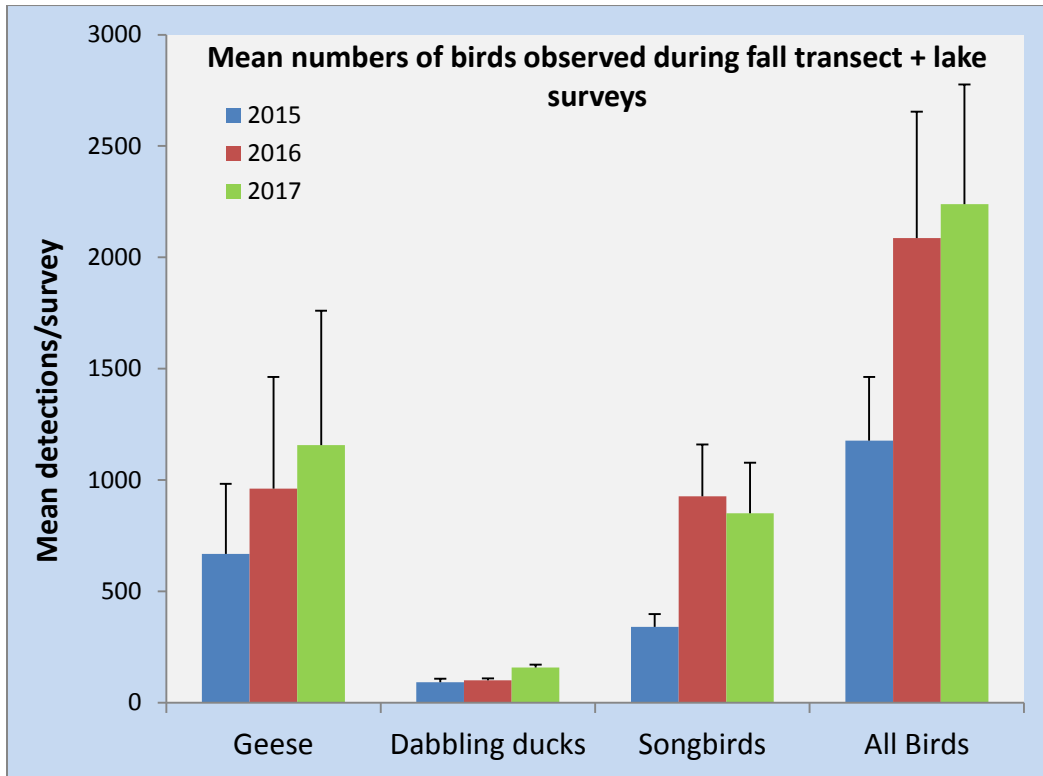


Figure 11. Average detections for all birds and most common bird guilds in the Fernhill Wetlands NTS post-restoration during fall.

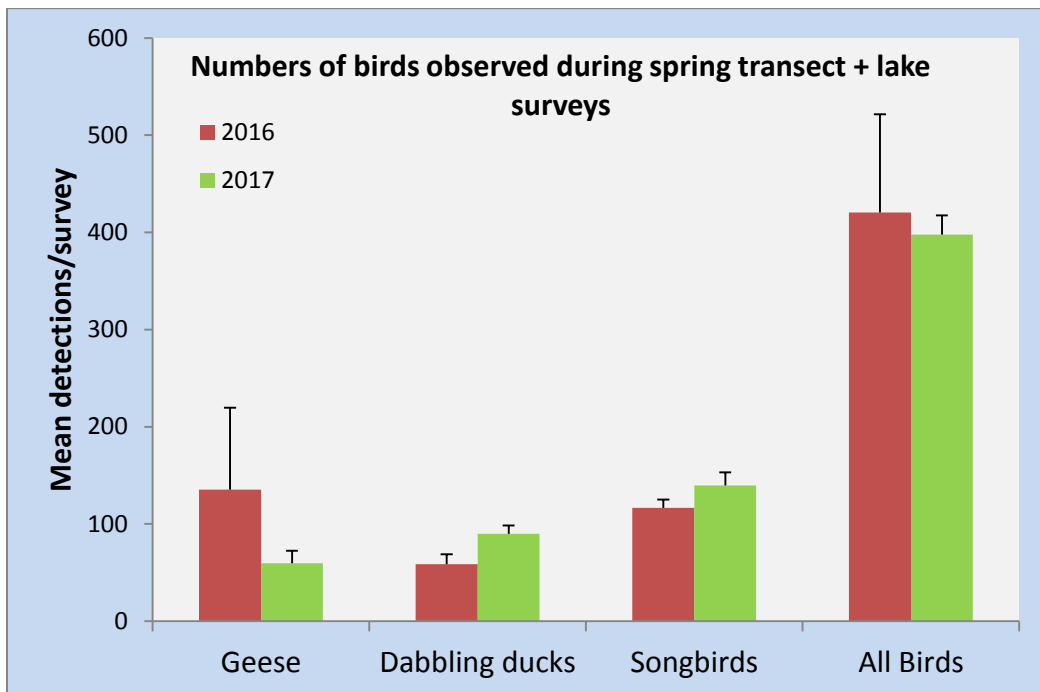


Figure 12. Average detections for all birds and the most common bird guilds at the Fernhill Wetlands NTS post-restoration during spring (no formal surveys conducted spring of 2015).

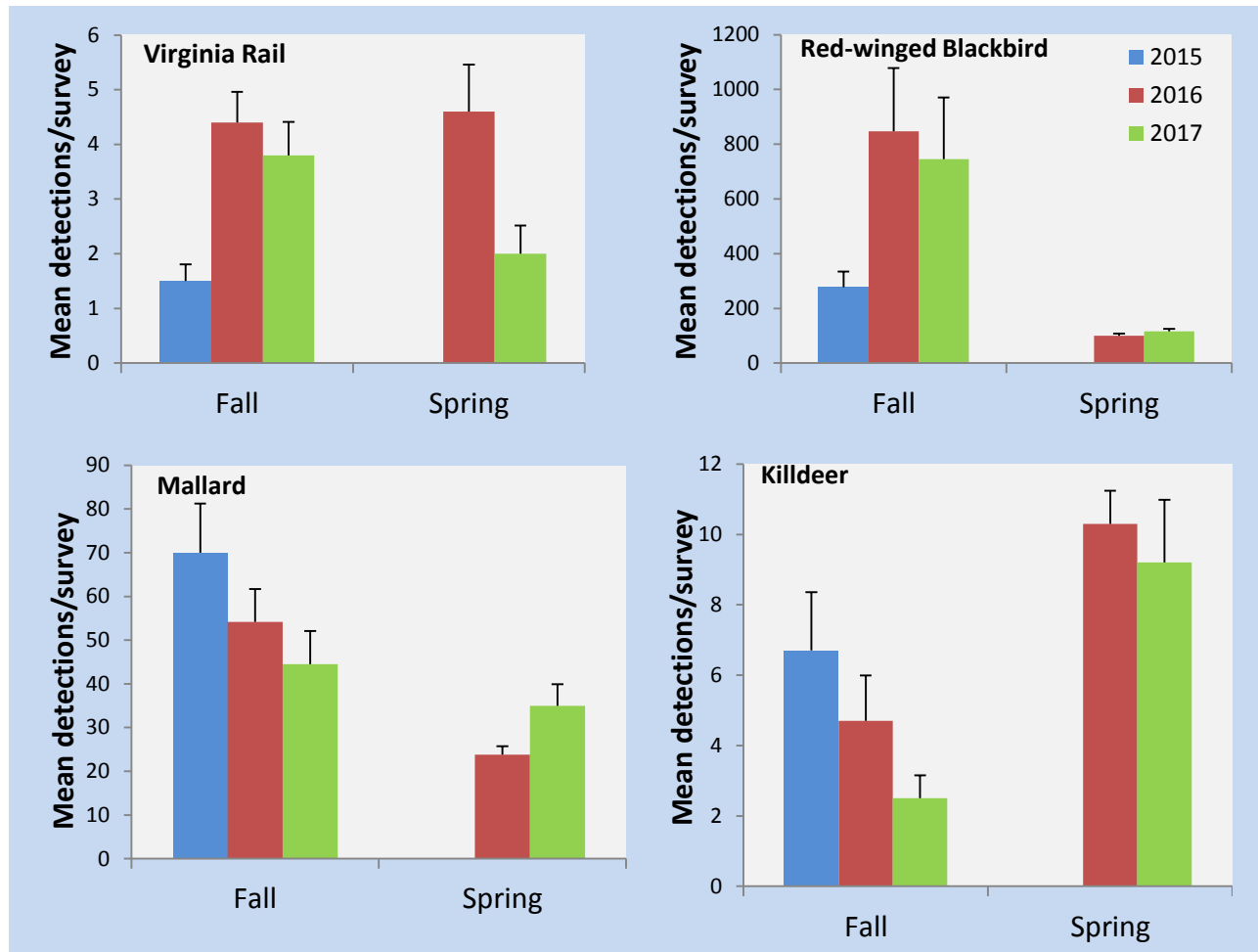


Figure 13. Select individual species detections at Fernhill Wetlands NTS during post-restoration (2015-17) during fall and spring (no formal surveys conducted spring of 2015).

Overall bird abundance increased from year 1 post restoration (2015) to year 3 (2017) during the fall ($Z = -20.90$, $p < 0.001$; Figure 11). In the spring, overall species abundance was not significantly different for year 2 (2016) and year 3 (2017) post-restoration ($Z = 1.226$; $p = 0.2827$; Figure 12). We did not conduct formal bird surveys in the spring of 2015 as that was prior to the partnership with ASOP and CWS. The increasing abundance during the post-restoration period during the fall period is likely explained by increasing habitat complexity as the vegetation planted during restoration activities in 2014-15 became established. It is possible that we did not see this in the spring because we did not collect the year 1 post-restoration data.

At the individual species level, for some species we documented increasing abundance during the post-restoration period in fall (see Virginia Rail and Red-winged Blackbird in Figure 13) while others actually showed the opposite response (see Mallard and Killdeer in Figure 13). This is likely related to individual species life history and habitat preferences. Virginia Rail and Red-winged Blackbirds require vegetation structure for cover and nesting while the Killdeer prefer more open habitats which was more prevalent early during the post-restoration period. The response of Mallards is harder to interpret.

Comparisons of eBird and formal survey - Species Richness

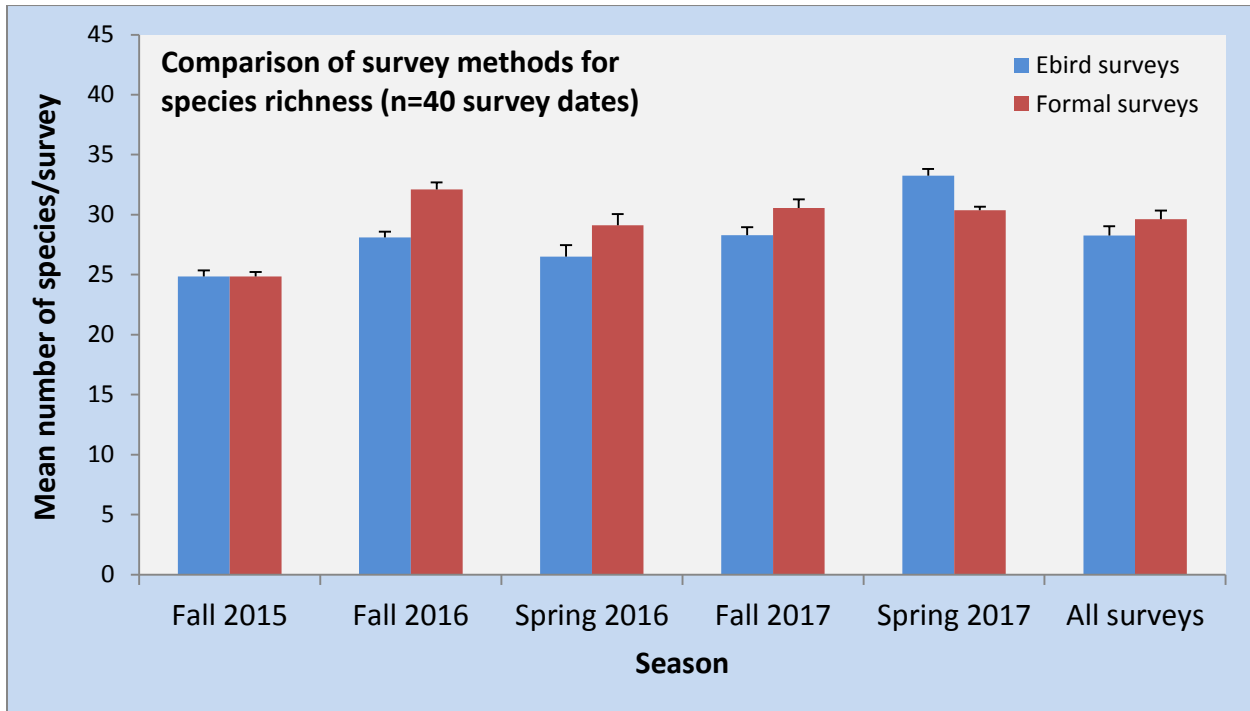


Figure 14. Species richness comparison between eBird surveys and formal surveys (line-transect) for each season/year in the Fernhill NTS.

Overall species richness estimates are not significantly different between eBird and formal line-transect surveys ($T=-1.75$, $df=39$, $P=0.09$). This suggests these two estimates are comparable. This same result held for the Shannon-Weiner species diversity estimates as well ($T=1.97$, $df=39$, $P=0.06$) although this estimate was closer to significance with eBird estimates slightly higher than formal survey estimates.

Comparisons of eBird and formal survey - Species Abundance

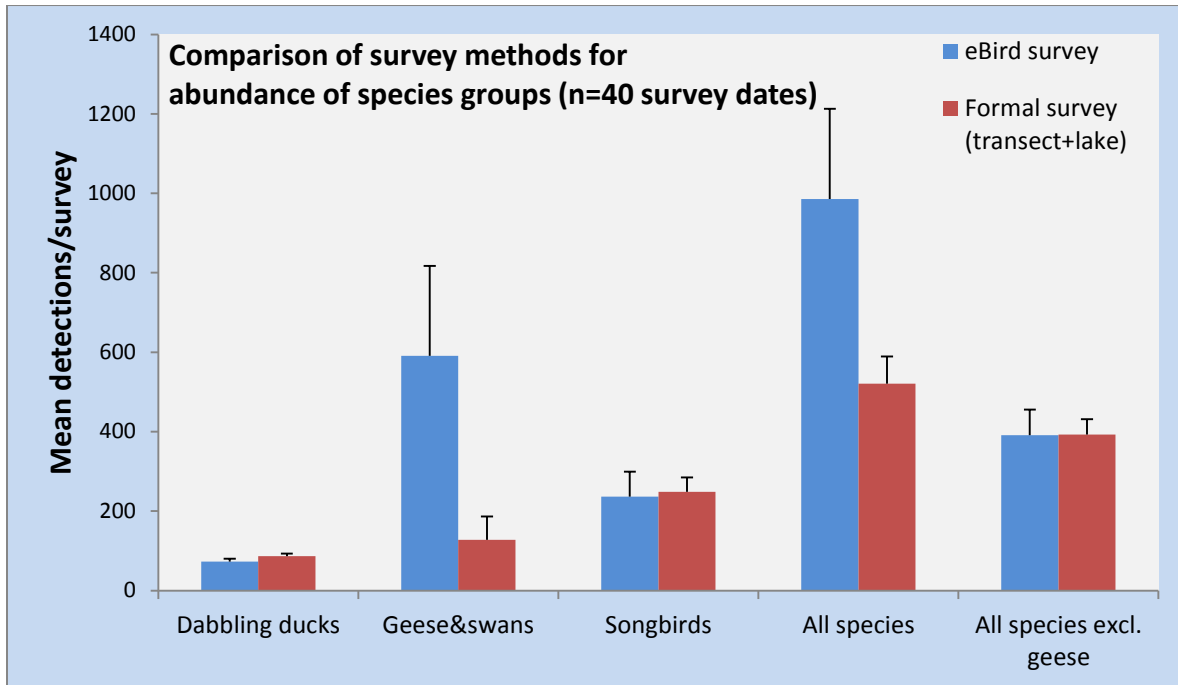


Figure 15. Species abundance comparison between eBird surveys and formal surveys (line-transect) for each season/year in the Fernhill NTS.

Overall eBird survey estimates provided a higher abundance estimate compared to the formal survey estimate ($T=2.01$, $df=39$, $P=0.05$) but when geese were removed (almost entirely Cackling Geese) abundance estimates between the two survey types are very similar and not statistically different ($T=-0.05$, $df=39$, $P=0.96$) (Figure 15).

NTS wetland water levels

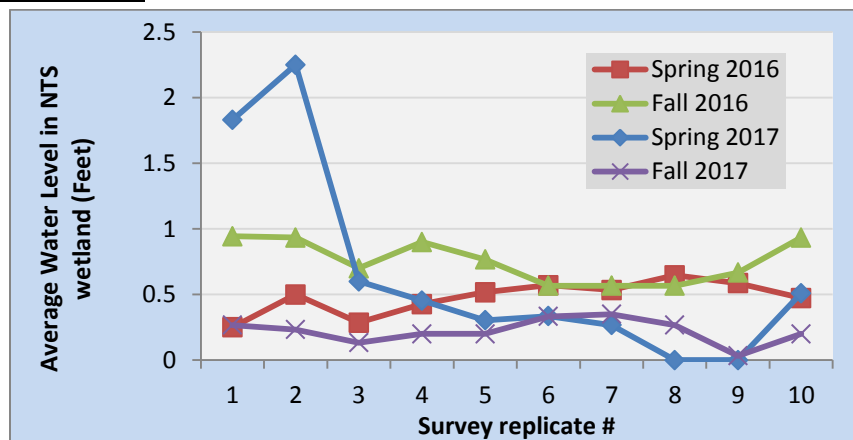


Figure 16. Average water levels in the NTS area (in Feet) as measure by three staff gauges during the bird monitoring periods in spring (early April to early June) and fall (mid-August to mid-October) in 2016 and 2017.

The average water level in the wetland NTS area (as measured from 3 water gauges placed within 10m of the transect line – one in each NTS cell) during the bird survey period was less than 1 foot except for in early April of 2017, when levels rose to over 2 feet (Figure 16).

Summary of key results

- Surveys indicate no significant difference in species richness and species diversity between the pre and post-restoration periods. Species diversity was lower in the fall and winter seasons compared to spring and summer across pre and post-restoration periods.
- Overall bird abundance was not significantly different between the pre and post-restoration periods.
- At the individual species level, we document significant differences between pre and post restoration period abundance levels. For many species, the patterns fit the predictions we made on species' responses to the restoration based on individual species life history characteristics. Many species that require complex vegetation structure showed a strong positive response (e.g. Virginia Rail, Red-winged Blackbird) while other species that prefer open water or less vegetated habitat showed a negative response.
- Species richness and diversity did not change significantly in the three years post restoration in the fall and the 2 years post restoration in the spring. However post-restoration species diversity in the fall was significantly lower than in spring.
- Overall bird species abundance increased from year 1 post restoration (2015) to year 3 (2017) during the fall while in the spring, overall species abundance was not significantly different for year 2 (2016) and year 3 (2017) post-restoration. These findings indicate a delayed response in many bird species / bird groups in utilizing the restored NTS site until the second year post-restoration. This lagged bird response, in turn, suggests that the newly planted vegetation (restoration completed February 2015) took two growing seasons to mature enough to provide sufficient quality habitat for many bird species. Full maturity of NTS Fernhill Wetlands native vegetation is expected by 2020 with the scrub-shrub wetland habitat maturation (pers. comm. J. Kinnear).
- At the individual species level, some species increased in abundance during the post-restoration period in fall (e.g. Virginia Rail and Red-winged Blackbird) while others showed the opposite response (e.g. Mallard and Killdeer).
- Overall species richness estimates were not significantly different between eBird and formal surveys suggesting these two estimates are comparable.
- With geese removed, overall eBird and formal survey estimates of species abundance were not statistically different indicating these two methods are comparable.

Future Direction

- We expect vegetation conditions to continue changing dynamically for at least a couple more years as, particularly, the shrub-scrub wetland habitat matures (J. Kinnear, pers. comm.). Presently it is unknown what affects this may have on species patterns, so we recommend continued support of these monitoring and assessment efforts for at least 5 years post-restoration so we can better understand the bird response to the NTS restoration. For example, even though the current results show “no difference” pre vs. post after 2.5 years, this is not necessarily the end of the story.
- At Fernhill Wetlands we are learning important information for some species of conservation concern including the Virginia Rail and shorebirds (as a group) that will help inform broader restoration and conservation work with these species.