Avian response to habitat restoration at Fernhill Wetlands

Interim report to Clean Water Services from Portland Audubon

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Introduction
Since the summer of 2015 Portland Audubon (PA) 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 2018). This report builds on the previous reports which covered effort through the fall of 2017. 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 information.

Methodology
Community science avian surveys
Since last reporting, community science effort at Fernhill Wetland using the protocol developed by ASOP in 2015 has continued at a steady level with at least several surveys conducted each month by experienced community scientists following the protocol methods. Since the fall of 2015 when this project was started, 896 checklists have been submitted to eBird for the Fernhill Wetlands NTS monitoring and 593 Fernhill Wetlands--area outside of NTS (ASoP/CWS survey) from over 60 community scientists. PA 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. However, in the past year, two birders that contributed a significant number of checklists to this data set (Steve Nord and Jon Plissner) have moved out of the area. This has led to fewer submitted checklists in the past year (131 versus well over 200/year in previous years). Steve Nord has recently moved back and is contributing to data collection again!

Formal avian surveys
PA 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. 1995, Lancia et al. 1996, Huff et al. 2000, Conway 2008). Three skilled biologists (Candace Larson, Shawneen Finnegan, and Joe Liebezeit) conducted the formal surveys. Between fall 2015 and fall 2018 70 formal surveys have been conducted. Please contact Joe Liebezeit for a copy of the formal avian survey protocol if desired.

1 Available upon request from Joe Liebezeit (jliebezeit@audubonportland.org)
Data prep - eBird Data

All available eBird data for Fernhill Wetlands was downloaded from 2010 through October 2018 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 2018.

Data prep - Formal NTS survey data

Formal survey data from fall 2015 through fall 2018 were included in the analysis constituting seven (four fall: 2015-18 and three spring: 2016-18) 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. While the transect sampling is a better fit at the Fernhill site we still recommend continued point count sampling at Fernhill in case, in the future, CWS wants to compare bird communities across sites at a more regional level and only point count data is available at other sites.

Statistical analysis

We used statistical analysis for this interim report developed for the previous interim report using multivariate methods and also including a detection probability estimate for abundance estimates. Multivariate methods (that include year and season as covariates) is a more appropriate analyses than the previous univariate methods in previous reporting because it controls for experiment-wise error. With this newer analysis we also control for detection probability with the formal survey data.

To compare pre and post-restoration species richness we used general linear mixed model (GLMM), with species richness and Shannon-Weiner index (species diversity) 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 (2015-2018) 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 (2015-2018) 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 = 0.81, P>0.05; diversity: F = 1.20, P>0.05). Shannon-Weiner species diversity estimates indicate that
species diversity varied significantly across seasons (F= 380.3, P<0.01), 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. Despite this, for species richness, numbers are appear to be shifting higher in the most recent years.

Results - Bird abundance pre and post restoration

![Figure 3. Total eBird detections of birds at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-18) periods per season.](image)

![Figure 4. Total eBird detections of birds (not including Cackling Geese) at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-18) periods per season.](image)

Overall bird abundance (# of detections) was not significantly different between the pre and post restoration periods (with or without Cackling Geese included). However, there were strong seasonal differences. There were significantly more detections of all
birds in summer during the post-restoration period compared to pre-restoration (Z=2.23, df=14, P=.04). No other such comparisons indicated a significant difference.

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 5. Total eBird detections of birds by guild at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-18) periods during the spring (April – mid-June).

Figure 6. Total eBird detections of birds by guild at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-18) 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, post-restoration abundance was significantly higher ($p<0.05$) in both seasons while swallows approached significantly higher detections pre-restoration in the spring but not the summer ($P>0.05$). Songbirds (primarily driven by Red-winged Blackbirds), wading birds (herons, egrets, etc.), and dabbling ducks all had significantly higher post-restoration abundances in the summer (all $P<0.01$) (Figure 6).

Figure 7. Virginia Rail eBird detections at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-18) periods by season.

Figure 8. Red-winged Blackbird eBird detections at Fernhill Wetlands during pre-restoration (2010-13) and post-restoration (2015-18) 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 ($Z = 70.34, p < 0.001$; Figure 8). Other species, like the Mallard, did not exhibit a clear overall (seasons combined) difference in abundance pre and post restoration; although in the case of Mallards, summer abundances were higher post-restoration (Figure 9). 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 10). 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**

![Species richness from line-transect + lake surveys](image)

Figure 11. 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).

In the fall, species richness has increased significantly in the four years post-restoration ($Z=-2.52$, $p<0.05$; Figure 11) based on our formal survey data. In the spring the trend is also increasing but not statistically significant. The gradual increase in avian species richness corresponds to maturation of restored native vegetation at the site (see Cascade Environmental Group 2019\(^7\)). Species diversity (as measured by the Shannon-Weiner index) also showed a positive annual change post-restoration although it was not statistically significant in either season. The trend for species diversity is less pronounced as that with species richness. 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 results in lower species evenness which could lower the overall species diversity estimate.

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\(^7\) Cascade Environmental Group. 2019. Fernhill South Wetlands Year 4 annual vegetation monitoring report
Post-restoration changes in bird abundance

Figure 12. Average detections for all birds and most common bird guilds in the Fernhill Wetlands NTS post-restoration during fall.

Figure 13. 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).
Overall bird abundance increased from year 1 post restoration (2015) to year 4 (2018) during both the fall and spring although this trend was not a statistically significant (Figure 11 and 12). We did not conduct formal bird surveys in the spring of 2015 as that was prior to the partnership with PA and CWS. The increasing abundance during the post-restoration period is likely explained by increasing habitat complexity as the vegetation planted during restoration activities in 2014-15 has reached or is nearing maturation.

At the individual species level, for some species we documented increasing abundance during the post-restoration period in fall (see Virginia Rail, Mallard, Red-winged Blackbird in Figure 14) while others actually showed a less clearly defined response (see Killdeer in Figure 14). 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. Killdeer prefer more open habitats which was more prevalent early during the post-restoration period although there appears to be a spike in this species abundance in fall 2018.
Overall species richness estimates are not significantly different between eBird and formal line-transect surveys ($T=-1.81$, $df=62$, $P=0.07$). This suggests these two estimates are comparable. Conversely, comparison of Shannon-Weiner index estimates (which combines species richness and species evenness) indicates eBird surveys provide a significantly higher species diversity estimate than formal surveys ($T=5.51$, $df=62$, $P<0.01$). This suggests that species diversity for the eBird surveys is likely driven largely by species evenness since species richness is similar between the formal and eBird surveys.
Comparisons of eBird and formal survey - Species Abundance

Figure 16. Species abundance comparison between eBird surveys and formal surveys (line-transect+lake) for each season/year in the Fernhill NTS.

Overall eBird survey estimates provided a higher abundance estimate compared to the formal survey estimate although this was not statistically significant ($T=1.66$, $df=56$, $P=0.10$). When geese were removed (almost entirely Cackling Geese) abundance estimates between the two survey types are very similar and also not statistically different ($T=0.24$, $df=56$, $P=0.81$) (Figure 16).
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 and in both seasons in 2018 when levels rose to over 2 feet during the early part of the survey period (Figure 17).

We originally intended to include water level information in our analyses as a predictor of bird abundance. However, the data are not robust enough (only from 3 gauges) to include in statistical analyses. This data still may be useful to CWS to provide a rough estimate on how differences in water level may influence bird abundance and diversity.

**Summary of key results**

- Surveys indicate no significant difference in species richness and species diversity between the pre and post-restoration periods. Despite this, species richness numbers appear to be shifting higher in the most recent years. Species diversity was lower in the 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. However, there were strong seasonal differences with more detections of all birds in summer during the post-restoration period.
- 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.

- In the fall, species richness has increased significantly in the four years post-restoration. In the spring the trend is also increasing but not statistically significant. This is the first year since monitoring began that we've documented a significant trending toward increasing species richness. The gradual increase in avian species richness corresponds to maturation of restored native vegetation at the site.
- Overall bird abundance increased from year 1 post restoration (2015) to year 4 (2018) during both the fall and spring although this trend was not a statistically significant. The increasing abundance during the post-restoration period is likely explained by increasing habitat complexity as the vegetation planted during restoration activities in 2014-15 has reached or is nearing maturation (pers. comm. J. Kinnear).
- At the individual species level, some species increased in abundance during the post-restoration period (e.g. Virginia Rail and Red-winged Blackbird) while others showed the opposite or neutral response (e.g. Mallard and Killdeer). This is likely related to individual species life history and habitat preferences.
- Overall species richness estimates were not significantly different between eBird and formal surveys suggesting these two estimates are comparable. However, eBird surveys provided a significantly higher species diversity estimate than formal surveys suggesting that species diversity for the eBird surveys is likely driven largely by greater species evenness since species richness is similar between the formal and eBird surveys.
- 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 within the NTS are reaching maturity, 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 (through Spring 2020) so we can better understand the bird response to the NTS restoration. A 5-year data set would provide more statistical rigor and better capture the range of inter-annual variability at the site.
- 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.
- At the site level, habitat improvement is more of a question of trade-offs. Creating and managing for more mud flat habitat (and the water levels that would be necessary to maintain mudflats) during spring and fall migration on the big pond would provide more
shorebird stopover habitat. Many shorebird species are experiencing declines and so, from a conservation perspective, this could be a productive way for CWS to manage the site. However, given limited space, expanding one type of habitat is going to be decreasing other types of habitat.

- Beyond the site scale, we recommend CWS manage its extent of properties in a way that will maximize connectivity for birds and other wildlife species, and again, where possible create habitats important for bird groups and species that are currently of conservation concern. At some point CWS may want to consider restoring properties adjacent to the Fernhill site to a more natural state. If birds have more habitat in the immediate region around them, then it won’t matter as much if they get flushed from the NTS area.

- In terms of minimizing human disturbance at Fernhill Wetlands, at this time we don’t recommend any new actions. The area of highest disturbance, particularly for waterfowl, is on the perimeter of the big pond. At some point, CWS may want to evaluate setting up a blind at the north end of the wetlands that offers good views of the big pond.

- Our results indicate the eBird community science counts can act as a good surrogate for the formal counts when looking at overall bird abundance and species richness. It may be in the interest of CWS to continue support and promotion eBird surveys beyond the 5-years post restoration if keeping track of the avifauna at this site is of interest in the long-term.