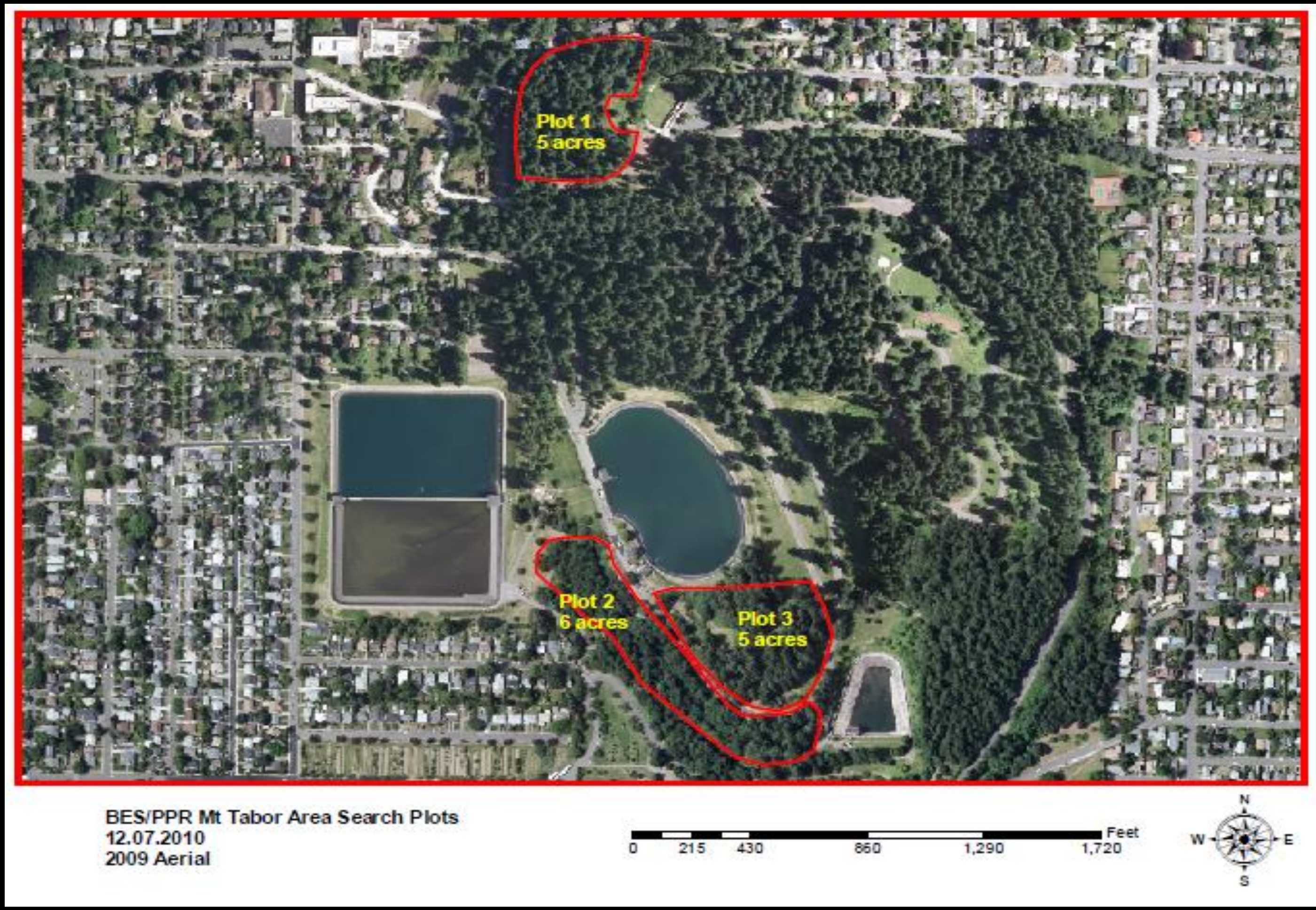

Photo: H. Crews

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MOUNT TABOR WINTER BIRD MONITORING

2010-2016 DATA SUMMARY

Prepared by Adam Baz, David Helzer & Joe Liebezeit – 2/2017

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1.0 ABSTRACT

Mt. Tabor Park is a popular recreational area and an important greenspace providing urban wildlife habitat. In 2009 the Bureau of Environmental Services (BES) launched a large-scale vegetation management program for the park focused on invasive plant removal. Concerns raised by the neighborhood about potential adverse impacts on birds prompted BES and Audubon Society of Portland (Audubon) to partner on a citizen science powered 6-year bird study, which included winter surveys. Audubon volunteers performed avian area searches during 6 consecutive winters using established methodologies. Objectives were to: 1) Establish a baseline inventory of the winter bird community at Mt. Tabor, 2) assess the impact of vegetation activity on the winter bird community, and 3) assess the efficacy of study methodology, and make recommendations for further improvements. We documented 36 species within the study area. Golden-crowned kinglets accounted for 32% of all detections, and were over 4 times more abundant than the next most numerous species, cedar waxwings and red crossbills. The best-supported multivariate regression model suggested that number of surveyors (2 in years 1-3; 1 in years 4-6) was the most important variable explaining a decrease in bird abundance detected in years 4-6. There was little support for vegetation manipulations and environmental variables affecting bird abundance. However, the lack of quantitative habitat data collected limited our ability draw strong inferences. This study provides baseline information for an important urban greenspace and contributes to a larger database of bird surveys in Portland, allowing for broader analysis of our urban bird populations.

2.0 PROJECT BACKGROUND

The BES Watershed Revegetation Program, in partnership with the Water Bureau and Portland Parks and Recreation, initiated large-scale invasive plant control and revegetation efforts at Mt. Tabor Park in 2009. These included tree stumping and removal, understory clearing, ivy and blackberry removal, herbicide application, seeding, and shrub and tree planting. The objectives were to enhance ecological conditions and improve stormwater management on site. Mt. Tabor is popular with local residents as a birding area and avian hotspot. As a result, many neighbors including wildlife enthusiasts expressed concern that these habitat modifications might negatively impact the bird community. In response to public input, BES initiated a 6-year avian monitoring study, which included breeding bird surveys and winter area searches. This document focuses exclusively on the winter area searches, conducted December 2010-February 2016 by Audubon volunteers and staff.

It is important to note that no formal data on the wintering bird community exist for the years prior to revegetation efforts. The first and most dramatic cut of invasive vegetation was executed in the fall of 2010, followed by periodic maintenance cuts, herbicide application, and revegetation over the next 6 years. Winter bird surveys began in December 2010. Consequently, the data and findings presented here address changes in the bird community in the 6 years *following* the initial cut, but while minor vegetation work was still underway. This made it difficult to draw any conclusions about the impact of the initial cut on birds at Mt. Tabor (i.e. a “before-and-after treatment” analysis). However, we could still monitor for changes in the bird community after the main vegetation manipulation and associated habitat modifications. We could also assess the effectiveness of the study design and survey protocol to help refine future monitoring projects. Finally, we established a baseline inventory for wintering birds on Mt. Tabor, an iconic Portland greenspace.

3.0 STUDY OBJECTIVES

The primary research objectives addressed by this study are:

1. Measure any changes in the bird community over the course of the 6-year vegetation management operation. What specific factors, if any, may have contributed to changes within the bird community at Mt. Tabor?
2. Assess the efficacy of study methodology, and make recommendations for further improvements.
3. Establish a baseline bird inventory of the winter bird community at sites on Mt. Tabor.

4.0 METHODS

4.1 Avian survey methods: To survey the winter bird community on Mt. Tabor, Audubon volunteers followed the Point Reyes Bird Observatory *Area Search Census Instructions* (PRBO 1999). These area searches entailed trained observers walking through survey plots at a slow, even pace, recording all birds seen or heard and collecting information on species, sex, behavior, and flock number. Data on weather conditions were also recorded. Three area search plots were delineated on Mt. Tabor (Figure 1) in areas where substantial vegetation work had been performed, and ranged in size from 5-6 acres. Each plot was covered in 20 minutes, with observers moving steadily through the plot to ensure equal coverage. All birds detected within plot boundaries, as well as birds detected just outside plot boundaries and immediately before or after the 20-minute count, were recorded. Surveys were completed between 0730-1030, and were not conducted on days with heavy wind or precipitation. Two observers (Adrian and Christopher Hinkle) conducted surveys during years 1-3, and only 1 observer (Candace Larson) conducted surveys during years 4-6. Although the Hinkles were instructed to travel together and “act as 1 observer,” there is no doubt that four eyes are better than 2. This switch from double to single observer midway through the study will be addressed later.

Area searches were conducted once per month in December, January and February from 2010-2016 (6 years of winter data). This resulted in 18 visits to the park (also referred to as “site”). Because each winter spanned the calendar year (ex: December 2010-February 2011 = Year 1) the annual surveys will be referred to as “Years 1-6,” rather than using calendar dates.

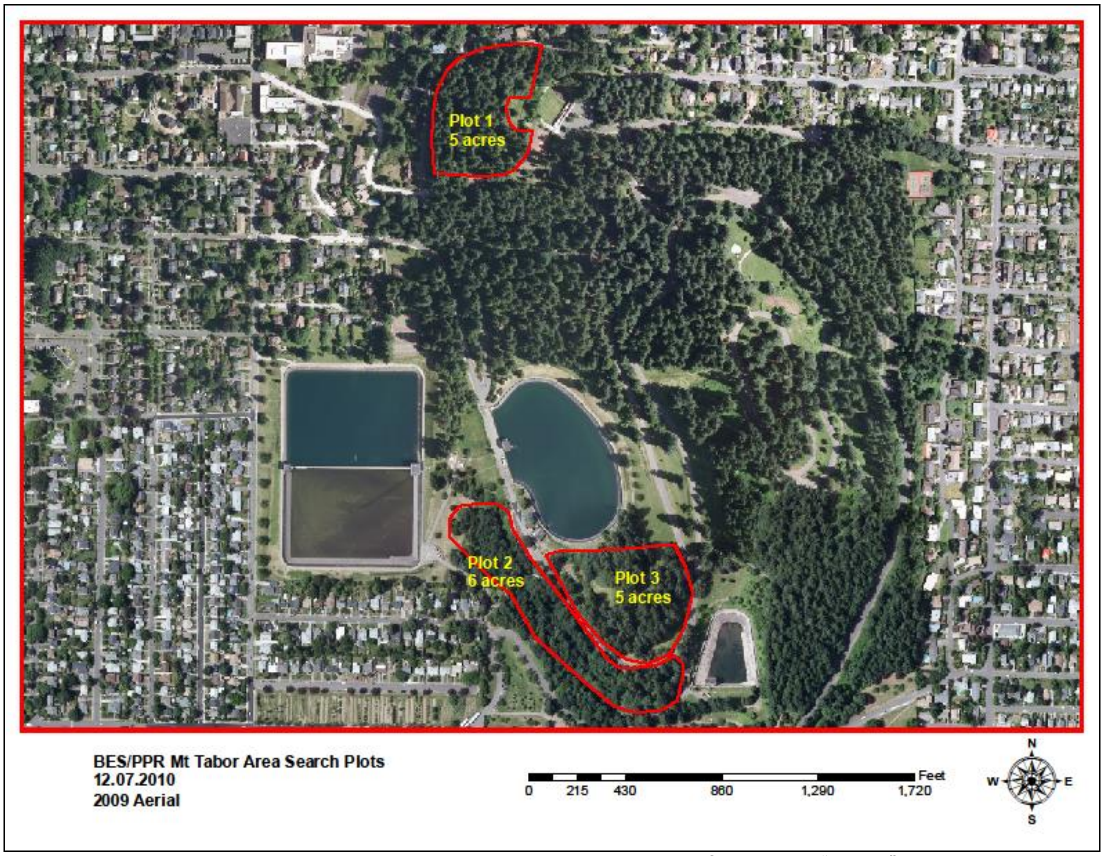


Figure 1. Map of the winter area search plots at Mt. Tabor Park. Plot 1 is referred to as "MT-01" in the text, and so on.

4.2 Data proofing and analysis: Area search data were digitized and entered into Microsoft Access by Audubon volunteers. They were then submitted to BES in digital format. BES proofed the data in communication with Audubon staff to ensure confidence in data quality.

Winter area search data were analyzed using summary statistics and graphs in Microsoft Access and Excel to explore temporal trends in species richness and abundance over the 6-year study. Analysis was performed for the whole site (all 3 plots combined) as well as for each of the three plots individually. Species richness and avian abundance were also estimated for each of four foraging guilds. Independent flyovers (birds seen flying overhead, but not associated with the local habitat) were not included in analysis. To investigate the relationship between avian abundance and specific vegetation treatments, least-squared linear regression modeling was completed in R (ver 3.3.1). Explanatory variables included in analysis were the number of observers, date of initial vegetation cut, date of shrub planting, temperature and wind. Because this study was not initiated until after vegetation management began (in response to public input), the available data on vegetation treatments was minimal. There were also no quantitative measurements of vegetation made during the 6 years of vegetation management. The explanatory variables considered in this analysis, therefore, capture habitat modification at a very coarse level. This should be acknowledged when interpreting the statistical models and their results.

Variable selection was performed using backward stepwise selection based on Akaike's Information Criterion (AIC) (Burnham and Anderson 2003). This analysis selected the independent variables most likely to predict changes in avian abundance, based on the data collected at Mt. Tabor. Diagnostic checks were performed on the final model to address multicollinearity and possible outliers. One anomalous flock of 139 cedar waxwings was excluded from analysis, and is addressed in greater detail below.

5.0 RESULTS: DATA SUMMARY & ANALYSIS

Various metrics of the avian community are provided below, including species composition, species richness, and abundance by survey plot, year, and foraging guild. In addition to a summary of the results, a description of the procedure for each analysis is given.

5.1 Site visit summary: As previously mentioned, 3 survey visits were made to Mt. Tabor each year from 2010-2016 (Table 1). Visits were made approximately 1 month apart in December, January and February.

Table 1. Summary of survey dates for Mt. Tabor winter area searches.

Mount Tabor Area Search Data (2010-2016) *Survey Visit Summary*			
Project Year	**Visit 1**	**Visit 2**	**Visit 3**
1	12/12/2010	1/8/2011	2/9/2011
2	12/9/2011	1/7/2012	2/11/2012
3	12/6/2012	1/6/2013	2/7/2013
4	12/3/2013	1/2/2014	2/3/2014
5	12/2/2014	1/5/2015	2/5/2015
6	12/12/2015	1/7/2016	2/9/2016

5.2 Species list: Thirty-six bird species were observed over the course of the 6-year winter study at Mt. Tabor. In Table 2 below, green cells represent presence, and red cells represent absence, of a given species in each of the 3 area search plots (MT-01, MT-02, MT-03). Rows shaded in light grey indicate that the species was detected during only 1 of the 18 total visits to the park, which may indicate that the species was passing through and/or not strongly associated with the sampled habitat on site. Plot MT-02 contained the highest number of species (n=33) and had 92 % of all species observed during the study. MT-03 had the second highest number of species, with 69 % of all species observed, and MT-01 had the lowest species count, with 61 % of all species. Although MT-02 had substantially more species, it should be noted that out of 6 species detected on only 1 occasion, 4 were detected in MT-02. If these species are excluded from analysis, MT-02 still contained 21 % more species than the second most species-rich plot.

Table 2. Bird species detected during winter area searches at Mt. Tabor. Green indicates the species was observed, and red indicates it was absent, at each of the 3 survey plots. Grey-shaded cells represent species only observed once during the 6-year study.

Mount Tabor Area Search Data (2010-2016)

Species List*

Species Name	MT-01	MT-02	MT-03
American Crow	Green	Green	Green
American Goldfinch	Red	Red	Green
American Robin	Green	Green	Green
Anna's Hummingbird	Green	Green	Green
Barred Owl	Red	Green	Red
Bewick's Wren	Green	Green	Red
Black-capped Chickadee	Green	Green	Green
Brown Creeper	Green	Green	Green
Bushtit	Red	Green	Red
California Scrub-Jay	Red	Green	Red
Cedar Waxwing	Red	Green	Red
Chestnut-backed Chickadee	Green	Green	Green
Dark-eyed Junco	Green	Green	Green
Downy Woodpecker	Green	Green	Red
Golden-crowned Kinglet	Green	Green	Green
Golden-crowned Sparrow	Red	Green	Red
Hermit Thrush	Red	Green	Green
House Finch	Green	Green	Green
Hutton's Vireo	Green	Green	Red
Lesser Goldfinch	Red	Green	Green
Merlin	Red	Green	Green
Northern Flicker	Green	Green	Green
Pacific Wren	Green	Green	Green
Pine Siskin	Green	Green	Green
Red Crossbill	Red	Green	Green
Red-breasted Nuthatch	Green	Green	Green
Red-breasted Sapsucker	Red	Green	Red
Red-tailed Hawk	Red	Green	Green
Ruby-crowned Kinglet	Green	Green	Green
Sharp-shinned Hawk	Red	Red	Green
Song Sparrow	Green	Green	Green
Spotted Towhee	Green	Red	Red
Steller's Jay	Green	Green	Green
Townsend's Warbler	Green	Green	Green
Varied Thrush	Green	Green	Green
Western Screech-Owl	Red	Green	Red
Species Count: 36	**22**	**33**	**25**

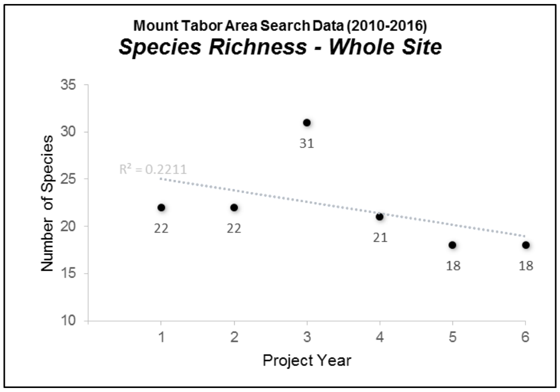
* Includes Additional Detections observed immediately adjacent to a plot and immediately before or after a survey. Does not include independent

= Species detected during only 1 of 18 visits

5.3 Species richness and diversity trends (change over time): Species richness (the number of bird species detected) did not change significantly from year to year throughout the study. Figure 2 (below, left) shows the number of species detected at Mt. Tabor during each of the 6 years. While there is some variation, the overall trend is fairly weak (R^2 = 0.22) and is probably not statistically meaningful. R^2 is the coefficient of determination, indicating that only 22 % of the variation in species richness can be attributed to a year-effect. Generally speaking, an R^2 value lower than ~0.60 is considered nonsignificant. Year 3 had the greatest number of species by a substantial margin (41 % greater than the second most species-rich year). However, 4 of the additional species observed that year were species detected only once during the study. If Year 3 is excluded, species richness declined consistently across the other 5 years of the study. Yet the number of species ranged from 18-22 per year, and therefore may not indicate a significant trend over time.

Figure 3 (below, right) shows species richness trends for each of the three survey plots. Species richness was highest in MT-02 across all years. The number of species observed in MT-02 was, on average, 53 % greater and 38 % greater than those observed at MT-01 and MT-03, respectively. Perhaps importantly, MT-02 is 20 % larger than the other 2 plots (6 acres as opposed to 5 acres). This could account for the increase in species richness, as described in the classic species-area relationship, which suggests that larger habitat patches will tend to contain more species than smaller ones. MT-02 is also longer and thinner than the other plots (Figure 1), which allows it to cover a wider stretch of area at Mt. Tabor, possibly encompassing a greater diversity of microhabitats.

We also estimated species diversity, which takes into consideration species richness as well as evenness. We calculated species diversity using the Shannon-Weiner diversity index, which is commonly used in ecological studies. Unlike the species richness estimate we found that species diversity was highest in years 3 and 4 of the study (Figure 4) although interannual differences were not statistically different (2-way ANOVA; F=1.70, DF=17, P=0.20) suggesting overall species diversity did not change during the course of the study.



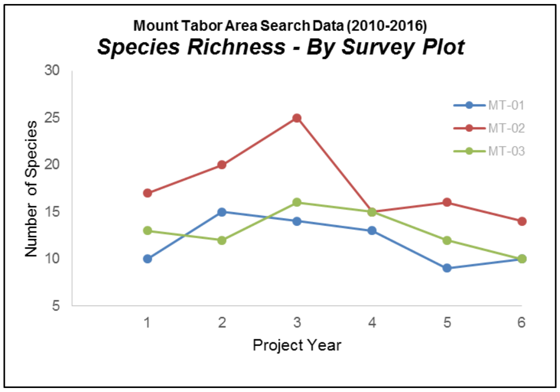


Figure 2 (left). Annual species richness over the 6-year study at Mt. Tabor. Year 3 represents an outlier, with 31 species detected. Four of those species were observed only once during the study. The dashed line is the best fit line and the R^2 value is the coefficient of determination, indicating the extent to which variation along the y-axis is explained by variation along the x-axis.

Figure 3 (right). Species richness trends in each of 3 survey plots. MT-02 contained consistently more species than the other 2 plots.

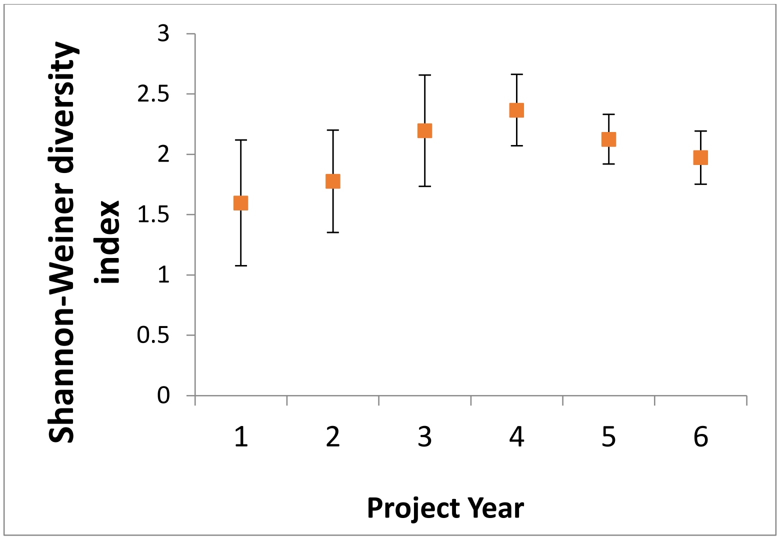


Figure 4. Annual Shannon-Weiner Index species diversity estimate (± SD) at Mt. Tabor winter plots, 2010-16.

5.4 Avian abundance (all years combined): In this study we define abundance as the number of individual bird detections made during discrete area searches. Inherent in this definition is the realization that some individuals and some species went undetected and, therefore, not recorded, and that some individuals may have been recorded during multiple visits (efforts were made to avoid double-counting on a given day, but it is difficult to know if the song sparrow detected in January was the same individual detected in December, for example). Moreover, since the entire park was not surveyed, these abundance estimates do not reflect the total number of birds at Mt. Tabor. Abundance provides a rough estimate of the number of birds present within the 3 survey plots, which can be used as an index to monitor changes over time.

A total of 1838 bird detections were made over 6 years. One species, golden-crowned kinglets, accounted for 32 % of all detections, and were over 4 times more abundant than the second and third most numerous species, cedar waxwings and red crossbills. Table 3 and Figure 5 display abundance by species in descending order. As with previous tables, the grey shading indicates that a species was detected only once. The second most abundant species, cedar waxwings, was one such species. A flock of 139 waxwings was detected on a single occasion, likely wandering in search of limited winter food.

Table 3. Abundance of each bird species detected at Mt. Tabor, listed in descending order.

Mount Tabor Area Search Data (2010-2016)		
Abundance in Descending Order		
Species Name	**Total Detections***	**Abundance Index****
Golden-crowned Kinglet	597	33.17
Cedar Waxwing	139	7.72
Red Crossbill	130	7.22
Dark-eyed Junco	113	6.28
Pacific Wren	110	6.11
Chestnut-backed Chickadee	108	6.00
Song Sparrow	91	5.06
Anna's Hummingbird	74	4.11
American Robin	70	3.89
Brown Creeper	63	3.50
Varied Thrush	55	3.06
American Crow	50	2.78
Red-breasted Nuthatch	32	1.78
Ruby-crowned Kinglet	32	1.78
Steller's Jay	25	1.39
Townsend's Warbler	22	1.22
Northern Flicker	21	1.17
Black-capped Chickadee	20	1.11
Pine Siskin	14	0.78
Lesser Goldfinch	11	0.61
Bushtit	10	0.56
House Finch	10	0.56
Red-breasted Sapsucker	8	0.44
Hermit Thrush	5	0.28
California Scrub-Jay	4	0.22
Red-tailed Hawk	4	0.22
Downy Woodpecker	3	0.17
Golden-crowned Sparrow	3	0.17
Hutton's Vireo	3	0.17
Bewick's Wren	2	0.11
Merlin	2	0.11
Sharp-shinned Hawk	2	0.11
American Goldfinch	1	0.06
Barred Owl	1	0.06
Spotted Towhee	1	0.06
Western Screech-Owl	1	0.06

* = Number of detections across 18 visits (3 visits/year for 6 years)

** = Total detections ÷ Number of survey visits (18)

(shaded) = Species detected during only 1 of 18 visits

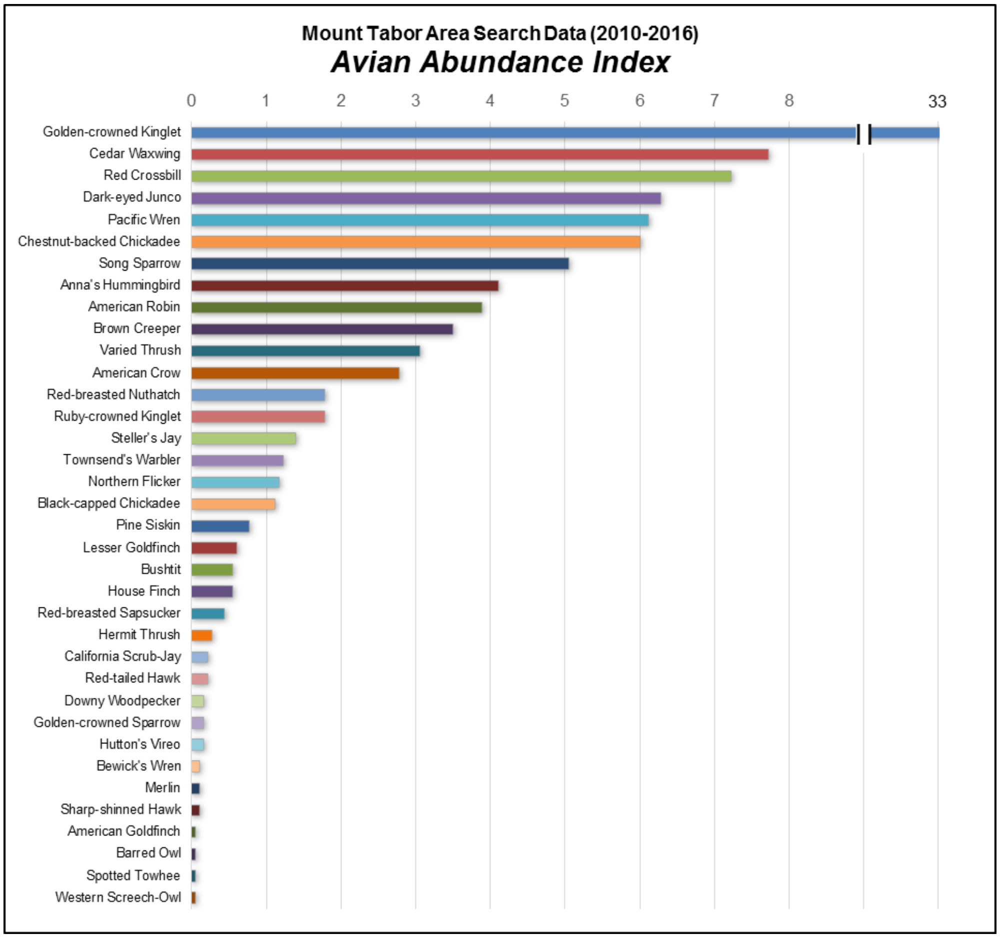


Figure 5. Avian abundance index (the average number of birds detected per visit) presented by species, in descending order. Note that the bar for golden-crowned kinglets has been broken for the sake of space. It is actually 4 times longer than the bar below it (cedar waxwings).

5.5 Avian abundance trends: The following 3 figures plot the change in bird abundance from visit-to-visit and year-to-year throughout the study. While the section above dealt with bird abundance by species, this section deals with bird abundance as a whole (counts of all species were combined and total bird abundance was calculated for each year). The black dots in Figure 6 represent the average number of birds detected in a given year. Three visits were made to Mt. Tabor each year (for a total of 18 visits). So in any given year, there were 3 counts of bird abundance. The black dots represent the average of those 3 counts, and the whiskers represent the maximum and minimum counts each year. Year 3 (2012-13) had the highest average abundance and the highest number of individuals counted during a single visit by far (n = 328). Unsurprisingly, the aforementioned flock of 139 cedar waxwings was detected on that visit. All further analysis will omit those detections because they greatly skew abundance estimates and probably do not represent a resident flock of birds. Rather, they represent an anomalous occurrence of birds not meaningfully associated with the vegetation in the study area. Figure 5 displays avian abundance trends after excluding the 139 waxwings.

The most noticeable trend in the Mt. Tabor bird data is the drop in average bird abundance starting in Year 4 (Figure 6). Years 1-3 had relatively high bird abundance (average for Years 1-3 = 131) and substantial variation between visits. Years 4-6 had relatively low abundance (average for Years 3-4 = 58), and counts were fairly consistent between visits. The lower bird counts in the second half of the study mark a noticeable change in the data. We are unable to determine if this change in the bird community is a result of vegetation management activities because sampling began after the major vegetation manipulation and no control sites were available for comparison. However, as mentioned previously, surveys in the first 3 years were conducted by 2 observers while in the last 3 years they were conducted by only 1 observer, indicating a reduction in sampling effort. To assess whether this change in sampling effort could account for the decrease in bird abundance, linear regression modeling was performed (Section 5.7, below).

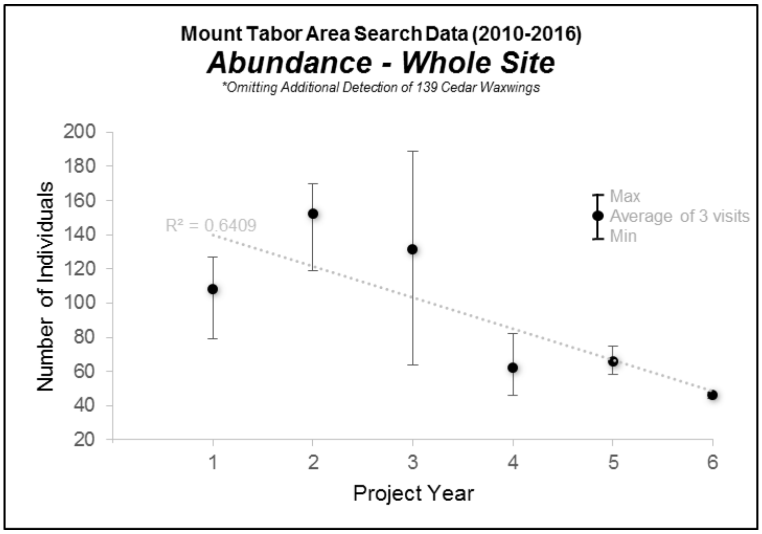


Figure 6. Avian abundance at Mt. Tabor throughout the 6-year study, excluding an anomalous detection of 139 cedar waxwings in Year 3. The number of individuals detected is displayed for each of the 6 years. Black dots represent the average number of birds detected across the 3 visits made each year. The whiskers represent the minimum and maximum number of birds detected during the 3 visits. The dashed line is the best fit line and the R^2 value is the coefficient of determination, indicating the extent to which variation along the y-axis is explained by variation along the x-axis.

5.6 Foraging guild trends: The winter bird community at Mt. Tabor was a diverse assemblage of 36 species, encompassing 4 foraging guilds. A foraging guild is a non-taxonomic group of species that forage for food on a shared substrate. For instance, “foliage gleaners” refers to all bird species that forage for insects, fruit, seeds, or nectar on the leaves and flowers of plants (ex: kinglets, bushtits, chickadees, vireos, etc.). We used foraging guild classifications as found in the BES Terrestrial Ecology Enhancement Strategy database. Table 4 provides information on species richness and abundance for each of the 4 foraging guilds detected at Mt. Tabor. Foliage gleaners comprised 63 % of all bird detections throughout the study, followed by ground gleaners at 30 %. The remaining 7 % of detections were comprised of bark gleaners and aerial foragers.

Table 4. Species richness and abundance for the 4 foraging guilds present at Mt. Tabor. A species' foraging guild was defined by its primary foraging behavior and/or the substrate on which foraging occurs.

Mount Tabor Area Search Data (2010-2016) *Species Richness and Abundance by Guild*			
Foraging Guild	**Number of Species**	**Total Detections***	**Abundance Index****
Foliage Gleaner	14	1164	64.67
Ground Gleaner	13	558	31.00
Aerial Forager	5	10	0.56
Bark Gleaner	4	106	5.89

* = Number of detections across 18 visits (3 visits/year for 6 years)

** = Total detections ÷ Number of survey visits (18)

Since foliage and ground gleaners together made up 93 % of all bird detections at Mt. Tabor we would expect that these guilds contributed heavily to the drop in overall bird abundance described earlier. Figure 7 confirms this, demonstrating that the abundance of aerial foragers and bark gleaners did not change over six-years, while the abundance of foliage and ground gleaners decreased substantially. Abundance trends for each foraging guild are represented as a unique colored line in the graph below. These trends could indicate that aerial and bark foragers are less susceptible to changes in vegetation, while foliage and ground foragers are more sensitive. It is more likely, though, that detections of aerial and bark gleaners were too few to show any meaningful change over time. Another explanation is that aerial and bark foragers have high detectability due to being more visible while foraging (i.e. in the air or on a tree trunk as opposed to foraging in or beneath dense foliage). Therefore, the change from 2 observers to 1 may not be reflected in counts of these conspicuous species, because 1 observer may be just as likely to detect them as would 2 observers.

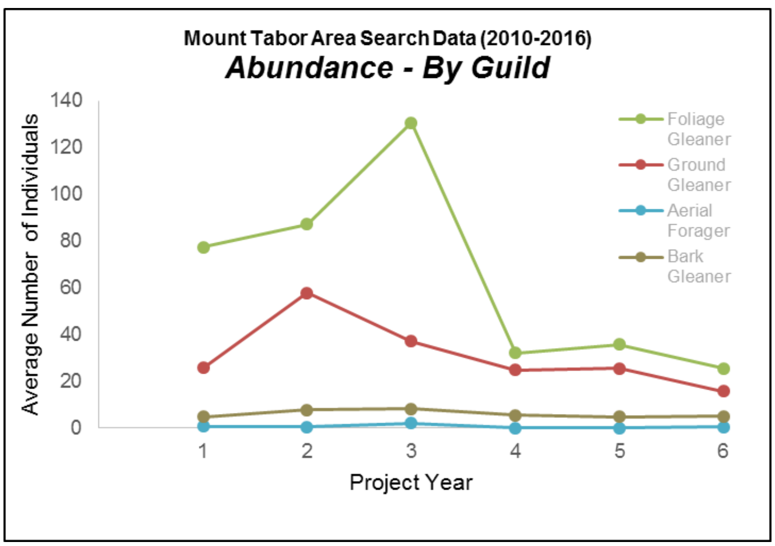


Figure 7. Abundance trends for the 4 foraging guilds observed at Mt. Tabor. The average number of individuals detected in a given year are shown for each guild (i.e. average number of individuals detected during the 3 visits made each year). Decreases in the number of foliage and ground gleaners reflect the decrease in overall bird abundance shown in Figure 6, while the numbers of aerial and bark foragers remained constant throughout the study.

5.7 Regression modeling: To examine the role of sampling effort and vegetation management activities on winter bird abundance, regression modeling was performed. Five explanatory variables were chosen as possible predictors of bird abundance and were included in the analysis: number of observers, date of initial vegetation cut, date of shrub planting, temperature, and wind speed. Noise level data was not collected during surveys. It is important to emphasize again that the bulk of vegetation cut was performed prior to the bird monitoring. To minimize variable redundancy prior to model selection, correlations between explanatory variables were assessed using Spearman rank correlations with a cutoff of $r_s = 0.70$. No variables showed strong multicollinearity, so all were included in analysis.

We constructed multiple linear regression models to determine which variables best predicted variation in bird abundance over the 18 visits made to Mt. Tabor. A hybrid information-theoretic approach was used for model selection (Burnham and Anderson 2002, Ellis et al. 2014). This approach is fitting for studies of complex environmental systems and data spanning a large spatio-temporal scale, as it compares the relative quality of all models based on AIC. A full model was constructed including the 5 explanatory variables. Then the full model was systematically reduced using a hybrid stepwise-criterion-based procedure. All models with ΔAIC < 2 were considered equally good, and selected for consideration (Table 5). Diagnostic checks were performed on the final models to ensure that residuals were normally distributed with equal variance, and there were no influential outliers. A Shapiro-Wilk test confirmed normality of residuals ($W = 0.96$, $p = 0.59$).

Three models were considered equally good based on ΔAIC < 2, and included 3 explanatory variables: number of observers, date of shrub planting, and wind speed. Because stepwise selection was used, these models contain nested variables; each model consists of the variable(s) present in the model before it, along with 1 additional variable. Therefore, the third model in Table 5 contains all 3 variables, whereas the first and simplest model contains only 1 variable. In interpreting models, it is often helpful to use the minimum adequate model (the simplest of all models considered to be equally good). Our minimum adequate model included the number of observers as the only explanatory variable and accounted for 45 % of variation in bird abundance ($R^2 = 0.45$, $p = 0.002$, *Residual SE* = 36.82). In other words, the switch from 2 observers to 1 observer explains 45% of the decrease in bird abundance at Mt. Tabor. When wind speed is added to the model, it is able to explain 49 % of the variation in bird abundance, which is 4 % more than the model containing only number of observers. Adding the date of shrub planting increases R^2 by another 2 %. Although adding these variables increase R^2 slightly, the number of observers appears to be the most significant variable predicting changes in bird abundance, by far. On average, 63 more birds were detected by 2 observers than 1 on a given visit to Mt. Tabor. This analysis suggests that the vegetation management activities at the sampled sites appear to have had little impact on the bird community, with the possible exception being shrub planting. However, it is important to frame this conclusion based on the fact that we only included a limited number of explanatory variables in the model and had no quantitative vegetation data (measurements like the *amount* or *extent* of vegetation removal and shrub planting were not available). We should not rule out the possibility that vegetation activity contributed to changes in bird numbers. A more controlled study design would help address this uncertainty.

Table 5. Three least-squared linear regression models describing variation in bird abundance as a function of 5 potential explanatory variables. All models with ∆AIC < 2 are included here. +/- indicates whether the variable had a positive or negative correlation with bird abundance.

Mount Tabor Area Search Data (2010-2016) *Final Regression Models*				
Explanatory variables in model	**AIC**	**∆AIC**	**R^2**	**p-value**
Number of observers (+)	131.7	0.0	0.45	0.002
Number of observers (+) Wind speed (-)	132.1	0.4	0.49	0.006
Number of observers (+) Wind speed (-) Shrub planting (+)	133.4	1.7	0.51	0.02

6.0 DISCUSSION & RECOMMENDATIONS

6.1 Addressing research questions: The winter area search data offer important insights into the bird community at Mt. Tabor and the sampling methodology used. The 3 study objectives outlined earlier are addressed below:

1. **Measure any changes in the bird community over the course of the 6-year vegetation management operation. What specific factors, if any, may have contributed to changes within the bird community at Mt. Tabor?** We detected a measureable decrease in bird abundance over a 6-year period. The first 3 years showed high variability in bird counts with an average of 131 birds detected per visit. The last 3 years yielded remarkably consistent counts, averaging 58 birds per visit (73 less than in Years 1-3). Therefore, the overall decrease in bird abundance at Mt. Tabor is best thought of as a distinct drop halfway through the study, rather than a gradual linear decline in bird numbers. This drop corresponded with a protocol switch from 2 observers to 1 observer. In our regression model, this reduction in sampling effort explains 45 % of the decrease in bird abundance and appears to be the single most significant factor we considered. Importantly, observer bias and changes in sampling effort affect the number of birds *detected*, but may not relate to bird *abundance* per se. The apparent decrease in bird abundance at Mt. Tabor is, therefore, better described as a decrease in bird detections. It is possible that the winter bird community at Mt. Tabor remained stable over the 6-years, and that the decrease in bird data was a reflection of reduced sampling effort alone. It is also possible that any real changes within the bird community were obscured or skewed by the shift in sampling effort.

Our analysis found that most vegetation treatments did not closely correlate with a change in bird abundance. Shrub planting had a weak positive correlation with bird abundance. Years when shrubs were planted averaged 42 more bird detections than years without shrub planting. Because shrubs were planted as small bare root stalks, it is unlikely that they offered useable cover or foraging opportunities to birds for at least 3 years after planting (R. Durocher, personal communication, September 2016). Therefore, the correlation between shrub planting and bird abundance is suspect and may be coincidental. The fact that there was no control site (study plot with no vegetation manipulation) nor robust quantitative vegetation measurements further complicates interpretation of the results. These uncertainties make it difficult to answer questions about the effects of specific vegetation treatments, or to detect temporal changes in bird abundance.

2. **Assess the efficacy of study methodology, and make recommendations for further improvements:** While the study design of this monitoring effort was ad-hoc (proposed after the initial vegetation removal), and options for including a control site were limited, it would have been advantageous to have ranked the 3 study sites in terms of their degree of vegetative manipulation. This would have required an estimation of the percentage of manipulated habitat in each study site. In addition, the inclusion of at least one "control" site with minimal disturbance would have been ideal. Finally, a more quantitative approach to collecting key vegetation variables during the course of the study would have provided a more robust way to evaluate the potential contribution of vegetation manipulation effects on bird community attributes.

Regarding the change in observer number, future monitoring projects should establish a clear and consistent protocol prior to data collection. It is critical that the effects of observer bias and sampling effort be considered in study design, and that sampling effort remain constant throughout the study. All field surveyors should receive identical training and should be tested to ensure their data is of equal quality (a double-observer approach can be used to evaluate field data). Additionally, realistic study objectives should be clearly defined, including a basic idea of how data entry, QAQC, and analysis will be handled. This includes identifying *a priori* variables and providing instructions on collecting data for each variable (ex: vegetation measurement, noise level, wind speed, weather, etc.). Any habitat components predicted to influence the study species should be measured according to accepted methodologies.

3. **Establish a baseline bird inventory of the winter bird community at sites on Mt. Tabor:** This study established the first baseline data on the winter bird assemblage at 3 sites on Mt. Tabor. Because the sites were not randomly established taking the entire park into consideration, we cannot extrapolate the bird inventory to the whole park. Nevertheless, this study provides a useful index of avian abundance for an important urban greenspace and contributes to a larger database of bird surveys in Portland, allowing for a broader analyses of our urban bird populations.

6.2 Lessons learned: Changes in sampling effort can cause significant variation in data, confounding efforts to detect habitat-driven changes in wildlife populations. In the case at hand, the switch from 2 observers to 1 observer halfway through the study resulted in a substantial decrease in bird detections, which may have overshadowed other trends in the data. Although this made it difficult to assess the impact of vegetation management on the winter bird assemblage at Mt. Tabor, it confirmed the importance of establishing a consistent survey methodology. This is a lesson-learned that should be applied to wildlife monitoring efforts moving forward.

REFERENCES

Burnham, K. P., and D. R. Anderson (2002). Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach. Springer, NY, USA.

Durocher, R. (City of Portland Environmental Services). Personal communication, September 2016.

Ellis, K. S., Larsen, R. T., Knight, R. N., and J. F. Cavitt (2014). Occupancy and detectability of Snowy Plovers in western Utah: An application to a low density population. Journal of Field Ornithology 85:355-363.

PRBO Area Search Census Instructions (1999). http://www.lagunadesantarosa.org/pdfs/AreaSearchCensusMethod.pdf