



Royal
Botanical
Gardens
CANADA

Long Watch Migratory Bird Monitoring 2015 -2023 RBG Monitoring Summary



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Document Description

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Abstract

RBG property is part of several international bird migration routes and ranked as a Nationally Important Bird Area (IBA). The volunteer program The Long Watch <https://longwatch.ca/> was established in 2014 to capture the species composition and diversity of birds at Royal Botanical Gardens (RBG) during the migratory season driven by Citizen Science. The locations are popular nature trails associated with Hendrie Valley and Cootes Paradise. From 2015-2022, a standardized methodology was developed for three trail routes (transect surveys) including one on the north shore forest of Cootes Paradise, one associated with the marsh shoreline and one in Hendrie Valley Nature Sanctuary. In 2023, a fourth transect was added to capture the south side of Cootes Paradise along Princess Point. Routes are about 2.5 km in length. The process is based in regular visits to the trails over an 8 week period during both spring and fall migration. This report constitutes the first formal summary and analysis of all collected data since 2015.

Long Watch volunteers have detected 220 species since 2015, and averages 166 species each year. A total of 727,170 birds have been counted during the project. The most common species noted were Double Crested Cormorants with a relative abundance of 18.16%, followed by the Red-winged Blackbird at 8.04%, and Canada Goose at 6.95%. Total detections rose early on, having peaked in 2018 and declining since, but have not gone as low as 2015 levels. On average around 78,302 birds are detected each year. The Captain Cootes route (Cootes Paradise Marsh shoreline) sees the highest number of detections each year, averaging 41,533 per year and dominated by Double Crested Cormorants, with the site capturing a staging/nesting island used by this species. Cherry Hill is the most diverse transect with an average diversity score of 3.36, followed by Grey Doe at 3.29 and Captain Cootes at 2.92.

Wetland and open water habitat users make up about 47% of all detections. After wetland users, the most common habitat guilds are generalists and forest generalists, making up about 40% of all detections. The most significant change among taxon is happening to Tits, Chickadees and Titmice, largely due to the downward trend of 33.4% in Black-capped Chickadees since 2015. Warbler detections are increasing but they are still present only in low numbers, averaging just 1,829 detections per year and a relative abundance of 2.4%. A total of 22 species-at-risk have been recorded, the most common being the Barn Swallow (66% of all detections), Eastern Wood-pewee (14%) and the Bald Eagle (9%).

A more in-depth trend analysis should be completed in 2026 at the earliest, when at least 10 years of data have been recorded to allow for robust statistical conclusions and inferences. Migratory birds at RBG are facing challenges from invasive species, habitat loss, climate change and anthropogenic pressures such as window strikes. It is imperative that Long Watch surveys continue to inform us on the effects of these pressures so we can attempt to mitigate them.

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1.0 Introduction

Royal Botanical Gardens' (RBG) nature sanctuaries are located in the Lower Great Lakes/St. Lawrence Plain Bird Conservation Region 13 (BCR 13), the Ontario portion of which is referred to as BCR 13 ON. The location forms the western tip of Lake Ontario where the escarpment intersects and is dominated by the Dundas Valley/Cootes Paradise glacial reentrant valley. The species in this region face the destruction and loss of habitat due to factors such as urban development, pollution, and other human disturbances because of the ongoing growth of the human population in the area. Despite the threats associated with the alteration to much of the southern Ontario landscape, BCR 13 ON maintains unique and important habitats for bird species.

Situated at the western tip of Lake Ontario, RBG's nature sanctuaries have long been recognized for their importance to a wide variety of plants and wildlife. In 1927 a block of property akin to the current Cootes Paradise property was formally established as a Provincial Wildlife Sanctuary, specifically tied to protection of migratory birds, known as the Dundas Crown Game Preserve. The land protection was not effective and was reinvented with the formation of RBG in 1941. Today RBG's 800 hectares of natural lands extend from Lake Ontario to the top of the Niagara Escarpment, with the diversity of habitats hosting 38% of Ontario's and 23% of Canada's native floral species. They also encompass significant wetlands, forests, and grasslands. The nature sanctuaries, named Cootes Paradise, Hendrie Valley and Escarpment Properties, have also been designated as an Important Area for Reptiles and Amphibians (IMPARA), an Environmentally Sensitive Area, a Provincial Area of Natural and Scientific Interest (ANSI), and an Important Bird Area (IBA) (Vincent, 2017).

Annual standardized surveys of birds have been completed during the breeding season across RBG property since 2008. The overall region supports the greatest diversity of breeding land birds of any other area in Canada and has an unusually high proportion of species-at-risk, due in part to the region's location at the northern range limit of some species (ECCC, 2014). However, RBG is also part of two important North American bird migration flyways (Ward, 2010). Therefore, the volunteer led program Long Watch was created in 2014 aiming to focus visitor enthusiasm for birds, and capture species composition and diversity during the migratory season. To do this, the number of individual detections, species richness, relative species abundance, diversity, and occurrence of species-at-risk are all examined.

A formal synthesis of the collected data property wide has not previously been done. The purpose of this report is to synthesize this collection of quantitative index data to highlight trends occurring across the property and in each nature sanctuary. Trends identified can help focus restoration and monitoring efforts to better restore and maintain the current natural landscape at RBG, and possibly be used to supplement other research and monitoring efforts made by other organizations.

2.0 Methodology

2.1 Transect Routes

Long Watch began in 2014 as a twelve-hour census (7:00 – 19:00) at a single location in Hendrie Valley. In 2015 the remarkable diversity and migration of birds transformed the survey experience the regular walking of trail routes (transects) to capture the bird migrations during spring and fall. This began in two nature sanctuaries: the North Shore of Cootes Paradise (CP-NS) and Hendrie Valley (HV) with sites passing through mixed habitats but with marsh habitat as a central feature. An additional route was added to CP-NS in 2016 passing through the large interior forest area of Cootes Paradise north side, and in 2023, a route on the South Shore of Cootes Paradise very popular Princess Point access (CP-SS) was added resulting in four transects total. For the purposes of the report only the years of 2015 to 2023 will be analyzed and reviewed. The Princess Point information has been removed from the majority of analyses due to the fact there is only one year of data at this location.

Transect routes occur along designated RBG trail systems and are approximately 2.5 kilometers in length (9.1 Appendix A: Transect Routes). The transects are loops and go through numerous habitat types and named trails, and all are at least partially exposed to gardens, urban city parks, and/or wetlands. Transect routes are based on the name of the primary trail.

For Cootes Paradise north side (CP-NS), the two routes are Grey Doe (added in 2016) and Captain Cootes (added in 2015). The majority of the Captain Cootes route/trail was renamed to Anishinaabe waadiziwin trail in 2017, however the route name will remain Captain Cootes for the purpose of this report. In HV, the route is known as Cherry Hill, and at CP-SS the route is known as Princess Point.

2.2 Transect Surveys

The sampling window for migratory transects occurs primarily in April-May and from September-October, though routes occurring in the shoulder months (March, June and August, November) occasionally happen. Each route is done three times a week, over the course of 8 weeks, weather depending, and begins at least one hour after sunrise and is completed before noon.

Conditions are recorded prior to beginning the transect and include location, temperature in Celsius, wind speed (Beaufort Scale), cloud cover, visibility, and noise (9.2 Appendix B: Survey Conditions). Routes are then conducted at a steady pace where all identifiable birds, either seen or heard, are recorded. Small stops to identify a species are done, but there are no long pauses during transects.

2.3 Methodology Limitations and Bias

As with all surveys there are inherent biases and limitations in data collection. Observations are impacted by ambient noise, weather, the number of observers and observer skill. These

impacts are controlled through standardized methodology and a high skill level of volunteers. Additionally, detection of crepuscular species, nocturnal species such as owls, and species which require playback to elicit calls are infrequent during transects due to the methodology selected.

Sampling effort is not always equivalent as multiple observers may go out on a transect. A rise in the number of observers increases detections and species richness, so effort hours are used in order to determine the rate of detections. However, as the number of observers continues to increase, the number of birds detected will reach a plateau. Therefore, while effort hours attempt to standardize the data to some degree, there are limitations to this methodology.

Transect routes occur in forests, gardens, and along shorelines, and up until 2023 grassland habitat was not surveyed. As a result, grassland species are poorly represented in transect surveys. With the addition of the new survey route in 2023, grassland species should see greater representation in the future.

Population estimates are unfeasible as distance sampling is not done. To determine trends species are examined using relative abundance and detections.

2.4 Data and Statistics

Data used for this report consists of migratory transect route data from 2015 to 2023. The day long census data in 2014, and data from the beginning of 2024 are excluded from this report.

Very little information has been removed from analysis. All unknown species were removed from analysis even if they could be designated to taxon. Transects that did not include critical data in the sheet, such as a start and end time, were removed from analysis.

For large groups of birds recorded as (species +), the estimate was used. For example, 300+ Double Crested Cormorants became 300. For records that included a range the average was used. For example, 100-150 Red-winged Blackbirds became 125 Red-winged Blackbirds.

Data collected in the shoulder seasons (March, June and August, November) was included in the analysis. Transects collected during these months are often at the tail end of the month (March, August) or just the beginning (June, November).

The onset of the pandemic in 2020 prevented many surveys from being conducted from March to June, due to the closure of RBG. The lack of transects caused a marked decline in species richness and detections, and as this was a unique phenomenon the data from spring 2020 is often removed from analysis. In some instances, such as species per effort hour, it is included.

To analyze community trends, each bird was assigned two guilds: taxon, and habitat (Appendix C). The purpose of placing species into guilds is to assess if there are any trends affecting whole communities which may require further in-depth analysis. There is no universal

agreement on what species belong to what guild, and studies often have conflicting or different guild assignments per species. For the sake of uniformity, every species was researched using Birds of the World, and All About Birds to assess nest location, habitat, and foraging guilds.

In the Upland Areas Bird Monitoring 2010-2022 RBG Data Review (RBG Report 2023-9) species were assigned guilds based on breeding habitat and behaviour. For the purpose of this report the foraging guild has been removed as birds become highly flexible in their diet during migration and a reassessment of each species for migration is beyond the scope of this report. Nest location is also excluded as many migrants that pass through RBG have nesting requirements not found at RBG's latitude. For the purpose of this report then only taxon and habitat are included.

Trends are analyzed using linear regression. Often the R^2 value is less than 0.65 and is statistically insignificant. Populations trends still stand out in more severe instances and can lead to further analysis and study. Changes over time are assessed using linear regression rather than percentage change between 2015 and 2023, as linear regression captures more of the fluctuations year over year. It should be noted that for species with very low numbers, the change will be more inaccurate and inflated. Regardless, the severity of a trend will be evident and indicative of further study.

3.0 Species Richness, Relative Abundance, and Diversity

3.1 Species Richness

Species richness is the count of how many species are present, typically within a sample, such as a survey. Species richness can be subject to bias via observer skill and sampling effort. Observer bias can cause species richness to increase or decrease depending on the skill of the observers. Sampling effort, such as the number of times a survey is done, length of time at the location, and if more locations are surveyed will also influence the number of species detected. As more effort is put into surveys more species are found until an asymptote is reached where the likelihood of finding another species reduces to near zero.

Long Watch has controlled these biases by ensuring counts are done by skilled observers, at the same time of year, the same locations, and with equal amount of effort per location when possible.

3.2 Relative Abundance

Relative abundance is a measure of each species in relation to all others detected. The method used for deriving relative abundance for bird point counts is one suggested by Nur et al. (1999). Relative abundance for a given area was obtained by taking the total number of detections of a species for a site, and dividing it by the total number of detections for all species at that site:

$$\text{Relative abundance of species } x = \frac{\text{Sum of detections of species } x}{\text{Sum of all detections of all species}}$$

Relative abundance is affected by the same biases as species richness. Any decrease or increase in a species relative abundance will be matched with some sort of increase or decrease in other species.

Relative abundance typically follows a pattern with several common to abundant species followed by a long 'tail' of uncommon to rare species. Issues arise when common species begin to become uncommon, the tail begins to shorten, or certain species become 'super dominant' and push out all other species, as with invasives. Relative abundance struggles to identify trends in rare or uncommon species as the changes in percentage over time can be lost compared to a more common species.

3.3 Diversity

Diversity is a measure of the number of the number of species present and their evenness. A more diverse area has not only more species, but each species is more evenly distributed. To measure diversity, the Shannon-Wiener Diversity Index is used, represented by the formula:

$$H' = - \sum_{i=1}^n p_i \ln(p_i)$$

Where H' is the diversity index, and p_i is relative abundance. The higher the value of H' the greater the diversity of a site.

The Shannon-Wiener Index relies on the assumption that all species are identified, which is often untrue. As such it typically under-estimates diversity and rare species have a greater effect on the index than dominant species. The index is most beneficial to use when comparing between surveys that have received equal effort in time, area surveyed, and observers, which is met by Long Watch's methodology.

The Shannon-Wiener Index works well when there are multiple data points to compare to. As there are eight years of data, comparisons and trends can be readily identified. Once the ten-year mark has been reached more significant analysis can be done.

4.0 Results

4.1 Species Richness

Long Watch has detected 220 species since 2015, and averages 166 species each year. Between 2015 and 2022, species richness increased almost 10% (FIGURE 1). The Captain Cootes transect has the highest average species richness at 146, followed by Cherry Hill at 133, and Grey Doe at 127. In its first year, 146 species were identified on the Princess Point transect. A full list of species can be found in Appendix D.

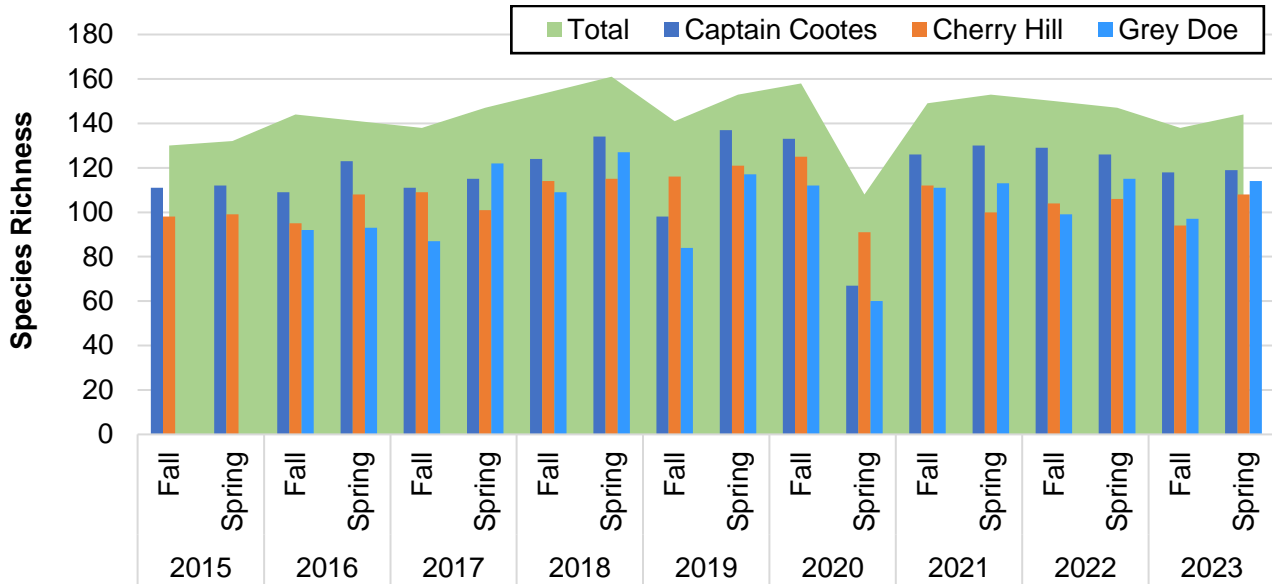


Figure 1: Species Richness for Grey Doe, Captain Cootes, & Cherry Hill Transects from 2015-2023.

4.1.1 Most Common Species

As expected, the most common species during migratory transects are waterfowl, with Double Crested Cormorants being the most common species detected. Red-winged Blackbird, Canada Goose, Mallard, American Robin, Ring-billed Gull, Blue Jay, Black-Capped Chickadee, Cedar Waxwing and European Starling make up the remainder of the 10 most common birds sighted, with all of these species displaying some form of residency.

4.1.2 Warblers

Multi-year data from Long Watch transects indicate that warbler detections are increasing but that they are still present only in low numbers, averaging just 1,829 out of 78,302 detections per year and a relative abundance of 2.4% (FIGURE 2).

A total of 29 unique warbler species have been detected since 2015, but only 24 are detected each year on average. Many of these species breed at higher latitudes than RBG and thus are not detected during terrestrial bird surveys. Grey Doe has the highest representation of warblers with 28 species, followed by Captain Cootes at 27 and Cherry Hill with 26. The highest number of warbler detections in 2023 came from the newly added Princess Point

Transect. 1,206 warblers were seen including 21 species at a relative abundance of 4.3%. A full summary of warbler detections can be found in 9.5 Appendix E: Warbler Detections.

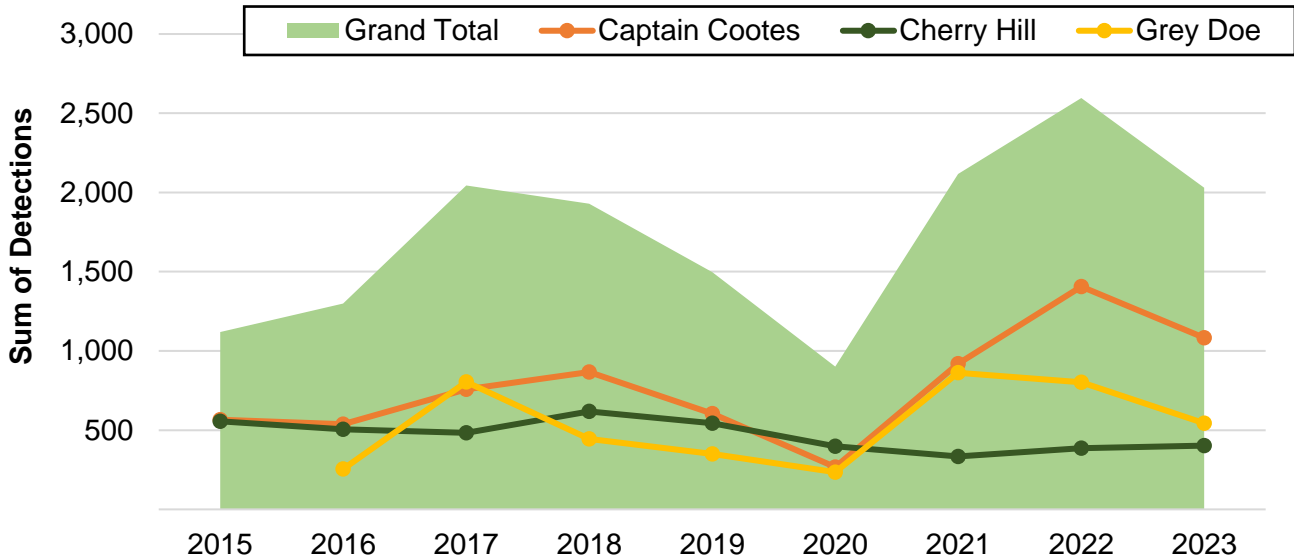


Figure 2: Sum of Warbler Detections Across Captain Cootes, Cherry Hill, and Grey Doe Transects 2015-2023.

4.1.3 Species at Risk

Species-at-risk are species that are facing population declines and potential extinction due to factors such as habitat loss, climate change, and invasive species. They are identified provincially and federally. Federally protected species fall under the Species at Risk Act, and provincially protected species under the Endangered Species Act. The purpose of these Acts is to prevent wildlife species from being extirpated, or becoming extinct and provide for the recovery of wildlife species that are extirpated, endangered, or threatened resulting from human activity. Additionally, species of special concern are managed to prevent them from becoming endangered or threatened (Species at Risk Act, 2002; Endangered Species Act, 2007). Full definitions of species-at-risk designations can be found in 9.6 Appendix F: Species-at-Risk.

On average, 11 species-at-risk are detected during migratory transects, and they account for 1% of all individuals detected. The total relative abundance of species-at-risk has increased from 0.26% in 2015 to 1.45% in 2022, an 89% increase overall. A total of 22 species-at-risk have been detected since 2015. Each nature sanctuary has an average species richness of 11 per year, but Grey Doe has had the most unique species at risk with 21 different species being detected since 2016 (9.6 Appendix F: Species-at-Risk). In contrast, Captain Cootes has had 16 unique species and Cherry Hill has had 13. The majority of species-at-risk detections can be attributed to the Barn Swallow, which accounts for 66% of all detections. The Eastern Wood-pewee accounts for 14% and the Bald Eagle Accounts for 9%.

Detections of species-at-risk have been variable over the years, namely on the Captain Cootes transect (FIGURE 3). However, the overall trend in detections at Captain Cootes is increasing by 77% with an average number of 536 birds recorded annually. Cherry Hill is seeing an increasing trend with an average number of 107 birds recorded annually. Grey Doe is the only transect that on average, is decreasing by 11%. The average number of detections of species-at-risk birds on this transect is 165, a higher average than Cherry Hill, despite its decline over the years.

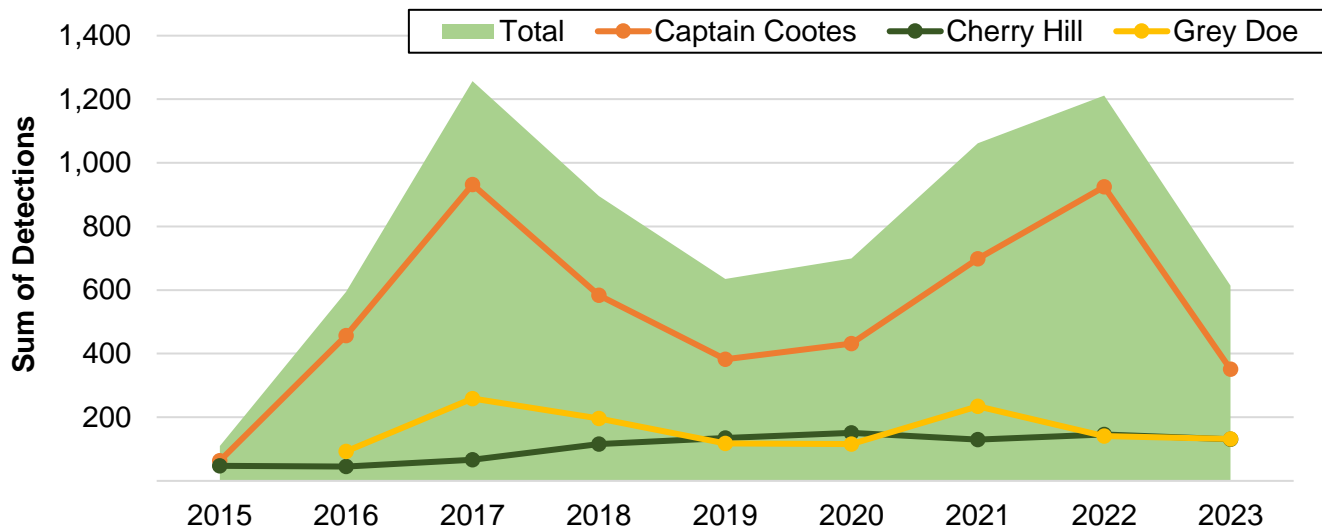


Figure 3: Sum of Species-at-risk detections across Captain Cootes, Cherry Hill, and Grey Doe transects 2015-2023.

4.2 Effort and Detections

Detections are up from 2015, having peaked in 2018 and declining since, but have not gone as low as 2015 levels (FIGURE 4). On average around 78,302 birds are detected each year during transects. Captain Cootes has the highest average detection rate at 41,533 per year due to the increased exposure to waterfowl. Cherry Hill and Grey Doe are at 20,551 and 18,474 average detections respectively (FIGURE 5). In 2023, there were 27,857 birds recorded on the new Princess Point Transect.

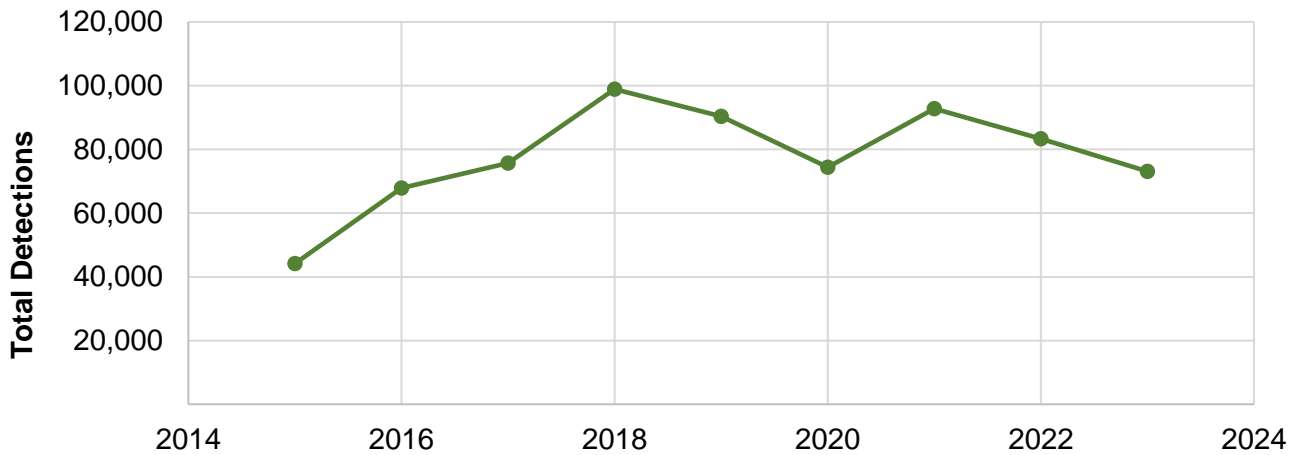


Figure 4: Total detections across Captain Cootes, Cherry Hill, and Grey Doe transects from 2015-2023. note the dip in 2020 is due to the pandemic restricting access to spring transect routes.

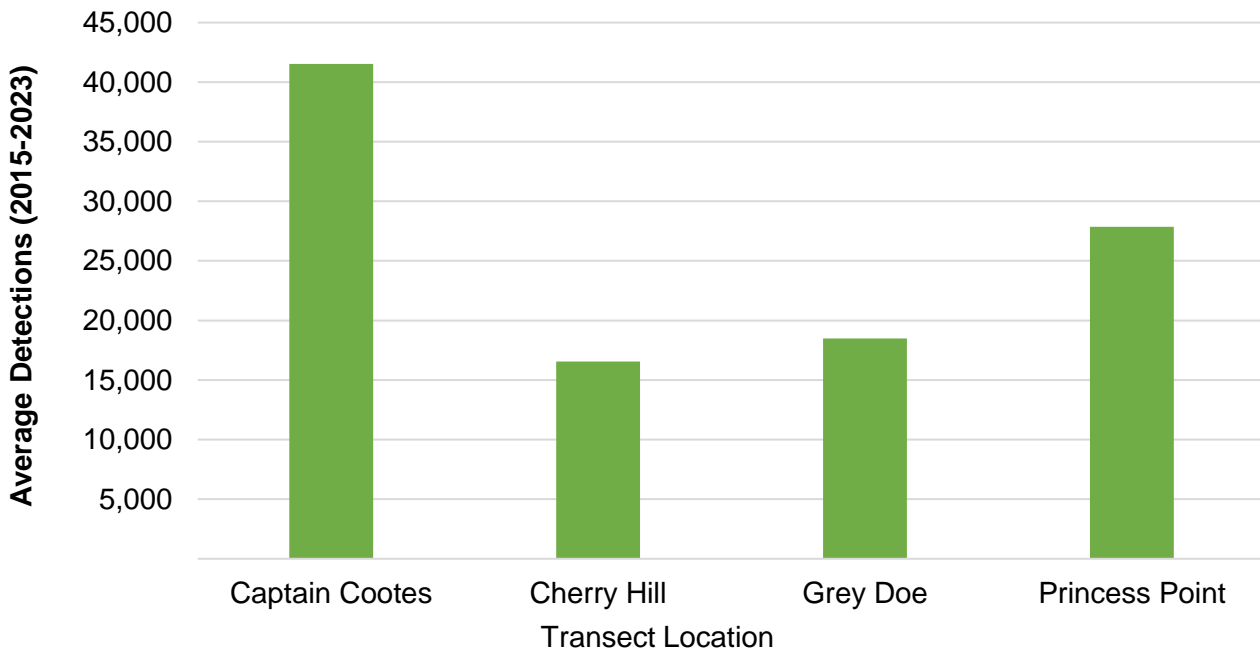


Figure 5: average number of detections across captain cootes, cherry hill, grey DOE, and princess point from 2015-2023.

In order to assess if the number of detections was significantly changing, detections were standardized using effort. Effort hours are the number of hours per transect multiplied by the number of people conducting said transect. An increase in the number of observers invariably increases the number of birds and species seen. In theory, effort hours also allow mitigation of events such as the pandemic, as detections per hour of survey would still hold true even if the number of surveys decreased.

Detections per effort hour have remained stable between 2015 and 2022, averaging 103 detections per effort hour (Princess Point and Spring of 2020 excluded from analysis).

However, when looking at the difference in detections per effort hour between 2015 and 2023, there is a decrease of 32.7%. Excluding 2023, detections per effort hour have trended downward by 9.4% for the fall season and have trended upward in the spring season 12.3% (FIGURE 6). There is a large dip in the Spring of 2020 likely due to the only transects being completed during June, which is past peak migration.

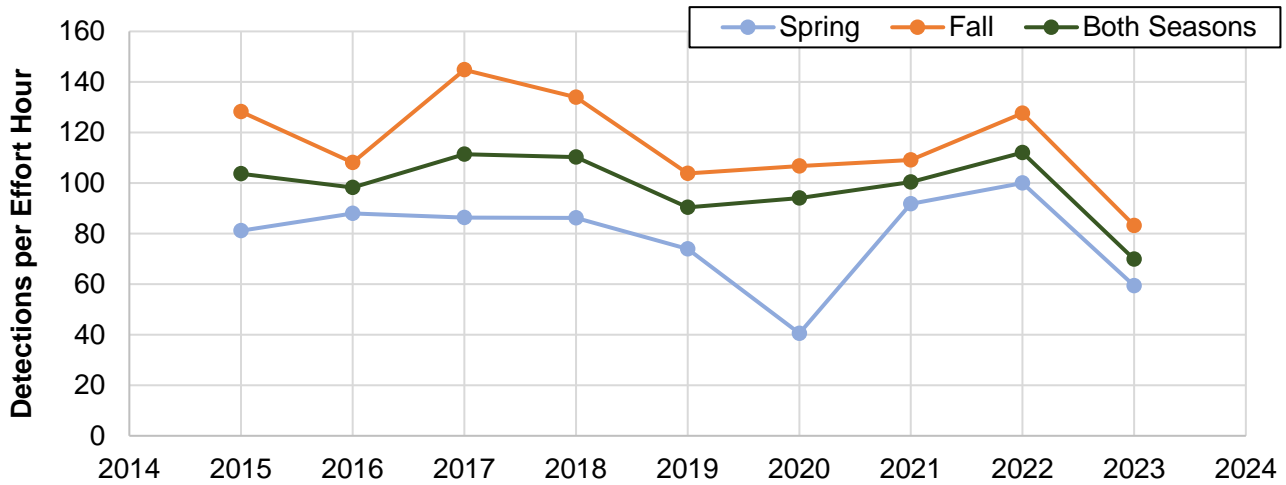


Figure 6: Seasonal detections per effort hour across Captain Cootes, Cherry Hill, and Grey Doe transects 2015-2023.

4.3 Diversity

Cherry Hill is the most diverse transect with an average diversity of 3.36 (FIGURE 7). Grey Doe comes in second with an average diversity of 3.29. Captain Cootes has the lowest average diversity despite the highest species richness and detections, at 2.92, likely due to the weight of waterfowl, especially Double-crested Cormorants, which skews evenness. While the Shannon-Wiener Index is better suited to comparing diversity between sites than declaring how diverse one specific site is, most values in ecological studies are between 1.5 and 3.5. Average diversity across transects sits at 3.36, which indicates that the north shore of Cootes Paradise and Cherry Hill provide important stopover habitat for many species and offer numerous services to migratory birds.

Princess Point had the highest overall diversity index at 3.54. However, this result is not as robust as the other areas which have years of data collected compared to the single year at Princess Point.

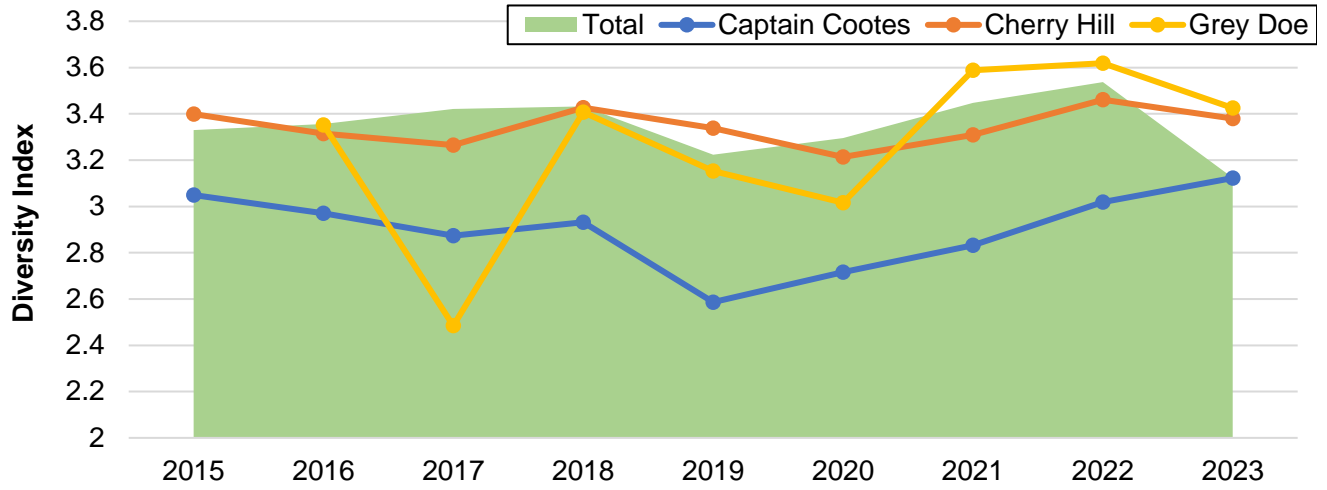


Figure 7: Diversity index score across Captain Cootes, Cherry Hill, and Grey Doe transects 2015-2023.

4.4 Guilds

4.4.1 Taxon

The most common taxa are waterfowl-like birds including the Cormorants and Shags, Ducks, Geese and Waterfowl, as well as Gulls, Terns, and Skimmers. This is to be expected considering the proximity of the transects to Cootes Paradise. These three taxa alone make up 42% of detections. The other significant taxon detected was Icterids at 10.94% of detections. This is likely due to the large number of Red-winged Blackbirds and Baltimore Orioles on the property. The relative abundance of taxa across transects can be found in Figure 8. A list of species assigned to each taxon can be found in 9.7 Appendix G: Species List by Taxon.

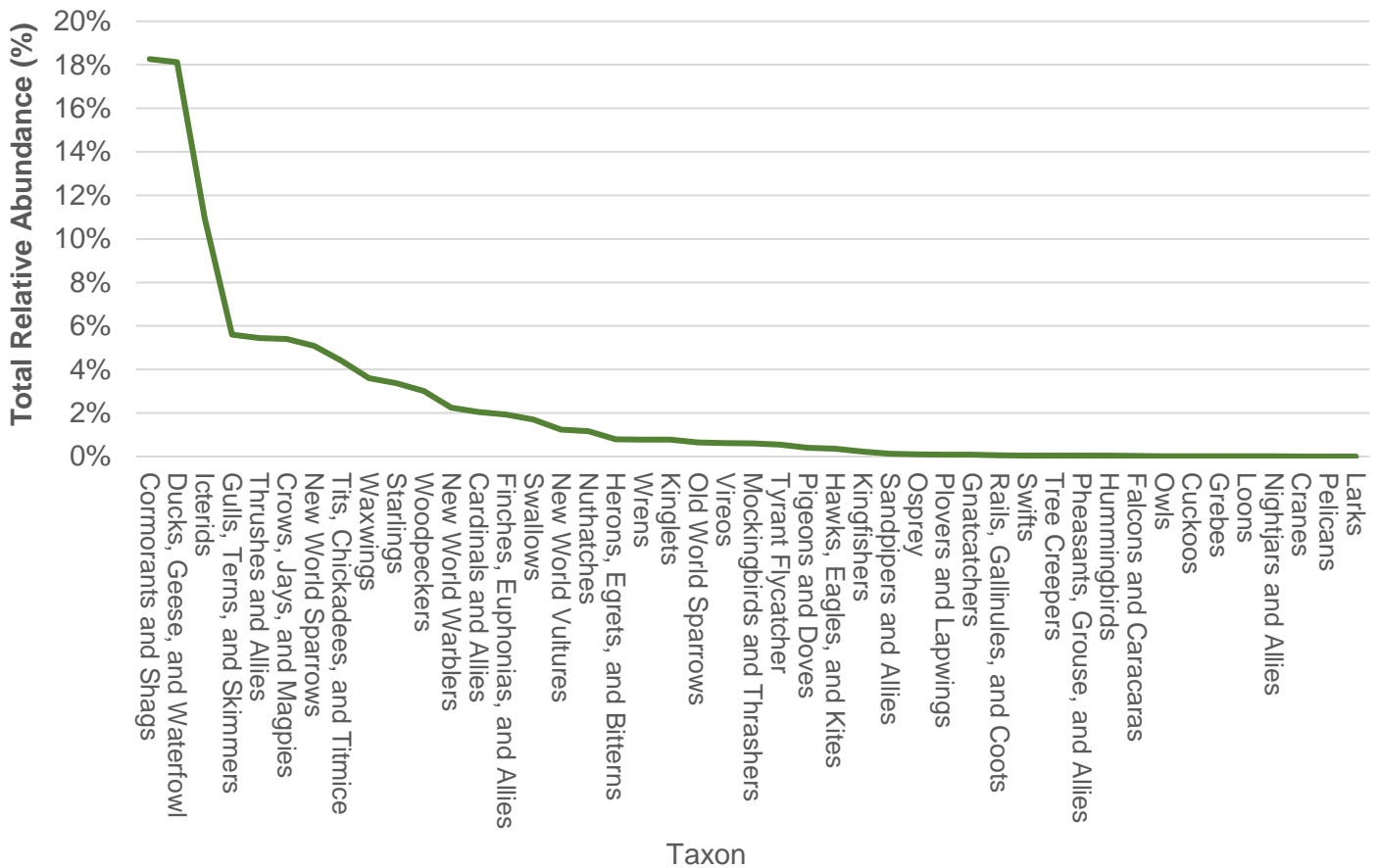


Figure 8: Total Relative abundance of taxa across grey doe, captain cootes, and cherry hill transects 2015-2023.

The top 15 taxa make up 91.15% of all birds recorded from 2015-2023 at Captain Cootes, Grey Doe and Cherry Hill. Trends in relative abundance can be seen in FIGURE 9 below. The most significant change is happening to Tits, Chickadees and Titmice. This is largely due to the downward trend of 33.4% in Black-capped Chickadees since 2015. Starlings have trended downward by 19.9%, and unfortunately Swallows have also seen a decline of 32.18%. Crows, Jays and Magpies as well as Thrushes and Allies have seen large upwards trends of 41.7% and 42.2% respectively.

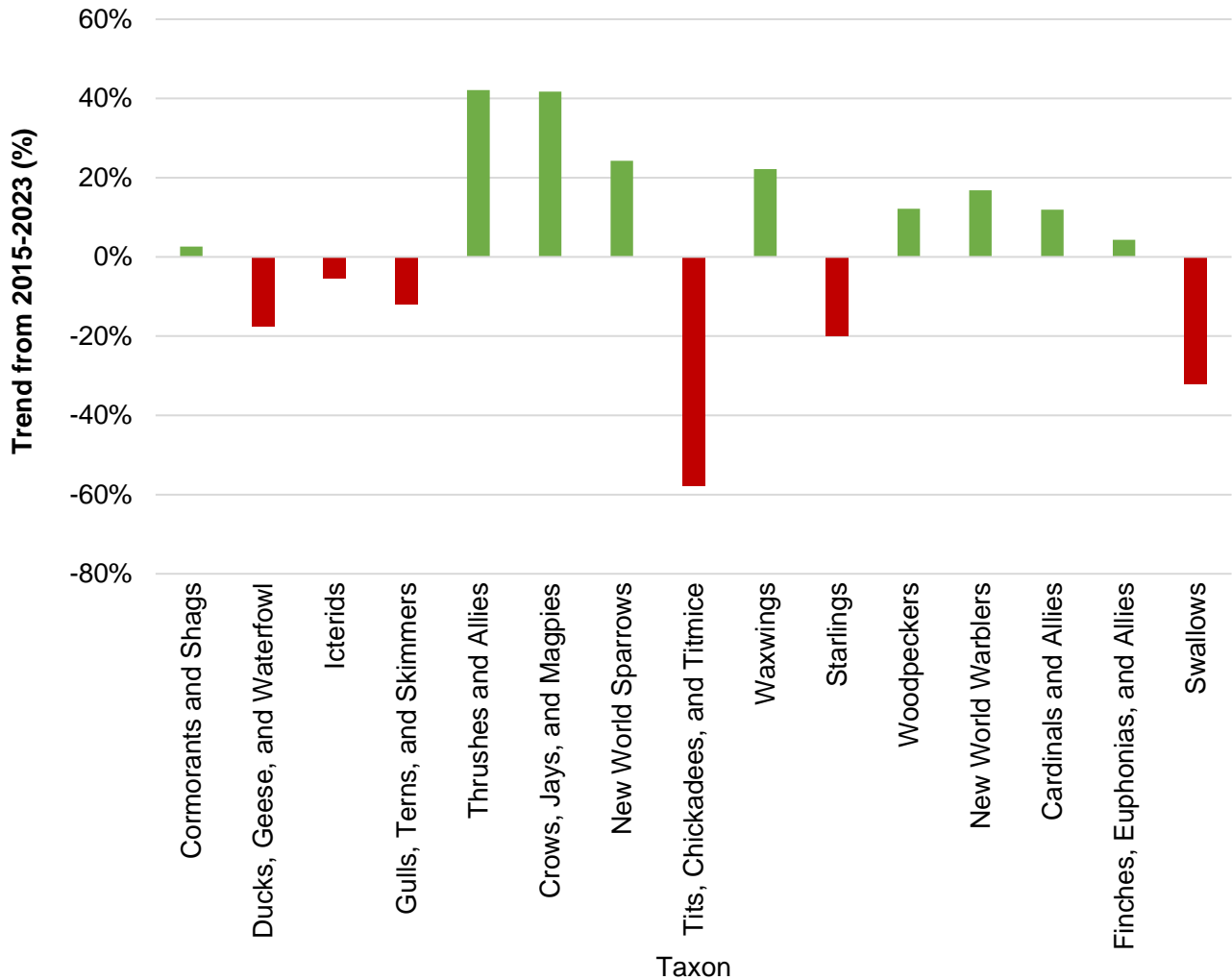


Figure 9: Trends in the most common 15 taxa from 2015-2023 across captain cootes, grey doe, and cherry hill transects.

4.4.2 Habitat

The average relative abundances of different habitat guilds between 2015 and 2023 can be seen in Figure 10. As expected, wetland and open water habitat users make up about 47% of all detections. After wetland users, the most common habitat guild is generalists and forest generalists, making up about 40% of all detections. The relative abundance of generalist species has been trending upward since 2015 by 20.6%, as they are able to adapt to a wide variety of habitats and food sources. However, forest generalists have been decreasing by 7.0%.

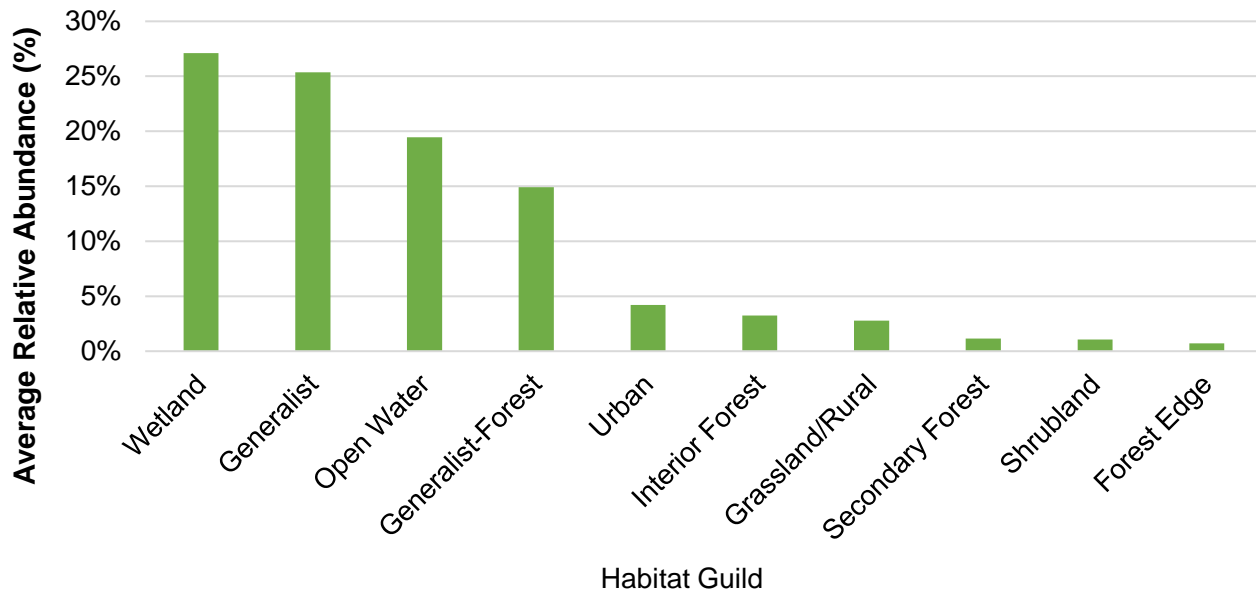


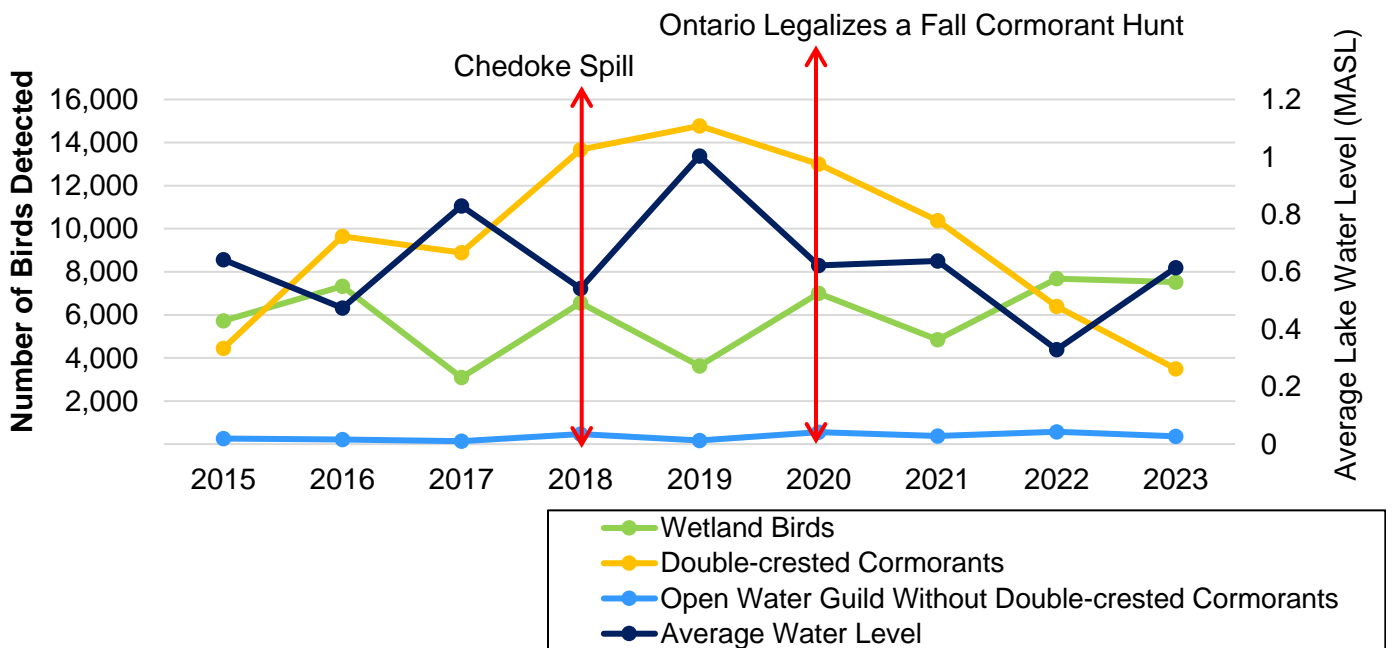
Figure 10: Average Relative abundance of birds in each habitat guild from 2015-2023 across Captain Cootes, Grey Doe, and Cherry Hill transects.

Interior forest birds only comprise 3.2% of birds recorded, however their relative abundance has been trending upwards by 83.1%. Although, this is not fully indicative of improving interior forest habitat at RBG as the habitat requirements or preferences for many species may differ between breeding season and migration (Archer et al., 2019). Additionally, the number of forest birds detected may remain low because transects often bisect areas of interior forest habitat along paths of known disturbance which these interior forest specialists may avoid. While shrubland users remain low (1.06% relative abundance), they are declining further by a trend of 26.9%. Evidence from forest monitoring shows that the shrub layer within forests on the north and south shores of Cootes Paradise are maturing and reaching unsuitable heights for many species within this guild. Secondary forest users are also seeing change, trending upwards by 23.8%, possibly due to the gaps created in the canopy by the Emerald Ash Borer. Grassland and Rural habitat users are under-represented due to the locations surveyed. A full list of which species are assigned to each habitat guild can be found in 9.8 Appendix H: Species List by Habitat.

Wetland birds are seeing a decreasing trend of 16.2%, which has previously been seen across the Carolinian region likely due to agricultural intensification limiting habitat (Cadman et al., 2007). However, the amount of wetland and open water birds detected in Cootes Paradise have been found to follow a cycle that is correlated to the average water levels. As seen in FIGURE 11, less birds in these guilds are seen during years of high-water levels. Inversely, during periods of low water levels, more wetland and open water birds are seen. During periods of high water, there are more stopover opportunities across the area for migrating birds, therefore the population is spread over a larger area. During low water level years, more birds tend to congregate in Cootes Paradise as this area has retained some water.

Additionally, birds that require mudflats and dabbling ducks which must reach the bottom of the marsh to forage will be more abundant during low water level years. There is an additional potential stressor to birds present in the marsh, and that is the sewage spill in Chedoke Creek (Theysmeyer, 2022).

Double-crested Cormorants seem to be an outlier to the rest of the data. They reached their peak number of detections in 2019, and have steadily been declining ever since, seemingly irrespective of fluctuating water levels. While no conclusions can be drawn directly from this graph as to the cause of this decline, a couple of causes can be speculated. Double-crested Cormorants could have reached a carrying capacity in which there are no longer enough resources to support such a large population of birds. Between 2019 (peak in detections) and 2022, the number of inbound fish at RBG’s fishway decreased 18.6%. However, diving ducks, which also rely on fish and would compete with Double-crested Cormorants, are not following a similar trend. Another potential reason for the multi-year decline in detections is the legalization of fall-season cormorant hunt. In 2020, the Government of Ontario legalized a fall cormorant hunt with a large daily bag limit of 15 birds per hunter, per day in 2020 (Environmental Registry of Ontario, 2020). A portion of Hamilton Harbour is considered a designated Important Bird Area (IBA) (Listing ON020) as it is globally significant for colonial waterbirds and nationally significant for congregator species (IBA Canada, n.d.). However, this does not afford the birds here any special protection laws. In fact, hunters have been seen in Hamilton Harbour legally harvesting large numbers of Double-crested Cormorants (Sarah Richer, personal communication, February 20, 2024). However, it is not required by law to report the number of birds shot by hunters each season, and it cannot be concluded that this is



the main reason for the declines.

Figure 11: fall season Wetland and open water birds from the captain Cootes transect in relation to average fall water levels. daily mean water level in the marsh were obtained from the government of Canada station 13150 between August 26th and November 5th of each year.

4.5 Seasonality

As expected, fall has a much higher number of detections than spring due to new young on their first migration (Figure 12). The fall season averages around 46,934 detections compared to spring with 34,036 detections. Detections across the board have increased over time with spring seeing an upwards trend of 61.1% since 2015. The increase in detections saw a bump when Grey Doe was added in 2016 and continued to climb but started to decline beginning in 2022. Spring 2023 saw a decline in detections of 16.6% from 2022. As aforementioned, the spring of 2020 is so low due to the pandemic restricting access to trails, and only a couple of surveys were completed after peak migration. Detections in the fall have been decreasing since 2020, falling 44.1% over 3 years.

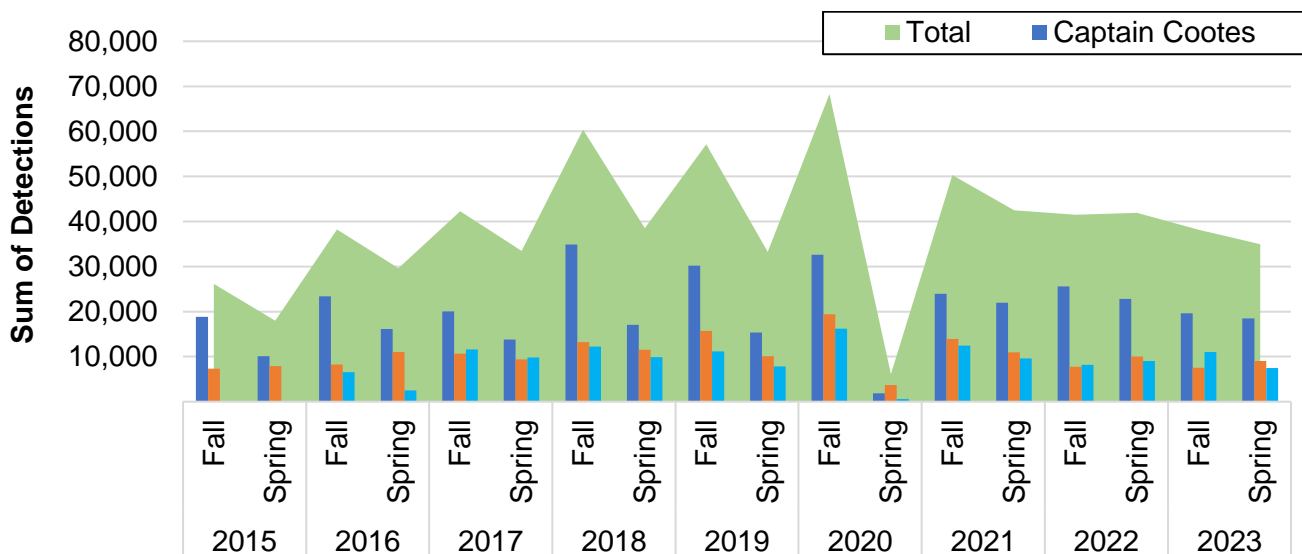


Figure 12: Sum of seasonal detections Captain Cootes, Cherry Hill, & Grey Doe transects 2015-2023. Grey Doe shows an increasing trend in species richness in both spring and fall seasons, but fall is trending upward by 11.5% compared to spring at 5.1%. Despite this, on average spring still has a higher species richness by 15%. Captain Cootes sees an even larger difference in growth between seasons with fall increasing at 15.5% and spring at 6.5%. On average spring has a higher species richness by 7%. Cherry Hill is growing at 3.5% compared to 2.6% in spring. On average spring has a higher species richness by 2%. Species richness by season is summarized in Figure 13.

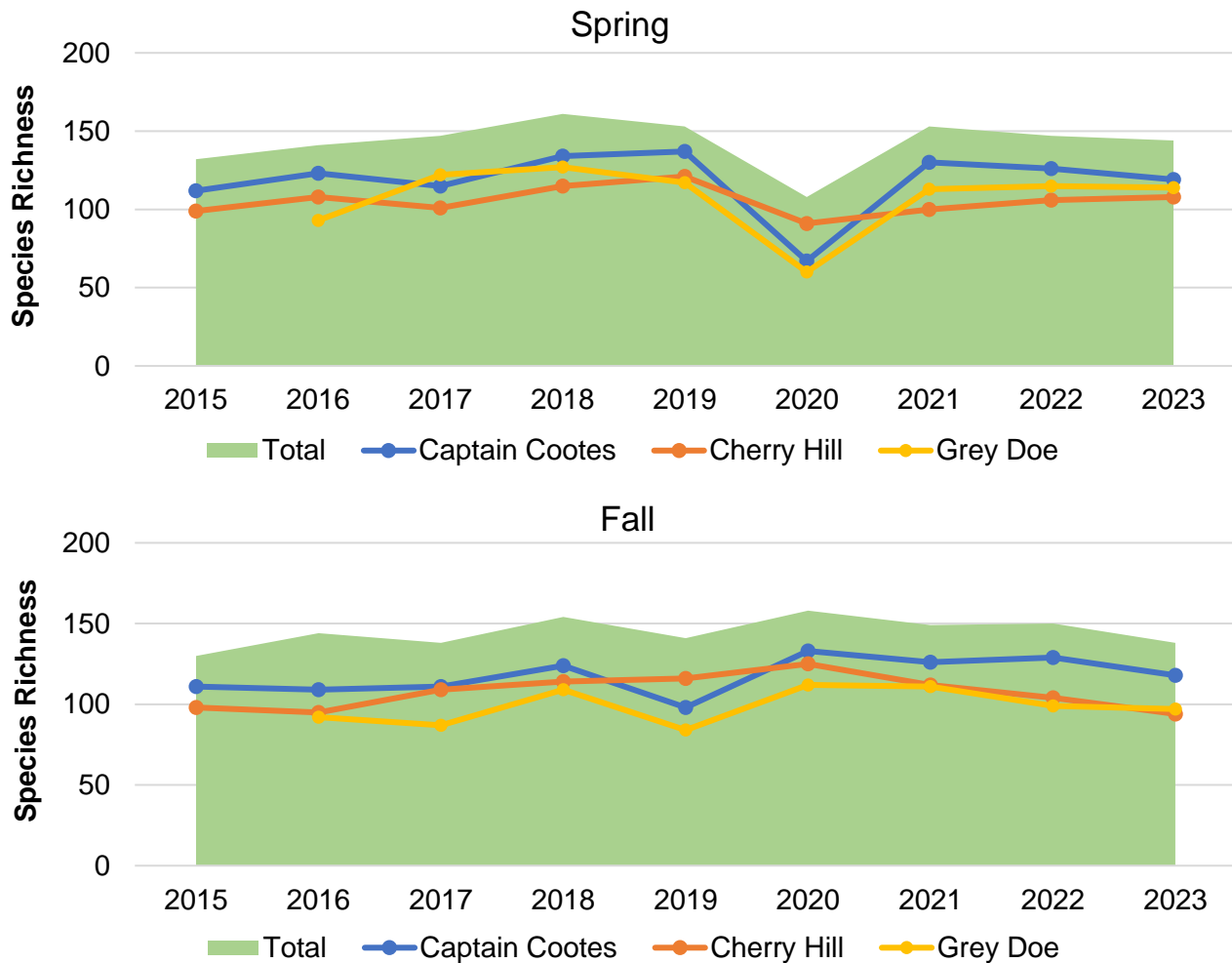


Figure 13: Species richness by season from 2015-2023 Captain Cootes, Cherry Hill, and Grey Doe transects.

Results of the Shannon-Weiner Diversity Index are variable (Figure 14). Overall, diversity in the fall season has trended upward by 11.6% while spring diversity has decreased by 2.1%. Captain Cootes saw the largest drop in spring diversity by 13.6% while fall increased by 14.9%. Cherry Hill has seen minimal changes with a slight decrease in fall by 2.6% and an increase in spring by 5.5%. Grey Doe has seen a large increase in fall diversity up 11.1% while spring remains relatively unchanged. Diversity on average is lower in the fall than in spring, due to the lack of evenness across species, despite there being more species present. Fall tends to see more species because birds tend to take more time and make more stopovers on the migration south than they do in the spring when they are racing to the breeding grounds. Therefore, some birds may not be detected in the spring if they fly by without stopping. The fall season also sees more frequent windstorms, which can bring in rare birds who may not normally be around or stop at RBG.

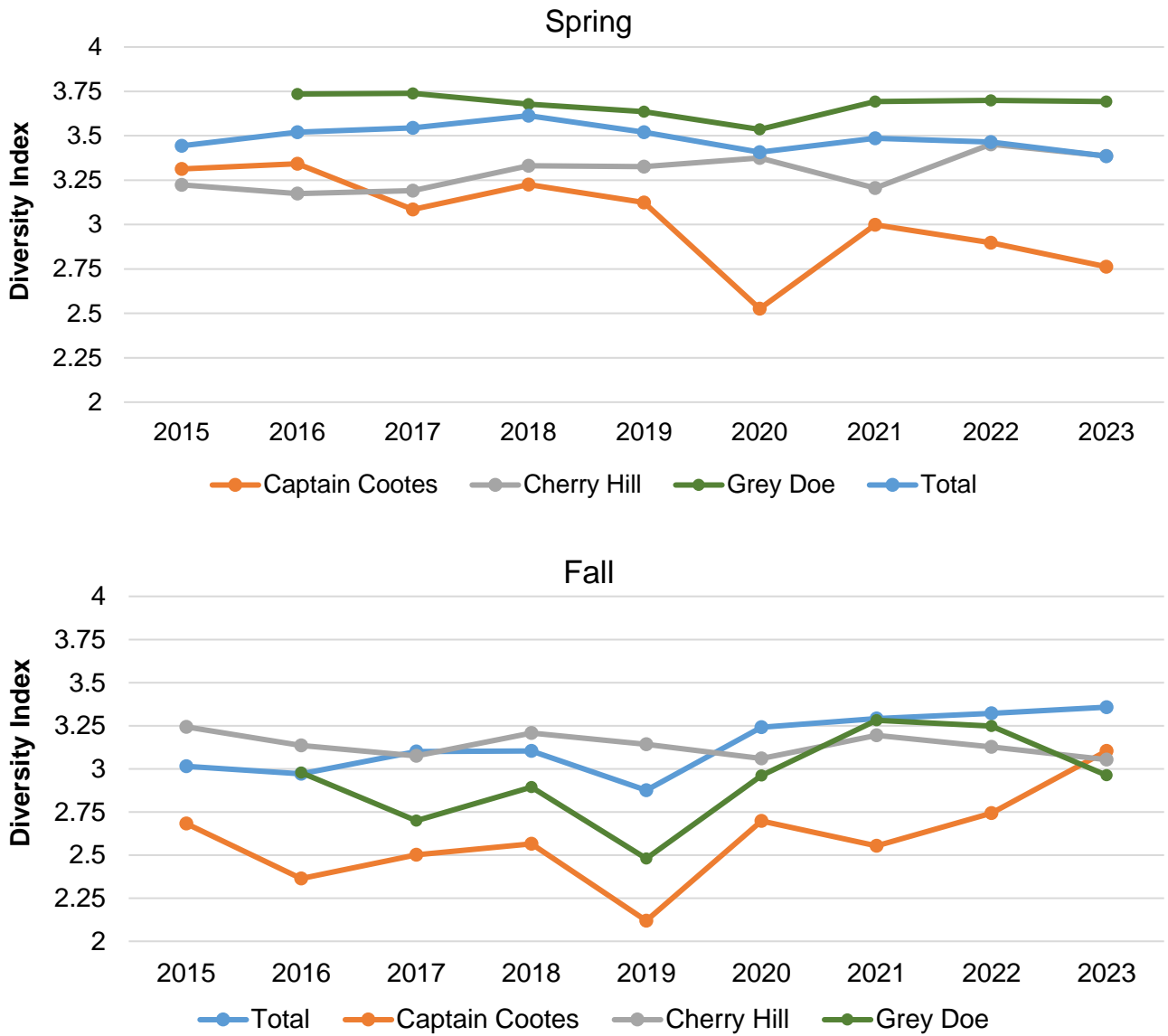


Figure 14: Diversity using the Shannon Weiner index by season across Captain Cootes, Cherry Hill, and Princess Point transects 2015-2023.

5.0 Discussion

Overall, the effort of volunteers to capture this information has been extraordinary during the 9-year period of 2015-2023. The results reflect the strategic location of the area as it pertains to migratory birds, as well as the dominance of the marsh habitat, and basis for the migratory bird habitat protection in the area over a century ago. A total of 266 species have been detected during the 9 years of spring and fall surveys, with the Double Crested Cormorant, the most often and easily observed. Large flocks of staging cormorants often exceed 1,000 individuals during fall migration. This number has been notably declining in recent years for factors mostly likely occurring outside the RBG location.

The Double Crested Cormorant was a rare visitor to the location 30 years previous (Curry 2006) and only established a local nesting population in the 1990s. It is one of many bird species formerly affected by DDT. Ongoing restoration of the marsh habitat from murky open water back to a mix of aquatic vegetation is also likely to further shift the dominance of the waterbird species in the coming years as the large areas of totally degraded open water disappear. In addition, the associated positive transformation of the insect community as marsh habitat recovers is also anticipated to dramatically affect multiple dimensions of bird migration behaviour and specifically insectivore species. In addition, the return of multiple once extirpated large bird species is also likely to have a notable effect on migratory bird behaviour. Birds in this recovering group currently included Bald Eagles, Osprey, Trumpeter Swan, Wild Turkey and Common Raven.

Wetland and open water habitat users make up about 47% of all detections. After wetland users, the most common habitat guilds are generalists and forest generalists, making up about 40% of all detections. The most significant change among taxon is happening to Tits, Chickadees and Titmice, largely due to the downward trend of 33.4% in Black-capped Chickadees since 2015. Warbler detections are increasing but they are still present only in low numbers, averaging just 1,829 detections per year and a relative abundance of 2.4%. A total of 22 species-at-risk have been recorded, the most common being the Barn Swallow (66% of all detections), Eastern Wood-pewee (14%) and the Bald Eagle (9%). The majority of Chickadees are thought to be onsite year-round resident birds with the local population in decline. Factors affecting this include the return of many predator bird species due to external factors, as well as disease and excessive urban animals raiding nests, such as raccoon. These factors are a direct outcome of excessive wildlife feeding and off hours drop offs of “nuisance” urban area animals at RBG nature trail access parking lots.

5.1 Comparison to Terrestrial Bird Surveys at RBG from 2008-2022

All comparisons in this section have been made using the breeding bird data analysis within RBG Report No. 2023-9 by J. Hamilton.

By first appearances, many species or guilds are fluctuating more significantly within migratory bird surveys than breeding bird surveys. There are a couple of likely reasons for this. First,

breeding bird surveys at RBG began in 2008, which provides 7 additional years of data in comparison to Long Watch. These additional years create a more robust statistical analysis and can account for outliers or short-term fluctuations more accurately. Second, sampling skill and effort have remained more consistent during breeding bird surveys as they are completed the same number of times year to year, at approximately the same dates, by the same staff.

Warblers represented a very small number of detections during Long Watch surveys. Warblers are known to be heavily impacted by climate change, unseasonal weather, and habitat loss (Rosenburg et al., 2019; Pham et al., 2022). At RBG, warblers have been declining during terrestrial bird monitoring surveys throughout the property and many species that could breed at RBG do not.

Black-capped Chickadees are experiencing a significant decline for being one of the most common species recorded, having trended down 37.5% since 2015. This is mirrored by a slight decline in detections during breeding bird surveys. Long Watch transects have a significant coverage of Black-capped Chickadee hot spots, such as Grindstone Marsh in Hendrie Valley where there is a large amount of wildlife feeding (Peirce, 2019). Therefore, the decline of this species is both surprising and alarming.

Interior forest birds, while still low in numbers, are increasing much more during the migratory season than they are during the breeding season. This indicates that the increase seen during migration is not indicative of an improving interior forest habitat, as the habitat requirements or preferences for many species likely differ between breeding season and migration (Archer et al., 2019). An increase of interior forest birds would need to be seen consistently during the breeding season to indicate improving interior habitat at RBG.

Shrubland birds are also seeing slight declines in the number of detections during breeding bird surveys. As aforementioned in section 4.4.2, evidence from forest monitoring shows that the shrub layer within forests around Cootes Paradise are maturing and reaching unsuitable heights for many species. An additional stressor during breeding season is invasive species removal can reduce the number of shrubs available for birds to nest in while waiting for the recolonization of native shrubs.

Interestingly, Long Watch detected an increase of 20.6% in the relative abundance of generalist species since 2015, while RBG's terrestrial bird surveys have observed a decrease of 4.6%. The decline of generalist species during the breeding season can be attributed to corresponding declines of American Goldfinches, Northern Cardinals, and Cedar Waxwings property wide. However, during the migratory season, each of these species have seen increasing trends between 24 and 47%.

Diversity is, on average, higher during the breeding season than the migratory season. During breeding bird surveys, average diversity measurements across the property were between 3.35 and 3.66. During Long Watch, diversity estimates from Captain Cootes, Grey Doe and

Cherry Hill transects average between 2.92 and 3.36. This is likely due to a combination of high numbers of waterfowl and migratory vagrants which skew species evenness.

More species-at-risk have been identified during Long Watch surveys than during terrestrial bird surveys at RBG. Since 2010, a total of 9 species-at-risk have been recorded during terrestrial bird surveys. These include Acadian Flycatcher, Bald Eagle, Barn Swallow, Bobolink, Chimney Swift, Common Nighthawk, Eastern Meadowlark, Eastern Wood-Pewee, and Wood Thrush. Amazingly, since 2015 Long Watch has recorded 22 species-at-risk using RBG as stopover habitat. This difference in detections is to be expected, as many species-at-risk breed at latitudes north of RBG, or in habitats not covered by terrestrial breeding bird surveys. A full list of the additional species-at-risk detected during Long Watch surveys can be found in 9.6 Appendix F: Species-at-Risk.

5.2 Impacts of Climate Change

Climate change is impacting species globally across all taxa and trophic levels. For birds, climate change has impacted migration through increased storms, increase in wildfires, unusual temperatures, and phenological mismatch in insect emergence to arrival/departure (NASA, n.d.; Carey, 2009).

Birds are vulnerable during migration to severe weather events, especially over large bodies of inhospitable terrain such as water and desert. Sudden shifts in winds, or the advent of storms can result in catastrophic mortality for birds (Newton, 2007). In North America, sudden storms over the Gulf of Mexico have resulted in the mortality of tens of thousands of individuals (Newton, 2007). As climate change continues, the frequency of these events mass mortality events are more likely to occur.

In addition to storms, climate change has resulted in unseasonal temperatures during migration, including cooler springs, warmer autumns, and sudden temperature shifts. Cooler springs often result in a phenological mismatch of birds with their prey (Carey, 2009). If birds arrive prior to insect emergence they face starvation. If birds arrive post-emergence, they have missed the peak of insect abundance, reducing available food for nesting chicks. This often results in fewer chicks being raised or chicks being in lower condition (Zhang et al., 2019). Aerial insectivores are particularly vulnerable to starvation from phenological mismatch (Clark & Hobson, 2022). Warmer autumns have been shown to delay migration for some species, leaving them vulnerable to starvation during sudden temperature drops causing dormancy of prey species (Newton, 2007; Brisson-Curadeau et al., 2020). Delayed migration could also have a role in why species richness is higher in the fall at RBG.

Climate change is likely to increase the frequency and severity of wildfires, which can have substantial impacts on migratory and breeding birds (Haider et al., 2019; Irannezhad et al., 2022). Timing of migration, resource acquisition and navigation can all be altered by smoke and fire, meaning some birds are forced to flee an area before they are ready to make the

journey. Lack of nutrition combined with smoke inhalation causing respiratory distress can mean that birds are either dying before they can complete their migration, or they arrive to the breeding grounds and face delays in breeding due to a necessary recovery period (Sanderfoot & Holloway, 2017; Irannezhad et al., 2022). Canada's wildfire season in 2023 was claimed to be the most destructive on record (NRC, 2023a). As of November 2nd 2023, 6623 wildfires had been recorded in Canada, over 1000 more than the 10 year average (NRC, 2023b). The smoke not only plagued much of Canada and the United States during the tail end of the spring migration, but fires in Quebec continued to rage on into July, extending into September in western Canada. Smoke can be seen by satellite covering much of eastern Canada right into October (NASA, 2023).

5.3 Impacts of Invasive Plant Species

5.3.1 Plants

Invasive plant species have both direct and indirect effects on migratory species as they may provide poor quality forage and structural habitat (Stewart, 2021). Native berries typically have higher fat stores than invasive berries which are needed for refueling during migration (Smith et al., 2013; Gallinat et al., 2020). Additionally, many invasive shrubs support fewer insects during spring and fall reducing available prey for migrating birds (Fickenscher, 2014).

Birds in autumn are more likely to forage on native berries first than on invasives, even if invasives are more plentiful (Gallinat et al., 2020). Birds without access to native fruits are forced to eat non-native fruits, often in larger quantities, to gain the fat reserves needed for migration. This often results in the need for more frequent stopovers, or longer stopovers.

Additionally, many invasive species support very few arthropods reducing available forage for migration. The impact of these effects are similar to that of non-native fruits with longer foraging times needed. In extreme cases starvation can occur.

5.3.2 Domestic Cats

Domestic cats are one of the leading causes of native bird mortality in north America (Blancher, 2013; Loss, 2013). Between 100 and 350 million birds are lost each year in Canada to domestic cats (Blancher, 2013). Studies have indicated that migratory birds are 'distracted' as they are seeking resources for refueling and pay more attention to resource acquisition than to predators (Metcalf & Furness, 1984). This leaves them vulnerable to predation from cats.

5.4 Impacts of Window Strikes

Window strikes kill an estimated 16 to 24 million birds per year in Canada alone, with migration being the highest time of mortality (ECCC, 2023). As birds move through the urban landscape, they are unable to see glass or reflective surfaces in the same way humans can. As a result, birds often strike windows trying to reach greenery such as a reflected tree or shrub (ECCC, 2023). Bird strike mitigation tape is essential and proper application is needed for its success (FLAP, n.d.). "Feather Friendly" brand strike mitigation tape is a recent initiative for RBG

facilities and has so far been installed on windows at the Rock Garden Visitor Centre, RBG Main Centre Atrium, and Hendrie Park Tea House. Multiple windows remain for further updates including Nature Interpretive Centre, Raspberry House and propagation greenhouses, to further reduce window strikes within RBG.

5.5 Neonicotinoids and Seed Eating Migratory Birds

Neonicotinoids are a class of insecticides used primarily in agriculture to protect crops from pest species. The three main neonicotinoids approved for agricultural use in Canada are imidacloprid, clothianidin, and thiamethoxam (Government of Canada, 2022). The lethal and sub-lethal effects of these neurotoxic chemicals on insects are heavily studied, namely on bee species. It has been suggested that certain neonicotinoids that will be encountered through foraging, either in contaminated pollen, dust, nectar, or water, can cause death or impairment of normal behaviour. This can include the bee's decision-making abilities including foraging patterns and reduced predatory avoidance (Tan et al., 2014). Since bees are colonial and rely on each other to complete tasks, neurotoxin-induced changes in individual bees' behaviour can greatly impact the colony as a whole (Gill et al., 2012).

More recently, research into the effects of neonicotinoids on wildlife has expanded to birds. The most likely route by which birds are consuming enough neonicotinoid residue to cause harm is through the consumption of treated seed (Roy & Coy, 2020). This is particularly true during spring migration in areas where this coincides with the spreading of treated seeds in fields (Eng et al., 2019). It has been shown that the ingestion of treated seeds by migratory songbirds alters their behavior by reducing their overall food intake, thereby reducing fat stores and body mass (Eng et al., 2019). This can not only delay the start of migration, but increase the amount of time required at stopovers, much like the effects of non-native plants discussed in section 5.3.1 (Eng et al., 2019). Late arrival to breeding grounds due to migration delays can impair reproductive success, however birds exposed to neonicotinoids may not make the correct journey at all. Consumption of treated seed has been shown to heavily impair the navigational ability of sparrows who could not properly orient themselves after as little as a few treated seeds a day (Eng et al. 2017). These findings are something to consider when looking at changes in species composition at RBG. In the future, it may be worthwhile to look at trends in detections of birds likely to consume seed during migration.

6.0 Recommendations

6.1 Wave Study (15+ years)

Studies have indicated that certain migratory species are arriving earlier and leaving later from their breeding grounds (Marra et al., 2005; Brisson-Curadeau et al., 2020). This is likely in response to phenological mis-match where insects emerge earlier than normal and birds arrive at the breeding grounds when insects have already emerged or have failed to emerge.

Species that are not adjusting departure or arrival times are experiencing more severe losses than species that are adapting (Taylor et al., 2016).

While there is significant data accumulation from April to May within this dataset, finding the 'peak' of arrival or departure for any specific species is not currently advised due to the lack of data. Ideally, at least ten years of data should be accumulated before analysis on peak arrival times and shifts are analyzed. A reassessment of these peaks every five years after should reveal species trends in arrival and departure.

Due to the complexity of residency and short-distance migrants, only neo-tropical migrants should be looked at, and due to the number of species, only species of concern or species at risk that migrate through or breed at RBG should be analyzed. Additionally, species detected in low numbers, while important, may not be able to provide enough data for analysis.

6.2 Additional Analysis

A statistically robust analysis of trends requires at least 10 years of data (White, 2019). While the trends identified in this report can certainly be indicative of true events, it is likely that some of the actual quantitative estimates are not a fully accurate portrayal of changes in the migratory birds passing through RBG due to observer skill and day to day varying weather conditions affecting migration behavior. That is not to say the trends identified in this report are not useful, but we cannot say for certain the severity of these changes. Therefore, another trend analysis should be completed when at least 10 years of data have been collected. Long-term monitoring programs such as Long Watch are imperative to our true understanding of factors driving population changes.

7.0 Conclusion

The Long Watch program is a valuable long-term Citizen Science monitoring tool that contributes to our understanding of the changing migratory bird populations and provides quantifiable information to share with visitors. Combined with other flora and fauna monitoring programs at RBG, this data creates a powerful tool to guide future management decisions. It can function as an early warning system as to which species are most vulnerable, and where efforts need to be focused. Similarly, the data has the potential to showcase the positive impacts that restoration efforts have on wildlife populations in differing habitats.

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9.0 Appendices

9.1 Appendix A: Transect Routes



FIGURE A1: CAPTAIN COOTES TRANSECT ROUTE.¹



FIGURE A2: CHERRY HILL TRANSECT ROUTE.¹



FIGURE A3: GREY DOE TRANSECT ROUTE.¹

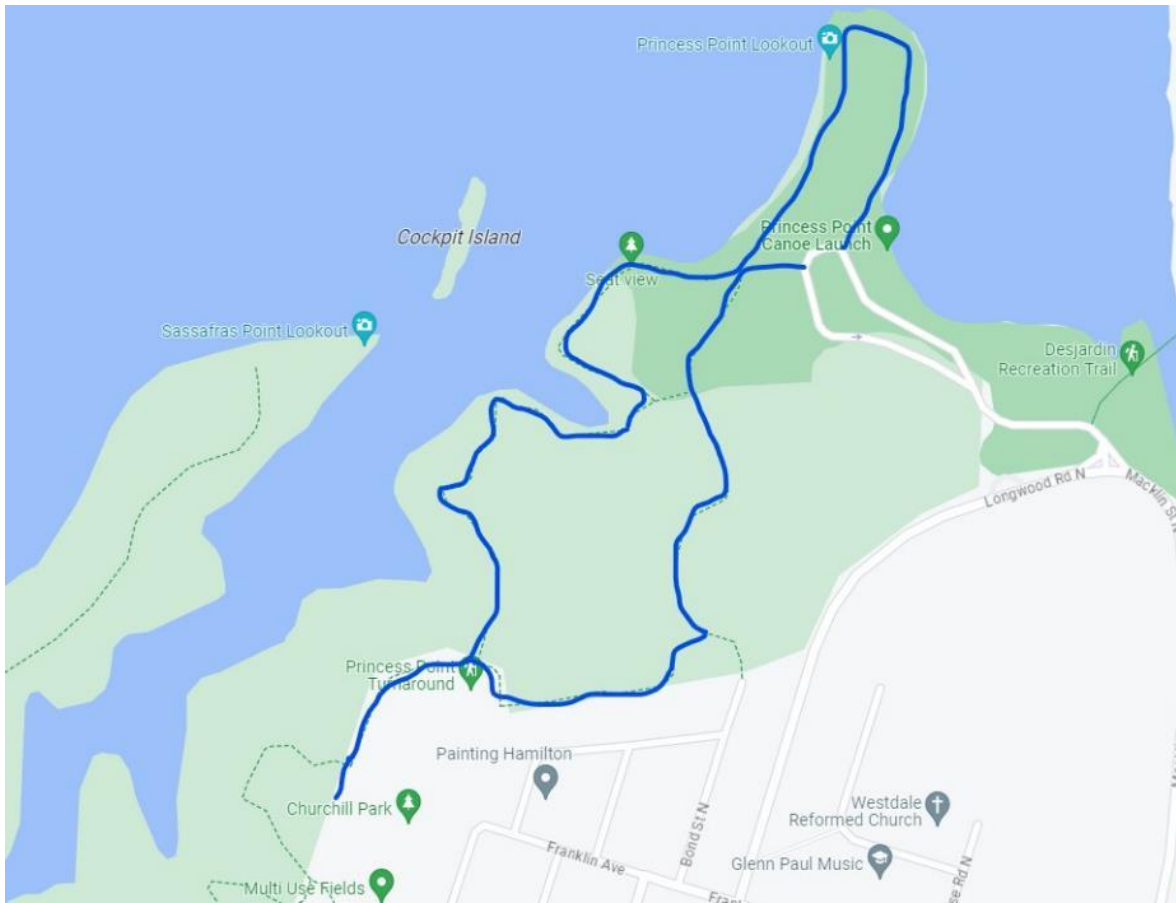


FIGURE A4: PRINCESS POINT TRANSECT ROUTE.

[1Long Watch Website: Transect Maps](#)

9.2 Appendix B: Survey Conditions

TABLE B1: SURVEY CONDITIONS TO BE RECORDED AT THE BEGINNING OF EACH LONG WATCH TRANSECT.

Condition	Parameters
Temperature	Degrees Celsius
Wind Speed	<p>Beaufort Scale:</p> <p>0 = Dead calm. Smoke rises vertically.</p> <p>1 = Direction shown by some smoke drift but not by wind vane.</p> <p>2 = Wind felt on face, leaves rustle. Ordinary vanes moved.</p> <p>3 = Leaves & small twigs in constant motion. Light flag extended.</p> <p>4 = Raises dust & loose paper. Small branches moved.</p> <p>5 = Small trees with leaves begin to move.</p> <p>6 = Large branches in motion. Whistling in telephone wires.</p>
Background Noise	<p>Noise Codes¹:</p> <p>0 = Quiet</p> <p>1 = Some noise , e.g, distant traffic, dog barking, but not distracting.</p> <p>2 = Significant noise but not constant enough to reduce detection.</p> <p>3 = Constant noise, e.g heavy traffic, roaring creek.</p> <p>4 = Unable to hear any call, e.g a passing train.</p>
Visibility	Poor, Fair or Good

Cloud Cover	Percent cover in increments of 10%
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¹ [Long Watch Website: Noise Codes](#)

9.3 Appendix C: Defining Guilds

The purpose of assigning birds found at Royal Botanical Gardens to guilds is to help make more informed decisions about habitat quality and restoration efforts. Guilds allow for the examination restoration on a community scale rather than individual species-specific needs. The decline or increase in certain guilds is also indicative of habitat quality, surrounding land uses, and can highlight stressors before individual populations are impacted to a noticeable extent.

All species detected during terrestrial bird monitoring, and the Long Watch Migratory bird monitoring were assigned guilds. Birds were assigned guilds based on needs during the breeding season, regardless of if they breed in the Hamilton area.

Each bird has been slotted into two guilds: taxon and habitat.

Research for each species was conducted using Birds of the World species accounts (<https://birdsoftheworld.org/bow/home>), and information from All About Birds (<https://www.birds.cornell.edu/home>). All information was retrieved between June 2022 – March 2023.

Birds were sorted taxonomically by using the groups provided by AllAboutBirds (<https://www.allaboutbirds.org/guide/browse/taxonomy>).

TABLE C1: DEFINITION OF HABITAT GUILDS.

Guild	Definition
Habitat	
Forest Edge	Forest Edge birds rely on the transition between forested areas and open ones. They are found on the edges of blown-downs, fires, clearcuts, grasslands, or spruce/bog transitions.
Generalist	This bird will use and breed in a mix of woodlands, grasslands, and occasionally wetlands/urban areas so long as suitable vegetation is found.
Generalist - Forest	This bird will be readily in any wooded areas, from interior forest to forest edge. So long as trees are present in good numbers they can breed there.
Grassland/Rural	These birds require areas of open space such as pastures, farm-fields (non-row crops), restored meadows and grasslands, or other large open areas.
Interior Forest	Mature forest that is at least 100 metres away from major disturbance and edge effects such as roads, fields, and trails. Canopy is usually closed and diverse. Birds that occupy this area are typically shy of humans.
Open Water	Birds usually nest on islands or beaches with abundant access to open water such as large lakes and rivers for foraging.
Secondary Forest	Regenerating forest after blowdowns, fires, or other disturbance, and can include small openings in Interior Forest. Birds rely on the young trees and shrub layer to successfully nest and forage.
Shrubland	Represents thicket and shrubby habitats dominated by shrubs, with few trees. Often areas are regenerating from disturbance or are near riparian areas.
Urban	Suburban homes, skyscrapers, roadways, and other human made infrastructure dominate the landscape. Birds typically rely on these structures to nest in.

Wetland	Birds found in cattail marshes, vernal pools, ponds, wooded swamps, bogs, fens, and rivers.
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9.4 Appendix D: Species List

TABLE D1: SPECIES RECORDED DURING LONG WATCH SURVEYS AT THE ROYAL BOTANICAL GARDENS 2015-2023.

Species	2015	2016	2017	2018	2019	2020	2021	2022	2023
----------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------

Acadian Flycatcher			✓						
Alder Flycatcher			✓		✓	✓	✓	✓	✓
American Bittern						✓	✓		
American Black Duck	✓	✓	✓	✓	✓	✓	✓	✓	✓
American Coot		✓		✓	✓	✓	✓		✓
American Crow	✓	✓	✓	✓	✓	✓	✓	✓	✓
American Golden Plover		✓	✓			✓			
American Goldfinch	✓	✓	✓	✓	✓	✓	✓	✓	✓
American Kestrel		✓	✓		✓		✓		✓
American Redstart	✓	✓	✓	✓	✓	✓	✓	✓	✓
American Robin	✓	✓	✓	✓	✓	✓	✓	✓	✓
American Tree Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
American White Pelican				✓		✓		✓	
American Wigeon	✓	✓	✓	✓	✓	✓	✓	✓	✓
American Woodcock				✓	✓			✓	
Baird's Sandpiper				✓					
Bald Eagle	✓	✓	✓	✓	✓	✓	✓	✓	✓
Baltimore Oriole	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bank Swallow		✓	✓	✓	✓		✓	✓	✓
Barn Swallow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bay-breasted Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Belted Kingfisher	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black-and-white Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black-bellied Plover							✓		

Black-billed Cuckoo	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blackburnian Warbler		✓	✓	✓	✓	✓	✓	✓	✓
Black-capped Chickadee	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black-crowned Night Heron	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blackpoll Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black-throated Blue Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black-throated Green Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blue Jay	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blue-gray Gnatcatcher	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blue-headed Vireo	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blue-winged Teal	✓	✓		✓	✓		✓	✓	✓
Blue-winged Warbler			✓	✓				✓	✓
Bobolink				✓					
Bonaparte's Gull			✓	✓				✓	✓
Broad-winged Hawk	✓	✓	✓	✓	✓	✓	✓	✓	✓
Brown Creeper	✓	✓	✓	✓	✓	✓	✓	✓	✓
Brown Thrasher	✓	✓	✓	✓	✓	✓	✓	✓	✓
Brown-headed Cowbird	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bufflehead	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cackling Goose						✓			
Canada Goose	✓	✓	✓	✓	✓	✓	✓	✓	✓
Canada Warbler			✓		✓	✓	✓	✓	✓
Canvasback	✓	✓		✓	✓			✓	✓
Cape May Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓

Carolina Wren	✓	✓	✓	✓	✓	✓	✓	✓	✓
Caspian Tern	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cedar Waxwing	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chestnut-sided Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chimney Swift	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chipping Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cliff Swallow	✓			✓			✓	✓	✓
Common Gallinule						✓		✓	
Common Goldeneye	✓	✓	✓	✓		✓			✓
Common Grackle	✓	✓	✓	✓	✓	✓	✓	✓	✓
Common Loon	✓	✓	✓	✓	✓	✓	✓	✓	✓
Common Merganser	✓	✓	✓	✓	✓	✓	✓	✓	✓
Common Nighthawk			✓		✓	✓		✓	
Common Raven		✓	✓	✓	✓	✓	✓	✓	✓
Common Redpoll					✓				
Common Tern	✓	✓	✓	✓	✓	✓	✓	✓	✓
Common Yellowthroat	✓	✓	✓	✓	✓	✓	✓	✓	✓
Connecticut Warbler		✓	✓						
Cooper's Hawk	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dark-eyed Junco	✓	✓	✓	✓	✓	✓	✓	✓	✓
Double-crested Cormorant	✓	✓	✓	✓	✓	✓	✓	✓	✓
Downy Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dunlin	✓	✓				✓	✓		✓
Eastern Bluebird	✓	✓	✓	✓	✓	✓	✓	✓	✓

Eastern Kingbird	✓	✓	✓	✓	✓	✓	✓	✓	✓
Eastern Meadowlark							✓		✓
Eastern Phoebe	✓	✓	✓	✓	✓	✓	✓	✓	✓
Eastern Screech-Owl				✓	✓	✓	✓	✓	✓
Eastern Towhee	✓	✓	✓	✓	✓	✓	✓	✓	✓
Eastern Wood-pewee	✓	✓	✓	✓	✓	✓	✓	✓	✓
European Starling	✓	✓	✓	✓	✓	✓	✓	✓	✓
Evening Grosbeak								✓	
Field Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fish Crow			✓			✓			
Forster's Tern				✓					
Fox Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gadwall	✓	✓	✓	✓	✓	✓	✓	✓	✓
Glaucous Gull	✓								
Golden Eagle		✓		✓			✓		
Golden-crowned Kinglet	✓	✓	✓	✓	✓	✓	✓	✓	✓
Golden-winged Warbler				✓		✓			
Gray Catbird	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gray-cheeked Thrush	✓	✓		✓	✓	✓	✓	✓	✓
Great Black-backed Gull	✓			✓	✓				
Great Blue Heron	✓	✓	✓	✓	✓	✓	✓	✓	✓
Great Crested Flycatcher	✓	✓	✓	✓	✓	✓	✓	✓	✓
Great Egret	✓	✓	✓	✓	✓	✓	✓	✓	✓
Great Horned Owl		✓		✓				✓	

Greater Scaup	✓	✓	✓	✓	✓		✓	✓	✓
Greater Yellowlegs	✓	✓		✓	✓	✓	✓	✓	✓
Green Heron	✓	✓	✓	✓	✓	✓	✓	✓	✓
Green-winged Teal	✓	✓	✓	✓		✓	✓	✓	✓
Hairy Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hermit Thrush	✓	✓	✓	✓	✓	✓	✓	✓	✓
Herring Gull	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hoary Redpoll	✓								
Hooded Merganser	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hooded Warbler	✓								
Horned Grebe	✓			✓			✓		
Horned Lark								✓	
House Finch	✓	✓	✓	✓	✓	✓	✓	✓	✓
House Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
House Wren	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hudsonian Godwit				✓					
Indigo Bunting	✓	✓	✓	✓	✓	✓	✓	✓	✓
Killdeer	✓	✓	✓	✓	✓	✓	✓	✓	✓
Least Flycatcher	✓	✓	✓	✓	✓	✓	✓	✓	✓
Least Sandpiper	✓			✓	✓	✓	✓		
Lesser Scaup	✓	✓	✓	✓	✓		✓	✓	✓
Lesser Yellowlegs	✓	✓		✓		✓	✓	✓	✓
Lincoln's Sparrow		✓	✓	✓	✓	✓	✓	✓	✓
Long-billed Dowitcher									✓

Long-tailed Duck	✓				✓				✓
Louisiana Waterthrush				✓				✓	
Magnolia Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mallard	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marsh Wren				✓				✓	
Merlin	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mississippi Kite				✓					
Mourning Dove	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mourning Warbler		✓	✓	✓	✓	✓	✓		
Mute Swan	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nashville Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Neotropic Cormorant						✓			
Northern Cardinal	✓	✓	✓	✓	✓	✓	✓	✓	✓
Northern Flicker	✓	✓	✓	✓	✓	✓	✓	✓	✓
Northern Goshawk		✓		✓			✓	✓	
Northern Harrier	✓	✓	✓	✓	✓	✓		✓	✓
Northern Mockingbird		✓	✓	✓	✓	✓	✓	✓	✓
Northern Parula	✓	✓	✓	✓	✓	✓	✓	✓	✓
Northern Pintail	✓				✓	✓	✓	✓	✓
Northern Rough-winged Swallow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Northern Shoveler	✓	✓	✓	✓		✓	✓	✓	✓
Northern Waterthrush	✓	✓	✓	✓	✓		✓	✓	✓
Olive-sided Flycatcher			✓	✓	✓	✓		✓	
Orange-crowned Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓

Orchard Oriole		✓	✓	✓	✓	✓	✓	✓	✓
Osprey	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ovenbird		✓	✓	✓	✓	✓	✓	✓	✓
Pectoral Sandpiper	✓	✓		✓		✓			✓
Peregrine Falcon			✓	✓	✓	✓	✓	✓	✓
Philadelphia Vireo	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pied-billed Grebe	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pileated Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pine Siskin	✓		✓	✓			✓		✓
Pine Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Purple Finch	✓	✓	✓	✓		✓	✓	✓	✓
Purple Martin		✓	✓		✓			✓	✓
Red-bellied Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓	✓
Red-breasted Merganser	✓	✓	✓	✓	✓	✓	✓	✓	✓
Red-breasted Nuthatch	✓	✓	✓	✓	✓	✓	✓	✓	✓
Red-eyed Vireo	✓	✓	✓	✓	✓	✓	✓	✓	✓
Redhead	✓	✓	✓	✓	✓				✓
Red-headed Woodpecker				✓			✓		✓
Red-necked Grebe									✓
Red-shouldered Hawk	✓	✓	✓	✓	✓		✓	✓	✓
Red-tailed Hawk	✓	✓	✓	✓	✓	✓	✓	✓	✓
Red-winged Blackbird	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ring-billed Gull	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ring-necked Duck	✓	✓	✓	✓	✓		✓	✓	✓

Rock Pigeon		✓	✓	✓	✓	✓	✓	✓	✓
Rose-breasted Grosbeak	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rough-legged Hawk	✓	✓							
Ruby-crowned Kinglet	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ruby-throated Hummingbird	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ruddy Duck	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rusty Blackbird	✓	✓	✓	✓		✓	✓	✓	✓
Sanderling				✓			✓		
Sandhill Crane	✓							✓	✓
Savannah Sparrow			✓			✓			
Scarlet Tanager	✓	✓	✓	✓	✓	✓	✓	✓	✓
Semipalmated Plover						✓	✓	✓	
Sharp-shinned Hawk	✓	✓	✓	✓	✓	✓	✓	✓	✓
Short-eared Owl		✓							
Solitary Sandpiper	✓	✓		✓	✓	✓	✓	✓	✓
Song Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sora					✓	✓	✓	✓	✓
Spotted Sandpiper	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stilt Sandpiper		✓				✓			
Swainson's Thrush	✓	✓	✓	✓	✓	✓	✓	✓	✓
Swamp Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tennessee Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tree Swallow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trumpeter Swan	✓	✓	✓	✓	✓	✓	✓	✓	✓

Tufted Titmouse		✓	✓		✓	✓		✓	✓
Tundra Swan	✓	✓		✓		✓			
Turkey Vulture	✓	✓	✓	✓	✓	✓	✓	✓	✓
Veery	✓	✓	✓		✓	✓	✓		
Vesper Sparrow				✓			✓		
Virginia Rail				✓	✓		✓	✓	
Warbling Vireo	✓	✓	✓	✓	✓	✓	✓	✓	✓
Western Palm Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
White-breasted Nuthatch	✓	✓	✓	✓	✓	✓	✓	✓	✓
White-crowned Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
White-eyed Vireo						✓			
White-rumped Sandpiper					✓				
White-throated Sparrow	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wild Turkey		✓	✓	✓	✓	✓	✓	✓	✓
Willet						✓			
Willow Flycatcher		✓	✓	✓	✓	✓	✓	✓	✓
Wilson's Snipe				✓	✓				
Wilson's Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Winter Wren	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wood Duck	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wood Thrush	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yellow Bellied Sapsucker	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yellow Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yellow-bellied Flycatcher	✓		✓	✓	✓		✓	✓	

Yellow-billed Cuckoo	✓	✓	✓	✓	✓	✓	✓	✓	
Yellow-crowned Night-heron					✓				
Yellow-rumped Warbler	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yellow-throated Vireo	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total Number of Species	157	165	161	181	166	168	170	172	158

9.5 Appendix E: Warbler Detections

TABLE E1: SUMMARY OF ALL WARBLER DETECTIONS BY LOCATION DURING LONG WATCH SURVEYS FROM 2015-2023.

Species	2015	2016	2017	2018	2019	2020	2021	2022	2023
American Redstart	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Bay-breasted Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Black-and-white Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG
Blackburnian Warbler		CH G	CH G	CH G	CH G	CH G	CH G	CG	CHG P
Blackpoll Warbler	C	CH G	CH	CH G	CH G	CH G	CH G	CH G	CGP
Black-throated Blue Warbler	CH	CG	CH G	CH G	CH G	CH G	CH G	CG	CHG P
Black-throated Green Warbler	CH	HG	CH G	CH G	CH G	CH G	CH G	CH G	CGP
Blue-winged Warbler			G	CG				C	HP
Canada Warbler			CH		CH G	CH	CH	C	CG
Cape May Warbler	C	CG	CH G	CH G	CH G	CH	CH G	CG	CHG P
Chestnut-sided Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Common Yellowthroat	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Connecticut Warbler		G	C						
Golden-winged Warbler				G		H			

Hooded Warbler	H								
Louisiana Waterthrush				C				G	
Magnolia Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Mourning Warbler		H	HG	H	CH	CH G	G		
Nashville Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Northern Parula	H	CH G	CG	CH G	CH G	CH G	CH G	CH G	CHG P
Northern Waterthrush	H	CH	H	CH	CH G		H	HG	HGP
Orange-crowned Warbler	CH	C	HG	H	HG	CH G	C	H	HP
Ovenbird		HG	CH G	HG	CH G	CH G	CH G	CH G	CHG P
Pine Warbler	CH	CH G	CH G	CH G	CH G	CH G	CG	CH G	CHG P
Tennessee Warbler	CH	CH G	CH G	CH G	CH G	CH G	CG	CH G	CHG P
Western Palm Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Wilson's Warbler	CH	CH	CH G	CH	CH	H	CH	C	CHG
Yellow Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P
Yellow-rumped Warbler	CH	CH G	CH G	CH G	CH G	CH G	CH G	CH G	CHG P

C= Captain Cootes, H= Cherry Hill, G= Grey Doe, P= Princess Point

9.6 Appendix F: Species-at-Risk

TABLE F1: STATUS DEFINITIONS FOR SPECIES-AT-RISK.

Status	Definition
Special Concern (SC)	“A wildlife species of special concern because of characteristics that make it is particularly sensitive to human activities or natural events.” ¹
Threatened (T)	“A wildlife species that is likely to become endangered if limiting factors are not reversed.” ¹
Endangered (E)	“A species facing imminent extirpation or extinction.” ¹
Extirpated (XT)	“A species that no longer exists in the wild in Canada, but occurring elsewhere.” ¹
Extinct (X)	“A species that no longer exists.” ¹

¹https://www.canada.ca/content/dam/eccc/migration/cosewic-cosepac/94d0444d-369c-49ed-a586-ec00c3fef69b/assessment_process_and_criteria_e.pdf

TABLE F2: STATUS OF SPECIES-AT-RISK DETECTED AT THE ROYAL BOTANICAL GARDENS DURING LONG WATCH SURVEYS 2015-2023.

Species	Status (COSEWIC)*	Status (SARO)+
Acadian Flycatcher	Endangered	Endangered
American White Pelican	Not at Risk	Threatened
Bald Eagle	Not at Risk	Special Concern
Bank Swallow	Threatened	Threatened
Barn Swallow	Threatened	Special Concern
Bobolink	Threatened	Threatened
Canada Warbler	Threatened	Special Concern
Chimney Swift	Threatened	Threatened

Common Nighthawk	Special Concern	Special Concern
Eastern Meadowlark	Threatened	Threatened
Eastern Wood-pewee	Special Concern	Special Concern
Evening Grosbeak	Special Concern	Special Concern
Golden Eagle	Not at Risk	Endangered
Golden-winged Warbler	Threatened	Special Concern
Horned Grebe	Special Concern	Special Concern
Louisiana Waterthrush	Threatened	Threatened
Olive-sided Flycatcher	Special Concern	Special Concern
Peregrine Falcon	Special Concern	Special Concern
Red-headed Woodpecker	Endangered	Endangered
Rusty Blackbird	Special Concern	Special Concern
Short-eared Owl	Special Concern	Threatened
Wood Thrush	Threatened	Special Concern

*Committee on the Status of Endangered Wildlife in Canada (Federal)

<https://laws.justice.gc.ca/eng/acts/s-15.3/page-10.html>

+Species at Risk in Ontario (Provincial)

<https://www.ontario.ca/laws/regulation/080230>

TABLE F3: SUMMARY OF SPECIES AT RISK DETECTIONS AT THE ROYAL BOTANICAL GARDENS DURING LONG WATCH SURVEYS FROM 2015-2023.

Species	2015	2016	2017	2018	2019	2020	2021	2022	2023
Acadian Flycatcher			G						
American White Pelican				C		CG		C	
Bald Eagle	CH	CHG	CHG	CHG	CHG	CHG	CHG	CHG	CHGP
Bank Swallow		CH	G	CG	C		CH	CH	P

Barn Swallow	CH	CHG	CHG	CHG	CHG	CHG	CHG	CHG	CHGP
Bobolink				G					
Canada Warbler			CH		CHG	CH	CH	C	CG
Chimney Swift	C	CHG	CHG	CHG	CHG	CHG	CHG	CHG	CHGP
Common Nighthawk			H		CG	CH		C	
Eastern Meadowlark							G		G
Eastern Wood-pewee	CHG	CHG	CHG	CHG	CHG	CHG	CHG	CHG	CHGP
Evening Grosbeak								G	
Golden Eagle		CG		CG			C		
Golden-winged Warbler				G		H			
Horned Grebe	C			C			C		
Louisiana Waterthrush				C				G	
Olive-sided Flycatcher			G	HG	H	C		H	
Peregrine Falcon			CH	CHG	HG	CG	CG	CG	CHP
Red-headed Woodpecker				C			H		CG
Rusty Blackbird	CH	CH	CHG	CG		CH	CHG	CH	CHG
Short-eared Owl		G							
Wood Thrush	CH	CHG	CHG	CHG	CHG	HG	G	CHG	CHG

C= Captain Cootes, H= Cherry Hill, G= Grey Doe, P= Princess Point

9.7 Appendix G: Species List by Taxon

TABLE G1: SPECIES DETECTED AT THE ROYAL BOTANICAL GARDENS DURING LONG WATCH SURVEYS 2015-2023 SORTED INTO TAXON GUILDS.

Taxon	Species
Cardinals and Allies	Indigo Bunting · Northern Cardinal · Rose-breasted Grosbeak
Cormorants and Shags	Double-crested Cormorant · Neotropic Cormorant
Cranes	Sandhill Crane
Crows, Jays, and Magpies	American Crow · Blue Jay · Common Raven · Fish Crow
Cuckoos	Black-billed Cuckoo · Yellow-billed Cuckoo
Ducks, Geese, and Waterfowl	American Black Duck · American Wigeon · Blue-winged Teal · Bufflehead Cackling Goose · Canada Goose · Canvasback · Common Goldeneye Common Merganser · Gadwall · Greater Scaup · Green-
Falcons and Caracaras	American Kestrel · Merlin · Peregrine Falcon
Finches, Euphonias, and Allies	American Goldfinch · Common Redpoll · Evening Grosbeak
Gnatcatchers	Blue-gray Gnatcatcher
Grebes	Horned Grebe · Pied-billed Grebe · Red-necked Grebe
Gulls, Terns, and Skimmers	Bonaparte's Gull · Caspian Tern · Common Tern · Forster's Tern
Hawks, Eagles, and Kites	Bald Eagle · Broad-winged Hawk · Cooper's Hawk · Golden Eagle Mississippi Kite · Northern Goshawk · Northern Harrier
Hérons, Egrets, and Bitterns	American Bittern · Black-crowned Night Heron · Great Blue Heron
Hummingbirds	Ruby-throated Hummingbird

Icterids	Baltimore Oriole · Bobolink · Brown-headed Cowbird · Common Grackle
Kingfishers	Belted Kingfisher
Kinglets	Golden-crowned Kinglet · Ruby-crowned Kinglet
Larks	Horned Lark
Loons	Common Loon
Mockingbirds and Thrashers	Brown Thrasher · Gray Catbird · Northern Mockingbird
New World Sparrows	American Tree Sparrow · Chipping Sparrow · Dark-eyed Junco Eastern Towhee · Field Sparrow · Fox Sparrow · Lincoln's
New World Vultures	Turkey Vulture
New World Warblers	American Redstart · Bay-breasted Warbler · Black-and-white Warbler Blackburnian Warbler · Blackpoll Warbler · Black-throated Blue Warbler Black-throated Green Warbler · Blue-winged Warbler · Canada Warbler Cape May Warbler · Chestnut-sided Warbler · Common
Nightjars and Allies	Common Nighthawk
Nuthatches	Red-breasted Nuthatch · White-breasted Nuthatch
Old World Sparrows	House Sparrow
Osprey	Osprey
Owls	Eastern Screech-Owl · Great Horned Owl · Short-eared
Pelicans	American White Pelican
Pheasants, Grouse, and Allies	Wild Turkey
Pigeons and Doves	Mourning Dove · Rock Pigeon
Plovers and Lapwings	American Golden Plover · Black-bellied Plover · Killdeer
Rails, Gallinules, and Coots	American Coot · American Crow · Common Gallinule · Sora

Sandpipers and Allies	American Woodcock · Baird's Sandpiper · Dunlin · Greater Yellowlegs Hudsonian Godwit · Least Sandpiper · Lesser Yellowlegs
Starlings	European Starling
Swallows	Bank Swallow · Barn Swallow · Cliff Swallow · Northern Rough-winged Swallow · Purple Martin · Tree Swallow
Swifts	Chimney Swift
Thrushes and Allies	American Robin · Eastern Bluebird · Gray-cheeked Thrush Hermit Thrush · Ovenbird · Thrasher · Yellow Warbler
Tits, Chickadees, and Titmice	Black-capped Chickadee · Tufted Titmouse
Tree Creepers	Brown Creeper
Tyrant Flycatcher	Acadian Flycatcher · Alder Flycatcher · Eastern Kingbird · Eastern Phoebe
Vireos	Blue-headed Vireo · Philadelphia Vireo · Red-eyed Vireo · Warbling Vireo
Waxwings	Cedar Waxwing
Woodpeckers	Downy Woodpecker · Hairy Woodpecker · Northern Flicker Pileated Woodpecker · Red-bellied Woodpecker
Wrens	Carolina Wren · House Wren · Marsh Wren · Winter Wren

9.8 Appendix H: Species List by Habitat

TABLE H1: SPECIES DETECTED AT THE ROYAL BOTANICAL GARDENS DURING LONG WATCH SURVEYS 2015-2023 SORTED INTO HABITAT GUILDS.

Habitat Guild	Species
Forest Edge	American Woodcock · Golden-winged Warbler · Gray Catbird · Least Flycatcher Olive-sided Flycatcher · Swainson's Thrush · Western Palm Warbler
Generalist	American Crow · American Goldfinch · American Robin · Carolina Wren · Cedar Waxwing Chipping Sparrow · Common Grackle · Common Raven · Common Redpoll Red-eyed Vireo · Golden-crowned Kinglet · Hairy Woodpecker · House Wren

Generalist-Forest	<p>Bay-breasted Warbler · Black-and-white Warbler · Blackburnian Warbler</p> <p>Black-capped Chickadee · Blackpoll Warbler · Black-throated Blue Warbler · Blue Jay</p> <p>Blue-gray Gnatcatcher · Blue-headed Vireo · Cape May Warbler · Cooper's Hawk</p>
Grassland/Rural	<p>American Kestrel · Barn Swallow · Black-bellied Plover · Bobolink · Brown-headed Cowbird</p> <p>Common Nighthawk · Eastern Bluebird · Eastern Kingbird · Eastern Meadowlark</p>
Interior Forest	<p>Acadian Flycatcher · Bald Eagle · Black-throated Green Warbler · Broad-winged Hawk</p> <p>Brown Creeper · Gray-cheeked Thrush · Hooded Warbler · Magnolia Warbler</p> <p>Northern Goshawk · Northern Parula · Northern Waterthrush · Ovenbird</p>
Open Water	<p>American White Pelican · Bank Swallow · Bonaparte's Gull · Canvasback · Caspian Tern</p> <p>Common Loon · Common Merganser · Common Tern · Double-crested Cormorant</p>
Secondary Forest	<p>American Redstart · Baltimore Oriole · Black-billed Cuckoo · Canada Warbler</p> <p>Chestnut-sided Warbler · Eastern Phoebe · Great Crested Flycatcher · Indigo Bunting</p>
Shorelines	Fish Crow · Glaucous Gull · Willet
Shrubland	<p>Alder Flycatcher · American Tree Sparrow · Blue-winged Warbler · Brown Thrasher</p> <p>Common Yellowthroat · Connecticut Warbler · Eastern Towhee · Fox Sparrow</p>
Urban	Chimney Swift · European Starling · House Finch · House Sparrow · Rock

Wetland	American Bittern · American Black Duck · American Coot · American Crow American Golden Plover · American Wigeon · Baird's Sandpiper · Belted Kingfisher Black-crowned Night Heron · Blue-winged Teal · Bufflehead · Cackling Goose Canada Goose · Cliff Swallow · Common Gallinule · Common Goldeneye · Dunlin Gadwall · Great Blue Heron · Great Egret · Greater Yellowlegs · Green Heron
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