# Rock Chapel Forest Environmental Status 2024

Mallory Peirce
Tys Theijsmeijer
Natural Lands Department
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Please forward questions to:
Royal Botanical Gardens
P.O. Box 399
Hamilton, ON L8N 3H8

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**Document Description**

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**Front cover photo:** View from one of many scenic lookouts along the Escarpment Trail at Rock Chapel, Mallory Peirce.

# Executive Summary

Royal Botanical Gardens' (RBG) Escarpment Properties spans 110 hectares of preserved nature sanctuary consisting of two areas: Rock Chapel and Berry Tract, both areas contain recently restored grassland ecosystems and forested habitat lining the edge of the Niagara Escarpment. The focus of this report is the environmental status of Rock Chapel's forested ecosystem, which provides refuge for migratory and resident birds, as well as suitable habitat for rare plant species. The index monitoring includes 2 vegetation EMAN plot systems, and 3 OBBA bird monitoring plots. Plot surveys were initiated in 2012 and were last visited in 2024.

Long-term forest monitoring data shows a shifting forest, with both trends of increase as well as decline in the species. The largest basal area tree of Rock Chapel, Red Oak, had the canopy declining nearly 10% since 2012. Similarly, canopy declines in Black Cherry, Shagbark Hickory, and Ironwood have also been observed. Sugar Maple and White Oak have increased by 11% and 10% respectively, in the same timeframe. Sugar Maple is most abundant tree, with approximately 54 trees per hectare. Invasive Norway Maple was present in one monitoring plot. Sugar Maple and Norway Maple were the two trees with the greatest percent change in the understory layer since 2012, with s respective 25.16% and 4.02% increase in cover. The loss of American Witch-hazel in the understory layer by nearly 15% can be explained from a tree blowdown in the plot that decimated a large American Witch-hazel. Species richness in the understory layer has been aided by canopy loss and has increased by eight species since 2012 (3 native and 2 non-native) with 21 species now in the plots but does not include oaks.

Not surprisingly, Sugar Maple was the most abundant species detected in ground vegetation surveys (at 57%), followed by Virginia Creeper (16%) and Choke Cherry (15%). Of the nine species detected in ground vegetation surveys, two were non-native (Amur Honeysuckle and Common Buckthorn). Choke Cherry had the highest relative cover (68%) in 2024, where as Garlic Mustard had the highest relative cover in 2012 (36%). Garlic Mustard was not observed in either forest monitoring plot at Rock Chapel in 2024, which continues to support the decline of Garlic Mustard in all RBG's forest monitoring plots. Due to the summer timing of the survey the spring ephemerals are not captured.

Of the 27 bird species detected in Rock Chapel's forested bird monitoring plots, the Blue Jay was the most abundant species (18% of all observations), and notable shift from former surveys. Wood Thrush detections continue to decline between 1% and 2% annually since 2019 (except for 2021). Detections of Wood Thrush, a Species at Risk (Endangered Status) peaked in 2016 and 2018, when 4 and 5 individuals were observed at one time. Continued monitoring is required to determine definitive trends.

Continued invasive species management is required at Rock Chapel to combat on-going threats to forest community; primary targets include continual invasive shrub removal on the plateau, as well as innovative methods for controlling Dog-strangling Vine that blankets the face of the Escarpment. Vigilant efforts should be made for early detection of nearby ecological threats (i.e. Oak Wilt) to ensure rapid response measures are implemented. Positive response to targeted invasive species removal around Species-at-Risk plants has been observed, supporting continued efforts to improve habitat.

Climate Change-induced range shifts should be considered in future reforestation plantings to increase resiliency and ecological vigor, not just at Rock Chapel, but across RBG's nature sanctuaries. Persistent extreme weather events and increased anthropogenic utilization will continue to place pressure on the ecological integrity of Rock Chapel's Forest.

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# Introduction

Royal Botanical Gardens' (RBG) Escarpment Properties spans 3km length of the escarpment and 110 hectares nature sanctuary, but with a former history of agricultural on the plateau lands. The overall area consists of two sites: Rock Chapel and Berry Tract. Both locations contain forested habitat along the Niagara Escarpment, as well as restored native grassland ecosystems. The focus of this report will be on the forested ecosystem at the Rock Chapel Nature Sanctuary.

The Rock Chapel forest is a thin ribbon of forest that wraps around the talus slope of the Niagara Escarpment, with forest above and below the slope. The lower portion of forest is lined by railway and urban residential neighbourhoods to its south. Northwest of the forest edge are newly restored native grassland habitats in the former agricultural fields. Rock Chapel Nature Sanctuary is part of the Niagara Escarpment, a UNESCO World Biosphere Reserve, a provincially designated Area of Natural and Scientific Interest (ANSI) and an Environmentally Sensitive Area within the Hamilton region.

Rare plant species have been identified within the Rock Chapel Forest, including Canada's largest known population of Red Mulberry (*Morus rubra*), a Species-at-Risk listed as Endangered both provincially and federally. Rare plant presence at Rock Chapel has resulted in numerous efforts to remove invasive species from the landscape as part of sustainability plans. Dog-strangling Vine (*Vincetoxicum rossicum*), Garlic Mustard (*Alliaria petiolata*), Common Buckthorn (*Rhamnus cathartica*), Multiflora Rose (*Rosa multiflora*), ornamental honeysuckles (*Lonicera sp.*) have all been heavily targeted and removed in past removal projects. These species still exist on the landscape in abundance and will need continued attention before they can be eliminated completely.

Rock Chapel also provides refuge for migratory and breeding birds, alike. Numerous migratory species pass through the sanctuary seasonally, and species that breed in the area utilize Rock Chapel's forest to raise their young. Ideal habitat for the Endangered status Wood Thrush is present at Rock Chapel, and this species is repeatedly detected during bird monitoring surveys.

Two long-term monitoring programs have occurred at Rock Chapel for more than a decade, providing insight into changes within the plant and bird communities within the forest. RBG uses methods described in the Ecological Monitoring and Assessment Network (EMAN) and Vegetation Sampling Protocol (VSP) to inventory plant species within Rock Chapel's forest. When combined, these two sampling techniques provide a glimpse into how the forest is changing over time and will alert ecologists of forest decline within the nature sanctuary. Used in conjunction with bird monitoring results, a more complete picture of the environmental condition of the Rock Chapel forest can be derived. These results are used to propose recommendations regarding restoration projects and/or land management and protection needs to ensure the ecological integrity of the forest.

# Methods

This report includes data collected through forest monitoring and bird monitoring surveys, of which methods for each are described below. There are currently eighteen 20 x 20 metre permanent long term forest monitoring plots established across RBG's nature sanctuaries. Six plots can be found in Hendrie Valley, two on the Escarpment Properties (the focus of this report), five on the north shore of Cootes Paradise, and five are located on the south shore of Cootes Paradise. The surveys were undertaken during the summer period, and thus spring ephemerals present were not captured.

## Long Term Forest Monitoring

Forest monitoring surveys follow the Ecological Monitoring and Assessment Network (EMAN) protocols and have been conducted at Rock Chapel in 2012, 2019, and 2024. Data is collected from all forest's layers (canopy tree/tree, understory, ground vegetation, and forest floor) to track any changes to the forest over a long period of time. Tree inventory and tree health data was collected from within the entire 20 by 20 metre plots; ground vegetation and forest floor composition data were collected from four 1 by 1 metre quadrats that are within each forest monitoring plot; tree regeneration sampling occurred in five 2 by 2 metre sub-plots, with 4 outside and 1 inside each 20 by 20 metre plot. Tree regeneration surveys record the number of all tree seedlings (16-200 cm tall) and tree saplings (>200 cm tall) within the sub-plots. In 2024, shrubs were included in the 2 by 2 sub-plots to better quantify changes in species of that plant form over time. Additional data was collected using the Vegetation Sampling Protocol (VSP), where all plants that occur within the 20 by 20 metre plot are identified and their percent cover estimated for each species. VSP classifies forest structure differently than EMAN. Under VSP, plants are categorized based on their height at the time of the survey. Hight classes are as follows: 0-0.5 metres, 0.5-2 metres, 2-10 metres and greater than 10 metres. For more details on the forest monitoring survey methods, refer to the *2009 Forest Monitoring Report* (Burtenshaw, 2010) and *Ecological Monitoring and Assessment Network: Terrestrial Vegetation Monitoring Protocols* (Roberts-Pichette & Gillespie, 1999). For more details on VSP methods search Vegetation Sampling Protocol on the University of Toronto Faculty of Forestry webpage. Combining these protocols, RBG obtains more robust and valuable data when looking into forest vegetation trends over time.

## Bird Monitoring Protocol

### *Monitoring Sites*

The site holds three forest monitoring plots, plus other plots in the grasslands. Monitoring sites were initially chosen to correspond with forest monitoring plots which undergo additional vegetation assessments under RBG's Forest Monitoring Program. The purpose was to assess the impact of Btk application to control Spongy Moth outbreaks, but surveys have since evolved to represent the health of terrestrial birds at RBG. These sites focus on terrestrial habitats, including forests with edge effects. Together, the monitoring plots are scattered amongst RBG's nature sanctuaries. During winter 2012, names of the forest monitoring plots, and bird monitoring plots were standardized to unify them; each was given a new name and ID number.

### *Point Count Surveys*

The sampling window ranged from May 31st- July 1st and all plots were visited twice. Point count methodology was based on protocols set by the Ontario Breeding Bird Atlas (OBBA, 2001). The time of day during which a given plot was visited was intentionally varied during repeat visits to eliminate biases associated with time-of-day bird activity levels. A five-minute period of silence upon arrival at the site allowed for nearby birds to adjust to the disturbance caused by surveyors. This time was also used to record the appropriate site information on the monitoring sheet, including the date, time, study plot code, temperature (°C), percent cloud cover, wind strength (Beaufort scale), surveyors present, noise code (with “1” meaning very low noise level and “5” being extremely loud), and other relevant notes. A compass on a smartphone was used to orient the field data sheet towards magnetic north. Following this time of silence was a ten-minute period where all species detected by song/call or visual observation within a 100-metre circular radius from the centre of the plot were recorded. Identification aids and other equipment were used at this time. In rare instances a smartphone could be used to make audio recording of the call of a rare and/or unknown bird. On the data sheet, species were mapped out on a circle, where the centre represented the data recorder, and the edge of the circle represented the plot boundary. Species were placed in the circle based on their direction and approximated distance from the surveyors. If several individuals could be heard, surveyors assumed that multiple birds of the same species were calling only if they were consistently heard calling from distinctly different points (or at the same time). Any species which were visually confirmed were marked with a “v” on the data sheet. Notes were made on breeding behaviour of observed birds and if any nests were present. For more information on Methodology and associated data-collecting biases, please review the Data Collection section in Hamilton (2023).

# Results

## Vegetation Monitoring

### *Canopy Tree Layer*

Table 1 displays the canopy tree results for the 2024 sampling window, including information such as abundance, relative abundance (%), basal area ($m^2$), percent basal area, and tree density per hectare. In total, 34 trees were tagged, measured, and examined for biological and stem defects. There were 7 species found in both monitoring plots, with only one non-native species, Norway Maple, detected. The most abundant tree species was Sugar Maple (*Acer saccharum*), followed by Ironwood (*Ostrya virginiana*), Black Cherry (*Prunus serotina*), and Red Oak (*Quercus rubra*). Sugar Maple comprised of the largest percent basal area (40.89%); however, Red Oak held the second-largest percent basal area with 40.02% over Ironwood (4.67%) and Black Cherry (13.90%). This is not surprising and can be explained through the fact that Ironwood and Black Cherry do not reach a similar mature size to Red Oak, with Red Oak being one of the largest basal area species on RBG property.

*Table 1. Summary of 2024 assessed canopy tree species in two forest monitoring plots at Rock Chapel (EMAN protocol) including basal area, percent basal area, and tree density/ hectare. Non-native species - asterisk.*

| Species Name | Basal Area ($m^2$) | Basal Area (%) | In-plot Abundance | Density (trees/ha) |
|---|---|---|---|---|
| Sugar Maple (*Acer saccharum*) | 6.51 | 40.89% | 13 | 54 |
| Ironwood (*Ostrya virginiana*) | 0.74 | 4.67% | 7 | 29 |
| Black Cherry (*Prunus serotina*) | 2.21 | 13.90% | 6 | 25 |
| Red Oak (*Quercus rubra*) | 6.37 | 40.02% | 5 | 21 |
| Norway Maple (*Acer platanoides*)* | 0.03 | 0.19% | 1 | 4 |
| Shagbark Hickory (*Carya ovata*) | 0.04 | 0.28% | 1 | 4 |
| White Ash (*Fraxinus americana*) | 0.01 | 0.05% | 1 | 4 |
| **Species Richness: 7** | **Native Species: 6** | | **Non-native Species: 1** | |

Using VSP to analyze canopy tree data provides an opportunity to calculate the percent change in relative cover of a particular tree species. Overall, four of the seven identified species in 2024 have declined in relative cover since 2012 (Table 2), with some species losing nearly 10% of their cover in that time-period. Two species (Sugar Maple and White Oak) have increased their relative cover since 2012, while White Ash, surprisingly, has remained the same. Both Sugar Maple and White Oak have increased their relative cover, by 11% and 10%, respectively. The reason is unclear; however, White Oak is a long-lived species and the increase in relative cover may simply be due to tree maturation.

*Table 2. Relative percent cover of all plot canopy species in 2012 and 2024, and change (VSP trees >10m tall).*

| Species Name | 2012 | 2024 | Percent Change |
|---|---|---|---|
| Red Oak (*Quercus rubra*) | 47% | 38% | -9% |
| Sugar Maple (*Acer saccharum*) | 26% | 37% | 11% |
| White Oak (*Quercus alba*) | Not detected | 10% | 10% |
| Ironwood (*Ostrya virginiana*) | 9% | 7% | -3% |
| Black Cherry (*Prunus serotina*) | 12% | 5% | -7% |
| Shagbark Hickory (*Carya ovata*) | 4% | 2% | -2% |
| White Ash (*Fraxinus americana*) | 1% | 1% | 0% |

### *Understory Layer*

In 2024, 21 species of shrubs and small trees were identified in the understory layer using VSP, with 18 native species and 3 non-native species (Table 3). Nine newly occurring species were identified in 2024 compared to 2012, changing the net total by 5 species. (2012-16 species, 15 native and 1 non-native) were surveyed. The relative cover of Sugar Maple increased the greatest since 2012 (25.16%), followed by Norway Maple (4.02%), and Ironwood (3.26%). The increase in Norway Maple relative cover is concerning, as Norway Maple now accounts for just over 6% of the understory layer. Eight new species were identified in the understory layer in 2024, compared to 2012, with seven native species and one non-native species (Multiflora Rose). Species that were detected in 2012 and not in 2024 include Maple-leaved Viburnum, Red Maple, and Shagbark Hickory. Concerningly, the largest decrease in relative cover was observed in American Witch-hazel, a common understory shrub in RBG's forests, with a decline of over 14% cover. Not as surprising is the decline in White Ash cover since 2012, as the Emerald Ash Borer (*Agrilus planipennis*) has pursued ash on RBG property for well over a decade.

*Table 3. Relative cover of understory species (sum of 0.5-2.0m and 2-10m) using VSP across Rock Chapel monitoring plots in 2012 and 2024. Non-native species are marked with an asterisk.*

| Species Name | 2012 | 2024 | Percent Change |
|---|---|---|---|
| Sugar Maple (*Acer saccharum*) | 25.98% | 51.14% | 25.16% |
| Norway Maple (*Acer platanoides*)* | 2.00% | 6.02% | 4.02% |
| Ironwood (*Ostrya virginiana*) | 8.83% | 12.09% | 3.26% |
| Choke Cherry (*Prunus virginiana*) | 9.99% | 10.83% | 0.84% |
| Common Buckthorn (*Rhamnus cathartica*)* | 0.00% | 0.66% | 0.66% |
| American Bladdernut (*Staphylea trifolia*) | 1.60% | 1.81% | 0.21% |
| American Basswood (*Tilia americana*) | 0.00% | 0.06% | 0.06% |
| Black Raspberry (*Rubus occidentalis*) | 0.00% | 0.06% | 0.06% |
| Eastern Poison Ivy (*Toxicodendron radicans*) | 0.00% | 0.06% | 0.06% |
| Gray Dogwood (*Cornus racemosa*) | 0.00% | 0.06% | 0.06% |
| Multiflora Rose (*Rosa multiflora*)* | 0.00% | 0.06% | 0.06% |
| Smooth Serviceberry (*Amelanchier laevis*) | 0.00% | 0.06% | 0.06% |
| Virginia Creeper (*Parthenocissus quinquefolia*) | 0.00% | 0.06% | 0.06% |
| Maple-leaved Viburnum (*Viburnum acerifolium*) | 0.04% | 0.00% | -0.04% |
| Hawthorn species (*Crataegus species*) | 0.80% | 0.06% | -0.74% |
| Red Maple (*Acer rubrum*) | 1.20% | 0.00% | -1.20% |
| Alternate-leaved Dogwood (*Cornus alternifolia*) | 2.00% | 0.60% | -1.40% |
| Red Elderberry (*Sambucus racemosa*) | 1.60% | 0.06% | -1.54% |
| Red Mulberry (*Morus rubra*) | 2.00% | 0.06% | -1.94% |
| Black Cherry (*Prunus serotina*) | 4.00% | 1.81% | -2.19% |
| Common Prickly-ash (*Zanthoxylum americanum*) | 6.00% | 3.61% | -2.39% |
| Shagbark Hickory (*Carya ovata*) | 2.40% | 0.00% | -2.40% |
| White Ash (*Fraxinus americana*) | 10.39% | 4.21% | -6.18% |
| American Witch-hazel (*Hamamelis virginiana*) | 21.18% | 6.62% | -14.56% |
| **Species Richness** | **16** | **21** | |
| **Native Species** | **15** | **18** | |
| **Non-native Species** | **1** | **3** | |

### *Ground Vegetation Layer*

#### Abundance

Nine species were identified and recorded during vegetation surveys using EMAN protocol at Rock Chapel in 2024. Of those species, two are non-native (Amur Honeysuckle and Common Buckthorn). The most abundant species observed was Sugar Maple (57% of all observations), followed by Virginia Creeper (16%) and Choke Cherry (15%). It should be noted that only one species, Choke Cherry, was observed in ground vegetation surveys at EP-RC-2 in 2024; no other plant species were detected (Table 4). Eight other species were observed at EP-RC-1, where Choke Cherry was not detected.

The highest stem count of any species observed during ground vegetation surveys was Sugar Maple seedlings, where 19 were detected in one quadrat at EP-RC-1 (Table 4). The second highest stem count was also observed at EP-RC-1, where 7 stems of Virginia Creeper were counted.

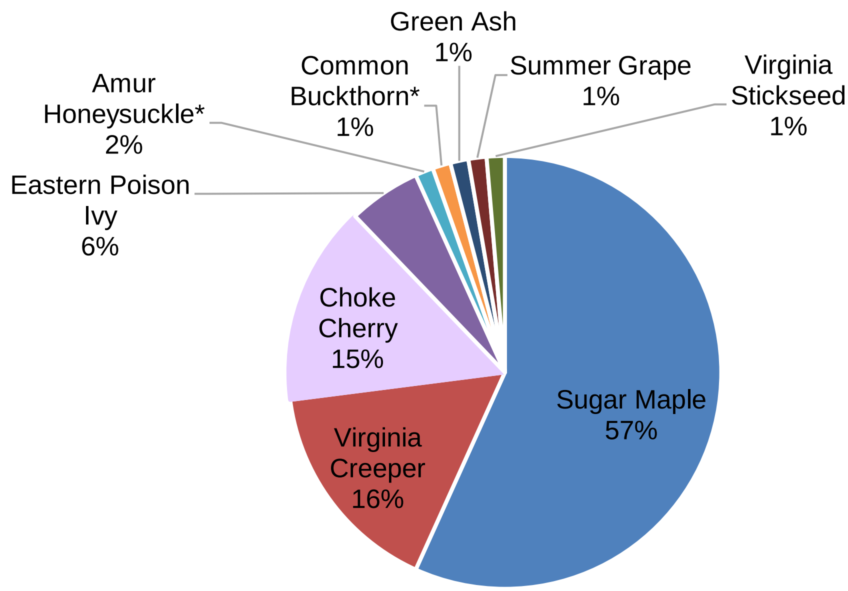


*Figure 1. The nine species observed during ground vegetation surveys (EMAN) and their associated relative abundance observed in 2024 in two monitoring plots at Rock Chapel.*

*Table 4. Minimum and maximum stem/clump counts from all ground vegetation (twelve 1m x 1m quadrats) for Rock Chapel forest plots in 2024 for the most abundant species. Non-native species marked by asterisk.*

| | **EP-RC-1** | | **EP-RC-2** | |
|---|---|---|---|---|
| **Species Name** | **Min** | **Max** | **Min** | **Max** |
| Amur Honeysuckle (Lonicera maackii)* | 0 | 1 | - | - |
| Choke Cherry (Prunus virginiana) | - | - | 1 | 5 |
| Common Buckthorn (Rhamnus cathartica)* | 0 | 1 | - | - |
| Eastern Poison Ivy (Toxicodendron radicans var. radicans) | 0 | 2 | - | - |
| Green Ash (Fraxinus pennsylvanica) | 0 | 1 | - | - |
| Sugar Maple (Acer saccharum) | 1 | 19 | - | - |
| Summer Grape (Vitis aestivalis) | 0 | 1 | - | - |
| Virginia Creeper (Parthenocissus quinquefolia) | 1 | 7 | - | - |
| Virginia Stickseed (Hackelia virginiana) | 0 | 1 | - | - |

## Relative Cover

Figure 2 displays the amount of space (a plant's percent cover) occupied by species. Choke Cherry had the largest amount of cover within the ground vegetation monitoring quadrats, accounting for 68% of the occupied space, followed by Sugar Maple (8%), Green Ash (7%), Virginia Creeper (4%), and Eastern Poison Ivy (4%). All other species accounted for 9% of the available space. In comparison to the relative abundance of species' stem counts, Sugar Maple dropped from the most abundant (stem count) to the second-highest relative cover (8%) and Choke Cherry rose from the third-most abundant (stem count) to the highest relative cover (68%).

Observations from 2024 are much more positive than those from 2012's monitoring results (Figure 2). At that time, Garlic Mustard accounted for more than one-third (36%) of the relative cover in the ground vegetation quadrats, followed by Choke Cherry (13%), Alternate-leaved Dogwood (13%), White Ash (13%), and Jack-in-the-Pulpit (6%). The disappearance of Garlic Mustard during the 2024 sampling window is encouraging

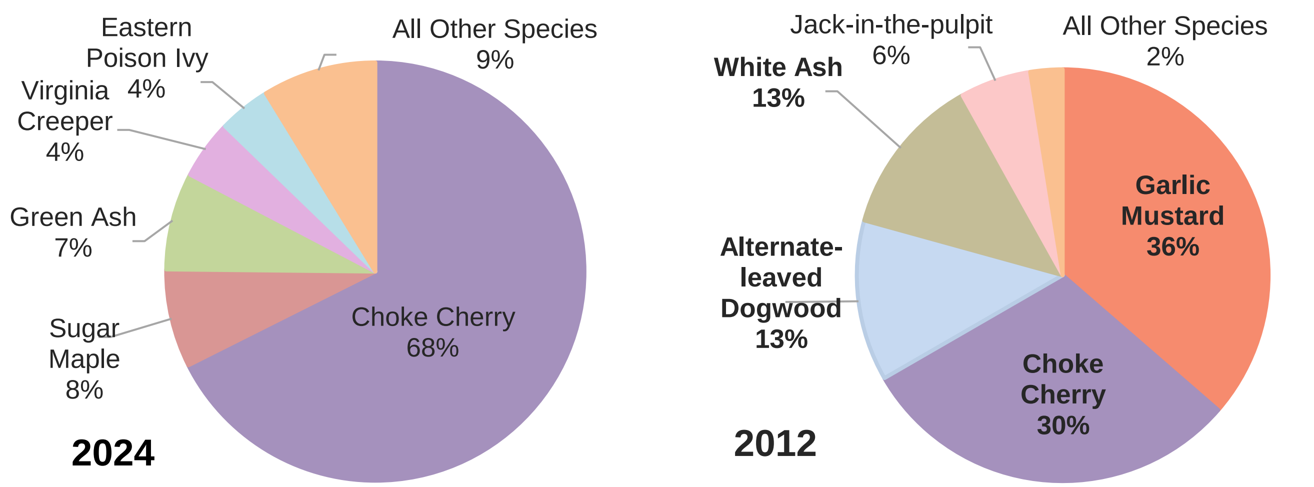


*Figure 2. Five most abundant species observed during ground vegetation surveys (twelve 1m x 1m quadrats) reflected as relative cover by species at Rock Chapel Forest in 2024 and in 2012 (EMAN protocol).*

## Non-native Species

In total, two non-native species (Amur Honeysuckle and Common Buckthorn) were identified during the ground vegetation surveys at Rock Chapel in 2024, with both being observed at EP-RC-1 (Figure 3). At EP-RC-2, there was 100% native species cover, however, there was only one species observed (Choke Cherry). Despite the low species count at both plots, there was still a very high percent relative cover of native species (Table 1); at EP-RC-1 there were 8 species observed and as mentioned above, only one species was detected at EP-RC-2.

*Figure 3. Percent native versus non-native species observed in ground vegetation quadrats for each forest monitoring plot at Rock Chapel Nature Sanctuary, using total individual stems/clump counts for 2024. (Eight plots, EMAN).*

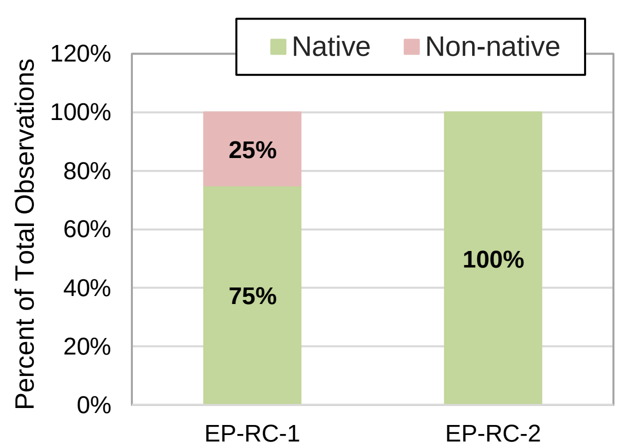

*Table 5. Sum of individual stems/clumps for ground vegetation surveys (EMAN) for each forest monitoring plot at Rock Chapel Nature Sanctuary, 2024. Native and non-native species counts are also presented.*

| Species Name | EP-RC-1 | EP-RC-2 |
|---|---|---|
| Amur Honeysuckle (*Lonicera maackii*) | 1 | |
| Choke Cherry (*Prunus virginiana*) | | 11 |
| Common Buckthorn (*Rhamnus cathartica*) | 1 | |
| Eastern Poison Ivy (*Toxicodendron radicans var. radicans*) | 4 | |
| Green Ash (*Fraxinus pennslyvanica*) | 1 | |
| Sugar Maple (*Acer saccharum*) | 42 | |
| Summer Grape (*Vitis aestivalis*) | 1 | |
| Virginia Creeper (*Parthenocissus quinquefolia*) | 12 | |
| Virginia Stickseed (*Hackelia virginiana*) | 1 | |
| **Grand Total** | 63 | 11 |
| **Native Species** | 6 | 1 |
| **Percent Native Species** | 75% | 100% |
| **Non-native Species** | 2 | 0 |
| **Percent Non-native Species** | 25% | 0% |
| **Species Richness** | 8 | 1 |

As reported in Peirce *et al.* (2024), the presence and abundance of Garlic Mustard within RBG's forest monitoring plots has displayed a general decrease since monitoring began in 2012. This is despite no active management or removal within forest monitoring plots. This trend was observed in 2024 at Rock Chapel, with the absence of Garlic Mustard within the plots. Historically, Rock Chapel has generally had low relative percent cover and of Garlic Mustard but not detected since 2012 (Figure 4).

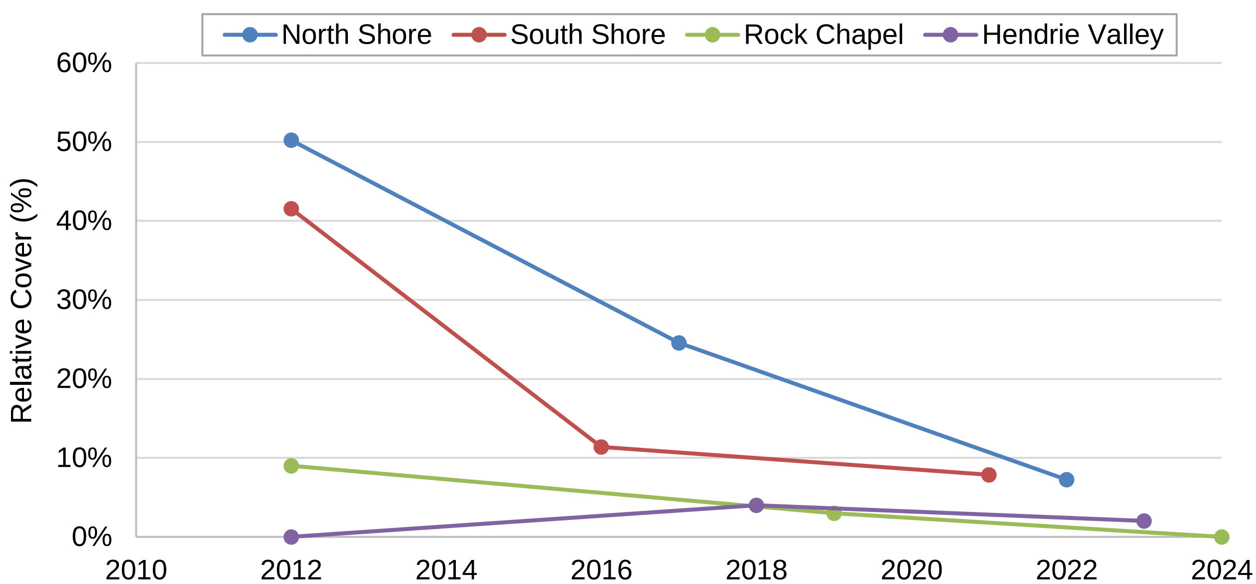


*Figure 4. Relative cover (%) of Garlic Mustard across ground vegetation plots (EMAN) for all four nature sanctuaries since monitoring began in 2012. **NOTE**: Each nature sanctuary has a unique number of long-term forest monitoring plots, and therefore, the sampling effort varies from nature sanctuary to nature sanctuary.*

## Forest Floor Composition

An observation that has been supported for many years through RBG's forest monitoring ground vegetation data is that there is a relationship between leaf litter and bare ground cover (Burtenshaw, 2010; Vincent, 2018; Radassao, 2019). This pattern is once again displayed in the forest floor composition data from Rock Chapel (Figure 5), however fluctuations in leaf litter and bare ground are minimal from 2019 to 2024. Leaf litter has increased significantly since monitoring began in 2012. Woody debris has declined from 14.5% in 2019 to just over 11% in 2024.

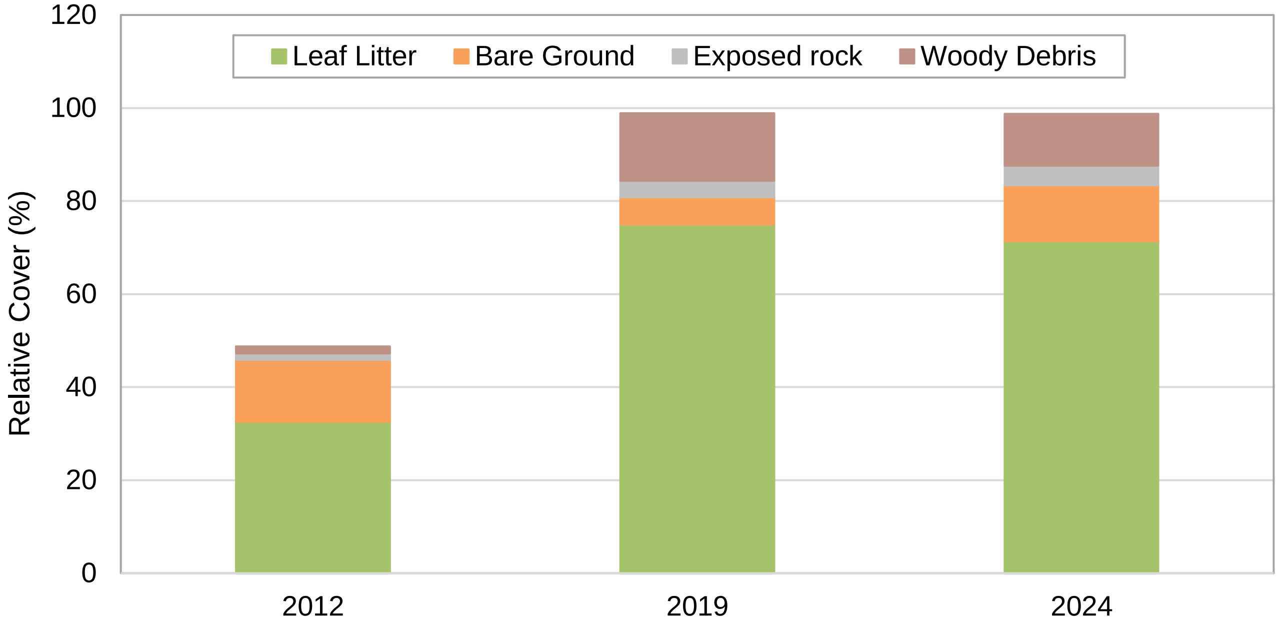


*Figure 5. Average percent cover per 1m x 1m ground vegetation survey quadrat (four per plot) of forest floor composition at Rock Chapel Nature Sanctuary since monitoring began in 2012. NOTE: Forest floor percent cover does not always equal 100%, as the forest floor is composed of many vertical strata. For example, plants take up ground space on the forest floor that would otherwise be covered by leaf litter or bare ground.*

### *Regeneration Surveys*

Tree regeneration surveys are part of the EMAN protocol, and consist of five 2m x 2m sub-plots, four of which are located outside of the official 20m x 20m monitoring plot. This may result in additional species records. Overall, in 2024 at Rock Chapel, White Ash was the most abundant species within the sub-plots accounting for 20% of all observations (Figure 6). This was followed by American Bladdernut and Black Cherry (17%), Common Prickly-ash (11%), and Sugar Maple (9%), and all other species accounted for 26% of all observations. In total, 11 species were captured during the regeneration surveys and a total of 35 seedlings were counted.

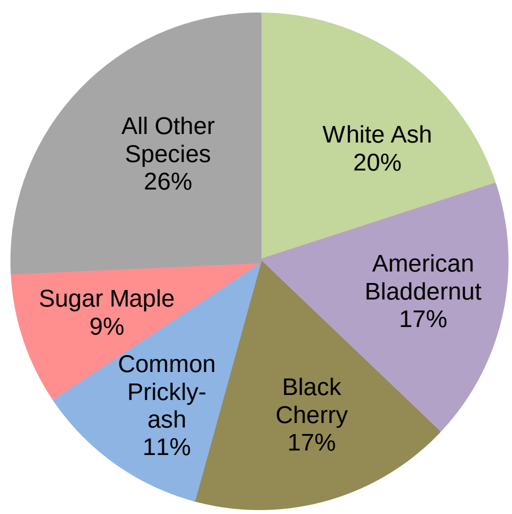


*Figure 6. Relative abundance of the top five tree and shrub species observed in ten 2m x 2m regeneration sub-plots at two forest monitoring plots (Rock Chapel Nature Sanctuary, 2024).*

Saplings (young trees taller than 200cm) were also counted in the sub-plots. In total, nine saplings were observed: 1 American Witch-hazel, 1 Common Buckthorn, 3 Common Prickly-ash, 1 Green Ash, 2 Sugar Maple, and 1 White Ash.

Historically, shrubs were not always included in regeneration surveys but have been recorded in the most recent round of sampling. This may account for lower overall species and stem counts in previous monitoring years. Therefore, this should be considered when looking at historical regeneration sampling. With, however, 2019 and 2012 monitoring years provide a glimpse into how the regeneration pattern has changed in the twelve- and five-year periods.

In 2012, only four species were documented in the regeneration surveys at Rock Chapel (Figure x). Norway Maple accounted for 43% of all observations, followed by White Ash (29%), Common Buckthorn (14%), and Slippery Elm (14%). Between Norway Maple and Common Buckthorn, non-native species accounted for 57% of the relative abundance.

Changes in relative abundance were noted in 2019, when Sugar Maple was the most abundant species at 31%, followed by Common Prickly ash (19%), White Ash (11%), American Bladdernut (12%), and Common Buckthorn (12%) (Figure x). All other species accounted for 15% of all observations. Nine species were detected in regeneration surveys in 2019.

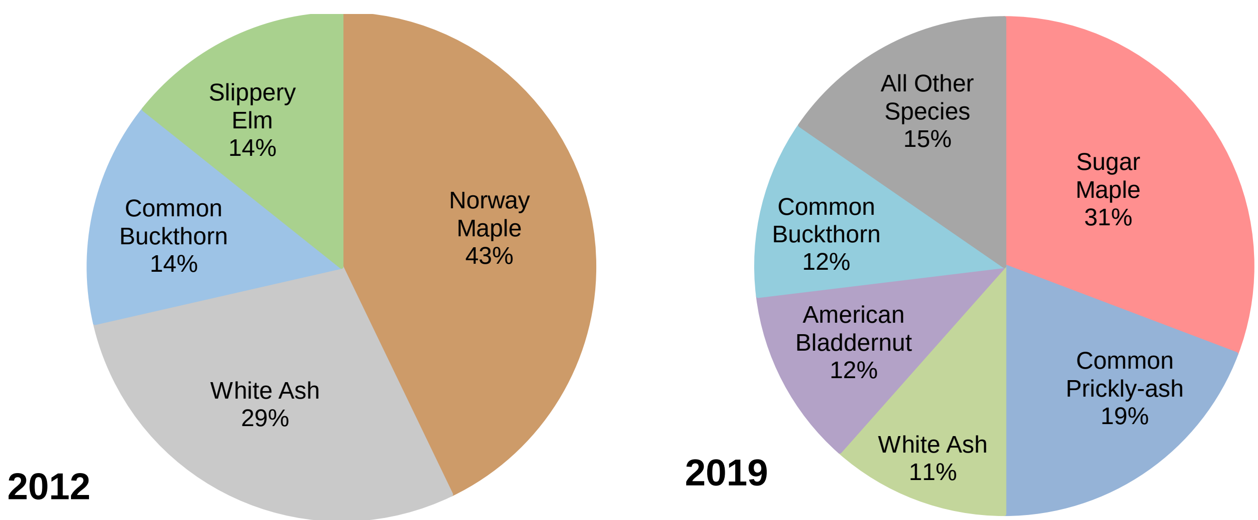


*Figure 7. Relative abundance of the top four tree and shrub species observed in ten 2m x 2m regeneration sub-plots at two forest monitoring plots at Rock Chapel Nature Sanctuary, 2012 & 2019.*

## Bird Monitoring

During the month of June, RBG staff conduct breeding bird surveys across RBG's nature sanctuaries. In Rock Chapel's forest, there are three breeding bird plots, two of which coincide with forest monitoring plots. The results are derived from the three forested bird monitoring plots, unless otherwise stated.

### Species Richness and Relative Abundance

In 2024, across the three surveyed bird monitoring plots within the Rock Chapel forest, there was a total of 27 bird species per visit with an average of 6 detections per visit. The top five most abundant species detected were: Blue Jay (18%), followed by a four-way tie for second place between American

Robin, Eastern Wood-pewee, Great Crested Flycatcher, and Red-eyed Vireo all accounting for 7%. The third most abundant species is again tied between Black-capped Chickadee and Red-bellied Woodpecker, both at 6%. The fourth-most abundant species is Northern Cardinal at 5%, followed by a three-way tie for fifth place between American Crow, Northern Flicker, and Wood Thrush, each accounting for 4%. All other species detected accounted for 27% of all observations.

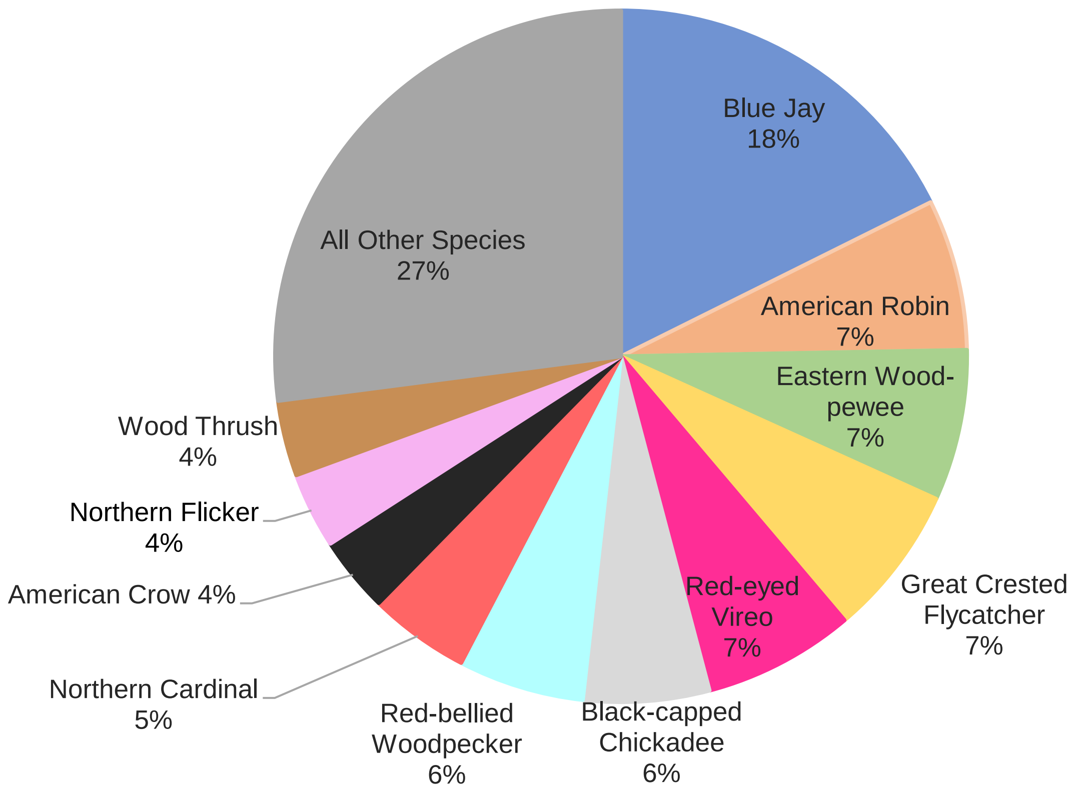


*Figure 8. Relative abundance of top five species observed in Rock Chapel's three forested bird monitoring plots during the 2024 sampling window.*

When comparing species' relative abundance to 2012, only two forested bird monitoring plots at Rock Chapel existed in 2012. Therefore, EP-RC-6 must be removed from 2024's data to ensure that comparisons are equal in sampling effort. In 2012, a total of 18 species were observed during surveys. The most observed species was the American Robin (16%), followed by American Crow (14%), and then tied for third-most abundant species is Wood Thrush and Northern Cardinal, each accounting for 13% of all observations, and all other species accounted for 44% (Figure 9). When compared to the top three most-abundant species in 2024, Blue Jay was the most-abundant species (13%), followed by Black-capped Chickadee (8%), and then tied for third place was American Robin, Eastern Wood-pewee, and Great Crested Flycatcher (7%). All other species accounted for 58% of all observations. Species richness in 2024 was 25 species, which is an increase of 7 species since 2012. Species detected in 2012 that were not detected in 2024 include Baltimore Oriole, Blue-gray Gnatcatcher, Cedar Waxwing, Common Grackle, Killdeer, and Turkey Vulture. Species detected in 2024 but not in 2012 include Black-billed Cuckoo, Blackburnian Warbler, Carolina Wren, Eastern Phoebe, Mourning Dove, Northern Flicker, Red-winged Blackbird, Song Sparrow, and Yellow-billed Cuckoo. It should be noted that the sampling effort in 2012 was 50% more than in 2024 (four visits versus two visits).

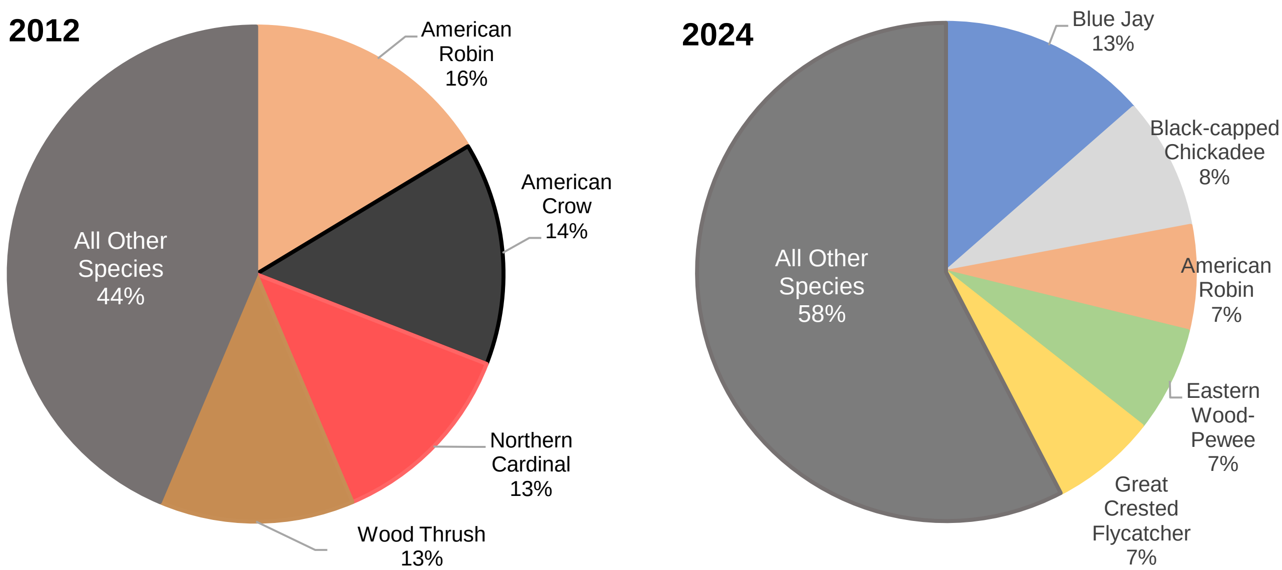


*Figure 9. Relative abundance of top species during bird monitoring surveys at EP-RC-1 and EP-RC-2 in 2012 (left) and 2024 (right) using a two-plot comparison (removing the newly added third plot).*

Species richness has maintained relatively stable over the past five monitoring years at Rock Chapel, ranging from a high of 25 species in 2020 to a low of 17 species in 2023 and back to a high of 25 species in 2024 (Figure 10), which may be explained due to the presence of wildfire smoke that year quieting the birds. The presence of wildfire smoke was also observed within the forests of RBG's three other nature sanctuaries. When compared to RBG's three other nature sanctuaries that contain forested bird monitoring plots, Rock Chapel has the lowest species richness. However, it also has the smallest number of bird plots in the forest thus having a lower sample size than other nature sanctuaries.

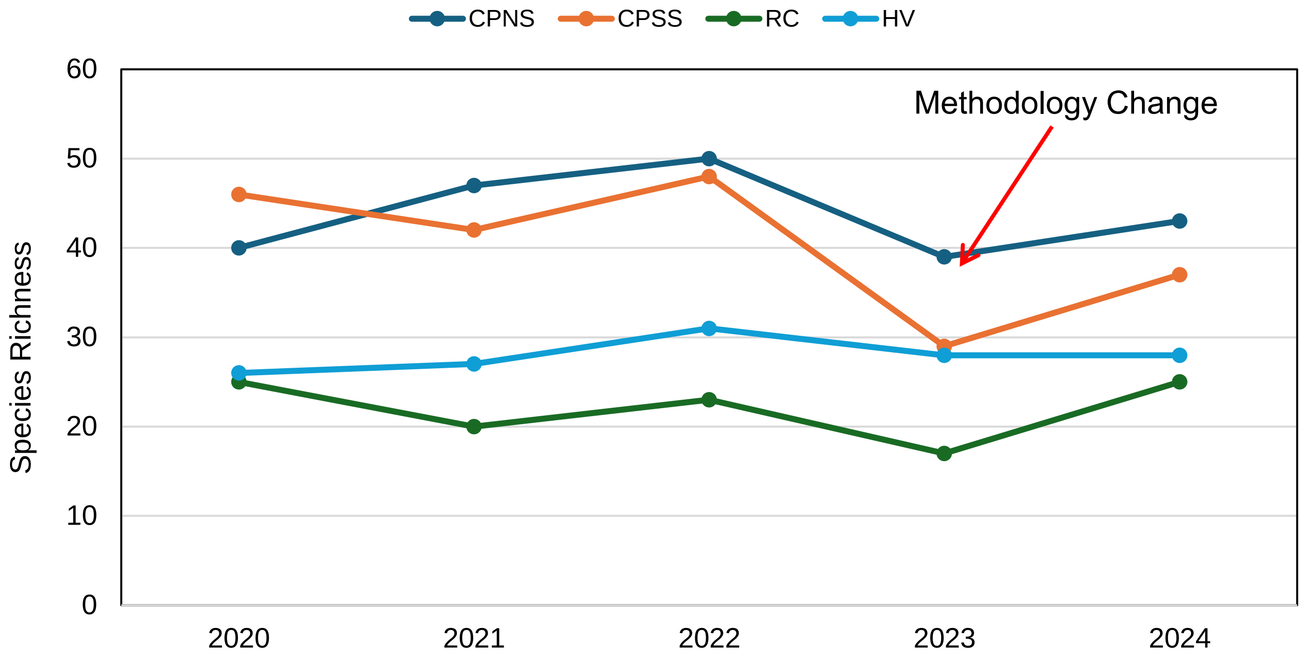


*Figure 10. Species richness across all four nature sanctuaries from 2020-2024.*

### Detections

The trend in the number of bird detections during surveys within Rock Chapel Forest has been notably lower since 2016, when an average of 10 bird detections per plot per visit (Figure 11). Bird detections in 2024 were the same as the number detected in 2012 (6). The lowest bird detections occurred in 2013 and 2014, when an average of 5 birds were detected per plot per visit.

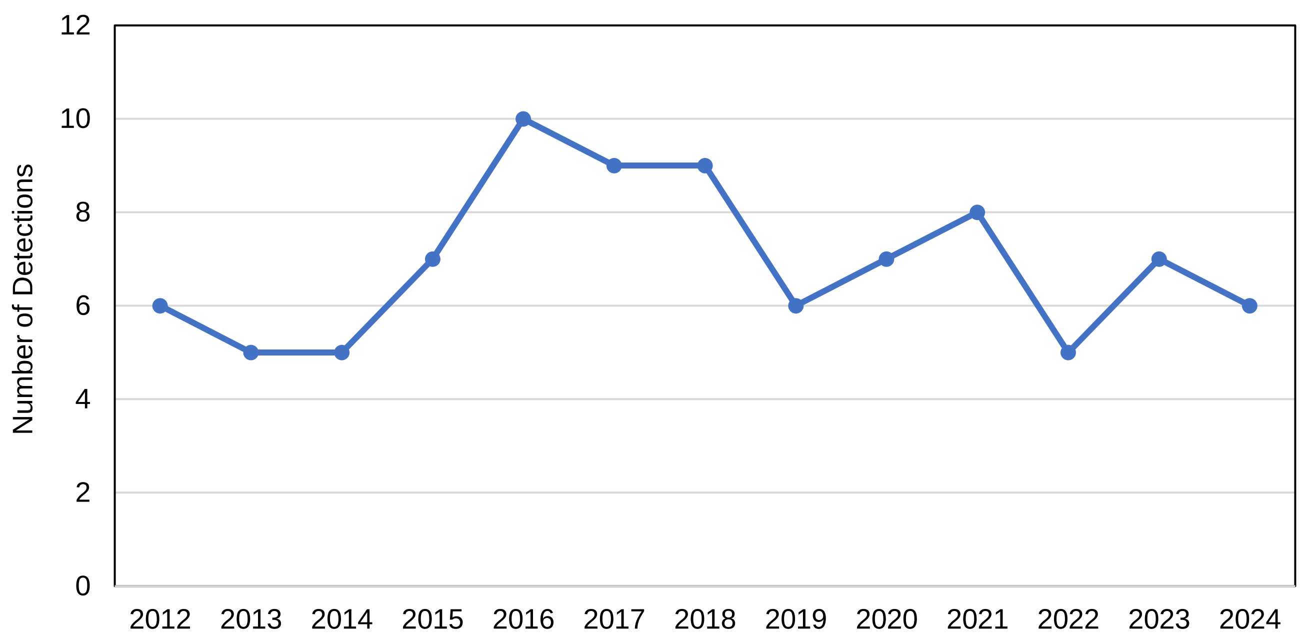


*Figure 11. Number of detections per plot per visit since 2012 at bird monitoring plots within Rock Chapel forest.*

### *Species-at-Risk*

Two Species-at-Risk have been regularly observed at bird monitoring plots within Rock Chapel's forest: Eastern Wood-pewee and Wood Thrush. Overall, RBG's bird monitoring program typically detects more Wood Thrush than Eastern Wood-pewee at Rock Chapel (Figure 12). Maximum Wood Thrush detections peaked between 2016 and 2018 at Rock Chapel, where between 4 and 5 individuals were heard at once during surveying periods. Since that time, lower maximum Wood Thrush detections have been recorded, with an all-time low recorded in both 2023 and 2024. This could be due to a survey methodology change that was implemented in 2023. However, Eastern Wood-pewee maximum counts appear to not be impacted by the methodology change, as maximum count detections have maintained consistent since that time. The maximum count of Eastern Wood-pewees was detected during surveys in 2020, when 3 individuals were observed. There has not been a survey window where neither Wood Thrush nor Eastern Wood-pewee has not been detected.

Nearly every year since 2019 (apart from 2021), there has been a decline in Wood Thrush relative abundance from the previous sampling year. The largest decline abundance in that timeframe occurred in 2020, when Wood Thrush abundance dropped by 3% from 2019. Wood Thrush abundance has continued to decline by either 1% or 2% annually since 2021. Wood Thrush have increased their abundance during three monitoring years, and in three other years, they have maintained their abundance (i.e. 0% change).

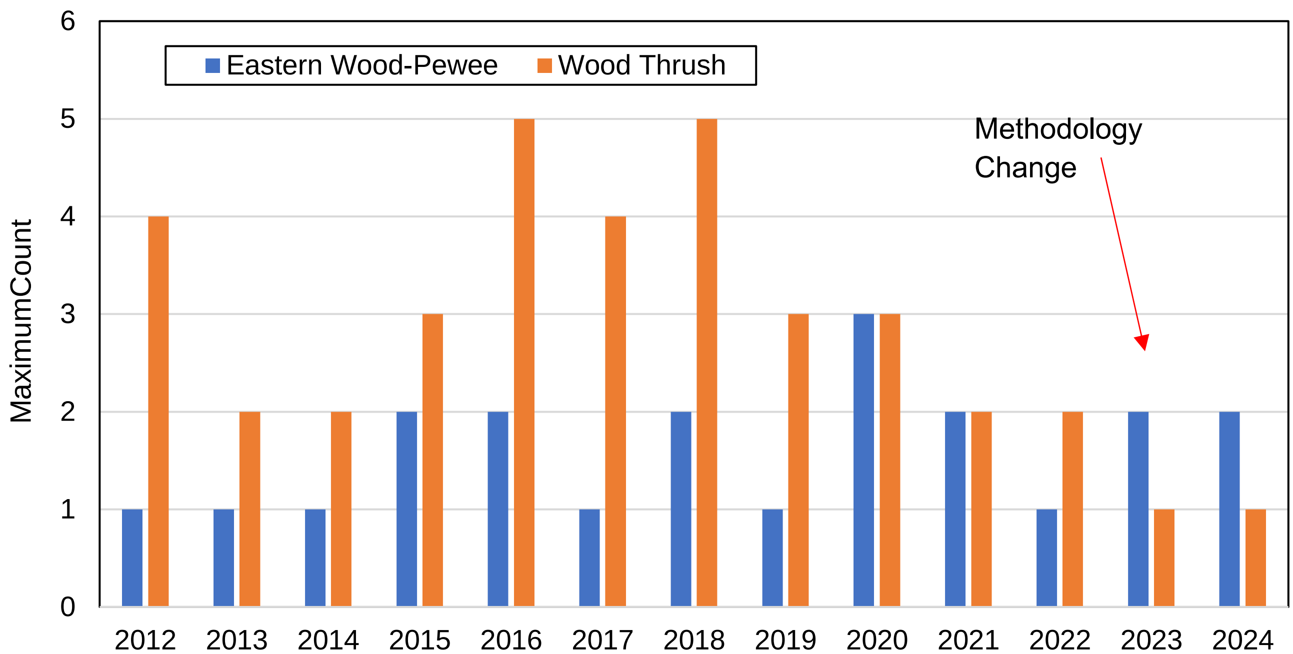


*Figure 12. Maximum count of Wood Thrush and Eastern Wood-pewee during bird monitoring surveys within Rock Chapel's forest from 2012 - 2024.*

# Discussion

## Plant Community

### *Canopy Tree Layer*

The canopy tree layer within Rock Chapel's Forest Monitoring Plots is composed primarily of Sugar Maple, Ironwood, Black Cherry, and Red Oak, all which account for a combined 91% of the relative abundance. Sugar Maple is both the most abundant species (13%) and the largest by basal area (40.89%). Red Oak surpasses both Black Cherry (13.9%) and Ironwood (4.67%) in basal area with 40.02%, slightly lower than Sugar Maple. This is not surprising, as Red Oak is a long-lived, large-growth tree when compared to Black Cherry and Ironwood. It is likely that Red Oaks are representative of some of the oldest trees within the Rock Chapel Nature Sanctuary. The results overall identify a rapidly shifting forest plant community given the period is only 2012 to 2024.

One invasive tree species was detected in one of Rock Chapel's forest monitoring plots in 2024. A mature Norway Maple was found at EP-RC-2. It was recorded within the tree canopy inventory, but then the tree was girdled after assessment. Although affecting the current natural process associated with the monitoring conditions, management of invasive species at RBG is of utmost importance and thus, action was taken to kill the tree and will lead to further removals of this species observed as colonizing the site. For more recommendations on invasive species removal at Rock Chapel, please see the Environmental Stewardship Recommendations at the end of this report for more details.

Comparing results from the 2012 canopy tree assessment (using VSP), the species detected within the canopy layer have relatively stayed the same. No species have been completely lost in the canopy, and only one species has been added, White Oak. It is possible that White Oak was not observed in the canopy layer in 2012 because it did not meet the requirements of being taller than 10 metres in height. Therefore, since that time, the tree has simply grown up into the greater than 10 metre category.

White Oak has increased in cover since 2012, because it was not detected in the canopy layer at that time. Only one other species has increased in relative cover since 2012, that being Sugar Maple. It is concerning that of the seven species detected in the canopy layer, only two have increased in relative cover in twelve years. Four species have declined in relative cover (Red Oak, Ironwood, Black Cherry, and Shagbark Hickory), and one species (White Ash) has maintained its relative cover. White Ash maintaining its 1% relative cover in the canopy layer is intriguing, as Emerald Ash Borer (sci name; hereafter referred to as EAB) has decimated ash trees across RBG property, and throughout Southern Ontario. Therefore, it is likely that the 1% relative cover was maintained due to a young White Ash, that was not killed by EAB, growing up into the greater than 10 metre category.

Red Oak declining by nearly 10% relative cover in the canopy is concerning, however, since 2012, oaks have experienced continued stressors. The largest, and likely most impactful stressor, was the Spongy Moth outbreak that began in 2020, which was only three years after a Fall Canker Worm outbreak. Spongy Moth defoliation was observed not only at RBG, but across Ontario. Severe defoliation of oaks occurred in the spring and summer of 2020, and based on forecasted defoliation for 2021, RBG decided to conduct an aerial spray to control Spongy Moth. Rock Chapel was treated in 2021, and the trees have not experienced severe levels of defoliation since that time. Despite the outbreak, no major death of trees occurred due to the outbreak, however, it is expected that canopies will likely shrink due to stress and branch loss from the outbreak. Moderate rainfall in 2022 and 2023 provided opportunity for oak recovery post-Spongy Moth outbreak. Continued monitoring of Spongy Moth populations should be continued to prevent severe defoliation of oak trees in the future.

### *Understory Layer*

In 2024, 21 species of trees and shrubs were identified in the understory layer using VSP, which is 5 more than 2012. New species in the understory layer in 2024 include: American Basswood, Black Raspberry, Eastern Poison Ivy, Gray Dogwood, Multiflora Rose (non-native), Smooth Serviceberry, and Virginia Creeper. Oppositely, species observed in 2012 but not detected in 2024 include: Maple-leaved Viburnum, Red Maple, and Shagbark Hickory.

Notable species that have increased in relative cover since 2012 include Sugar Maple, Norway Maple, and Ironwood. The most dramatic increase in percent cover was observed with Sugar Maple, which increased by more than 25% relative cover. It is encouraging to note the increase in Sugar Maple regeneration, as the Rock Chapel Forest Monitoring plots are dominated by Sugar Maple. It should also be noted that Norway Maple has increased by 4% cover since 2012, which is concerning and should be monitored.

Another encouraging observation is the increase in Ironwood cover in the understory. Despite only increasing by under 3%, the total cover now stands at just over 12% for Ironwood. As noted previously, Ironwood is a key species in the canopy layer at Rock Chapel. Therefore, its increase in the understory layer is positive as this is an example of Ironwood's natural regeneration.

A notable species that has declined in the understory layer is American Witch-hazel, which has declined by nearly 15% since 2012. It is theorized that this loss is due to a single American Witch-hazel falling victim to a blowdown of mature trees at one of the forest monitoring plots. The blowdown decimated the mature witch-hazel, which would explain the dramatic drop in cover since 2012. Blowdowns are a significantly ongoing issues tied to both increasingly powerful winds and more significantly the loss of large ash trees to Emerald Ash Borer. Specific management of ash has occurred around Red Mulberry trees along the escarpment face, felling large dead trees to prevent further crushing of these individual trees. The effect of the blowdowns are also notable in the plant community with understory species significantly increasing in the monitoring plots as canopy opens up.

One item to note, is that a prominent tree in Rock Chapel's canopy was not detected within the understory layer in 2024. The absence of Red Oak within the understory layer is worrisome, as Red Oak currently occupies 38% of the relative cover in trees greater than 10 metres in height. Therefore, Red Oak recruitment is failing at Rock Chapel. Extensive literature on oak species' recruitment outlines the increased pressure on oak regeneration due to White-tailed Deer (Fei and Steiner, 2007). Acorns account for a large portion of the White-tailed Deer diet, and thus, with unmanaged deer populations in Southern Ontario, the browse pressure on acorns is greatly unbalanced. Therefore, without management of White-tailed Deer populations in Southern Ontario, the pressure on oak recruitment will continue, and oaks will fail to regenerate within the forest community.

### *Ground Vegetation Layer*

For 2024, when ground vegetation data from both monitoring plots is combined, there was a total of 9 species identified (EMAN). Of the 9 species, two were non-native, which means 97% of the stems counted were native species. The most abundant species was Sugar Maple, which is not overly surprising, as Sugar Maple is the dominant tree in the canopy and understory layers. This shows that natural regeneration of Sugar Maple from seedling to sapling to mature tree is occurring at Rock Chapel.

Minimal plant cover is present on the forest floor of Rock Chapel. This is observed not only when examining the diversity of the plant community, but also when calculating the minimum and maximum stem counts. Not surprisingly, Sugar Maple had the highest stem count across vegetation monitoring quadrats (EMAN), with 19 stems counted in one quadrat. All other maximum stem counts were below 8. That is to say that the forest floor is not covered with plant cover. In fact, at EP-RC-2, only one species, Choke Cherry, was observed in the quadrats with a maximum stem count of 5.

The ground vegetation plant cover has changed significantly since 2012, when Garlic Mustard accounted for more than one-third of all plant cover at that time. For reference, Garlic Mustard was not detected in ground vegetation surveys in 2024. This is a positive observation, as RBG ecologists do not actively manage Garlic Mustard populations in Forest Monitoring Plots.

Oppositely, Choke Cherry has greatly increased in cover since 2012, which means native shrub recruitment is occurring within the strata of the forest ecosystem. Ideally, these seedlings will grow up into the understory to boost the native plant cover in that layer.

One native shrub species was lost since 2012, however, as Alternate-leaved Dogwood accounted for 13% at the time, but twelve years later was not detected during ground vegetation surveys. This could be once again attributed to inflated White-tailed Deer populations. Similarly, two other species were in the top five species in percent cover in 2012 but not detected at all in 2024: White Ash and Jack-in-the-pulpit. Both species are native, and their disappearance from the ground vegetation layer should be investigated.

Overall, non-native species' presence was relatively low within ground vegetation plots in 2024. EP-RC-2 had completely 100% native plant cover, however the sample size is incredibly low, as only one species was detected in the quadrats. EP-RC-1 had 75 native plant presence, with only 25% being non-native. Despite small sample sizes in both plots, an urban forest with high percentages of native plant cover in Southern Ontario in 2024 is most certainly a success.

When looking at the relative cover for leaf litter, it has more than doubled in twelve years. As expected, the relationship between bare ground and leaf litter continued to be displayed, as supported in previous years during RBG's forest monitoring surveys (Burtenshaw, 2010; Vincent, 2018, Radassao, 2019). Leaf litter has increased significantly since monitoring began in 2012, despite RBG's nature sanctuaries, amongst the rest of Ontario, experience an intense outbreak of Spongy Moth from 2020-2022. Rock Chapel was treated for Spongy Moth in 2021, which has left three growing seasons for leaves to once again accumulate on the forest floor after trees were severely defoliated in 2020.

Woody debris has also increased in cover since 2012. It is possible that this increase might be resulting from more frequent intense windstorms, causing increasing numbers of branches and twigs to fall to the forest floor.

### *Non-Native Invasive Plants*

The sample of non-native, invasive plants presented within the results of quadrat monitoring do not accurately reflect the intensity and extent of non-native plant presence and cover within Rock Chapel Nature Sanctuary. Only Amur Honeysuckle and Common Buckthorn were detected within vegetation quadrats, both of which are present in mature form at Rock Chapel, as well. However, this data is not complete and is does not accurately represent the invasive species community present at Rock Chapel.

Invasive species present within Rock Chapel's forest include, but is not limited to, Garlic Mustard, Nipplewort, Dame's Rocket, Dog-strangling Vine, Multiflora Rose, Common Privet, Amur Honeysuckle, Common Buckthorn, Japanese Barberry, Norway Maple and Winged Euonymus. These species have been managed at Rock Chapel in localized areas for many years and should continue to be removed to reduce the impact of their spread throughout the forest. One non-native invasive species of grave concern at Rock Chapel is highlighted below.

Dog-strangling Vine (hereafter referred to as DSV) is an aggressive invasive plant that forms dense monocultures, crowding out native plants – including tree and shrub seedlings and saplings. Preferred habitat for DSV includes open habitats, such as meadows or prairies, however, disturbances in the forest canopy layer and the resulting penetration of light to the forest floor, creates habitat suitable for DSV. DSV has allelopathic tendencies, which can rapidly transform ecosystem function. If left unmanaged in a forested ecosystem, DSV has the potential to lower native herbaceous plant diversity and reduce forest regeneration. Continued DSV management at Rock Chapel is highly recommended to avoid negative impacts, such as biodiversity loss, to the forest ecosystem.

### *Yard Waste Dumping: Spreading Invasive Non-native Plants*

Continual spread of invasive species and smothering of native plants is proliferated when neighbouring properties use RBG's nature sanctuaries as compost sites. Yard waste dumping is an unfortunately common occurrence across most of RBG's nature sanctuaries as neighbouring properties are often private residences. This activity promotes the spread, and occasionally, the introduction of non-native, invasive species to RBG's nature sanctuaries. Rock Chapel is not immune from this behaviour, with dumping occurring at both the eastern and western peripheries of the property. Despite continual attempted communication explaining the impacts of this activity, residents do not change their habits. Further research into the psychology and communication techniques required to engage neighbours in responsible stewardship is recommended.

### *Climate Change Resiliency*

Climate Change is expected to drastically impact, and potentially change, the species composition of natural ecosystems. Although outcomes regarding how the climate will impact natural ecosystems cannot be truly determined, calculated hypotheses can be made based on climate modelling scenarios. Natural Resources Canada's resource "Plant Hardiness Zone Maps" have been used since the 1960s for gardeners to determine which species of trees or shrubs will grow in their garden. Readily available online, their maps include comprehensive climactic data and in-depth forecasting calculations. This tool will be remarkably valuable for ecologists to determine which species present in their current ecosystems will persist through the changing climate, and which species may be suitable for new and changing climactic conditions in their area.

This calculation predicts shifts in core and range habitats for plant species. Core habitat generally refers to the central and most critical areas within a species' range, that are essential for its reproduction and survival. Whereas range habitat refers more generally to the broader habitat in which a species is found, including all areas that a species might utilize – from core habitats to areas on the periphery where species might live but do not contain as optimal conditions as the core habitat.

*Table 6. Canopy tree species present in Rock Chapel's forest monitoring plots in 2024, and their associated current and forecasted distribution based on climate modelling scenarios (scenario model 4.5).*

| Species Name | Basal Area (%) | In-plot Abundance | Calculated Density (trees/ha) | Current Habitat Distribution (2024) | Forecasted Habitat Distribution (2071-2100) |
|---|---|---|---|---|---|
| Sugar Maple (*Acer saccharum*) | 40.89% | 13 | 54 | Core | Range |
| Ironwood (*Ostrya virginiana*) | 4.67% | 7 | 29 | Core | Core |
| Black Cherry (*Prunus serotina*) | 13.90% | 6 | 25 | Range | Range |
| Red Oak (*Quercus rubra*) | 40.02% | 5 | 21 | Core | Core (Range in most extreme scenario) |
| Norway Maple (*Acer platanoides*) | 0.19% | 1 | 4 | N/A | Not Present |
| Shagbark Hickory (*Carya ovata*) | 0.28% | 1 | 4 | Range | Range |
| White Ash (*Fraxinus americana*) | 0.05% | 1 | 4 | Core | Range |

Interestingly, Norway Maple is the only forecasted tree to hypothesized to not be present by 2071, which will certainly be ecologically beneficial, as it will remove one stressor from forested ecosystems. Notable shifts in core habitat to range habitat are forecasted for Sugar Maple and White Ash. For RBG, Ironwood, Black Cherry, and Shagbark Hickory remain within their current distributions. Forecasted habitat distribution shifts should be considered during the planning stages of reforestation projects across RBG property.

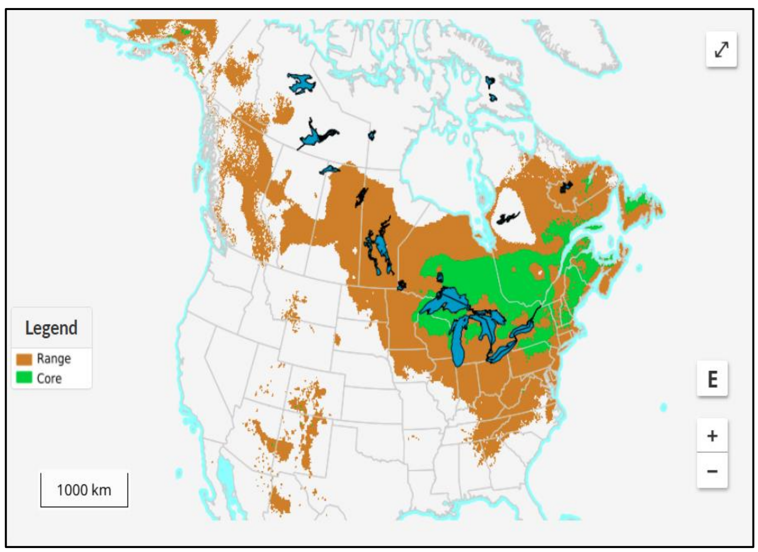


*Figure 13. Forecasted climate change-induced distribution for Sugar Maple (Acer saccharum) for 2071-2100 under scenario model 4.5.*

## Wildlife Community

### *Breeding Bird Surveys*

Despite having only three bird monitoring plots within the forest of Rock Chapel, nearly 30 species of birds were detected in 2024. When comparing to previous monitoring windows, only two-long term bird monitoring plots are used, as one plot (EP-RC-6) was added in 2023. 18 species of birds were detected during bird monitoring surveys in 2012, whereas 25 species were detected in 2024. This could be a result of improved surveyor skill, even despite two less visits in 2024 than in 2012.

Noting the methodology change in 2023, it is impressive that species richness increased to 25 in 2024, which is the same number of species detected in 2020 (two visits versus four visits to each plot). Despite a drop in species richness in 2023, an increase to expected species detections was observed in 2024. Surveys completed in 2023 may have been affected by high levels of wildfire smoke that blanketed Southern Ontario during the sampling window. Therefore, the drop in species richness for 2023 may be explained due to the smoke. However, detections did not decrease within the forest bird monitoring plots at Rock Chapel, which potentially suggests that certain species were sensitive to the wildfire smoke.

Wildfires have been shown to have direct physiological impacts on birds, specifically from toxic gases found in the smoke (Engstrom 2010). The impact of smoke on bird behaviour has been studied, with one study suggesting altered vocalization patterns (source). However, the cause for the change in singing behaviour is yet to be determined (source). Many hypotheses exist, such as changes in visibility (Haider et al. 2019) or declining air temperatures (Robock 1991). Additionally, it has noted that species' presence during extreme wildfires may not be as affected by wildfire smoke as is the change in their behaviour and the surveyors' detection ability due to decreased visibility caused by smoke (Sanderfoot and Gardener 2021). Further scientific research into this topic is crucial, as wildfires are predicted to increase in abundance as our climate changes.

### *Wood Thrush*

Despite on-going forest conservation efforts at RBG, Wood Thrush detections have continued to decline for many years (Hamilton et al. 2023). Decline in detections of migratory species using RBG's nature sanctuaries as breeding habitat might not always be the fault of land mangers. Research on Wood Thrush over-wintering habitat showed that more than 50% of the birds tracked were occupying an area only one-third the size of all potential winter habitat (Stanley et al. 2014). This area spans from Honduras to Costa Rica, has undergone dramatic landscape changes, in the form of deforestation and thus, has put greater stress on overwintering Wood Thrush populations.

Older research suggests that Wood Thrush abundance has decreased at rates of 4.0% per year from 1978-1987, and by 3.6% per year from 1969-1986 (Robbins et al. 1989; Holmes and Sherry, 1988). Declines in Wood Thrush abundance at Rock Chapel are somewhat comparable to these values, however, the sample size at Rock Chapel is significantly smaller than what was surveyed in the previously mentioned studies. Therefore, landscape level Wood Thrush abundance should be analyzed in the surrounding Hamilton-area to gain better understanding of the Wood Thrush status in our region.

Preferred nesting habitat for Wood Thrush includes a variety of deciduous forest compositions, however increased urbanization in Southern Ontario has resulted in immensely fragmented forest parcels. This results in significantly less interior forest habitat and increased forest edge effects, leading to higher rates of nest predation and parasitism (Brittingham and Temple 1983, Wilcove 1985, Terborgh, 1989). Although not yet detected in the forest bird monitoring plots at Rock Chapel, RBG should continue to track Brown-headed Cowbird detections, as this species is a known parasite of Wood Thrush nests. However, other potential predators of Wood Thrush eggs and nestlings include Eastern Gray Squirrels, Common Raccoon, Blue Jays, and American Crows. Non-native predators of adult Wood Thrush include feral cats, which have been noted by RBG staff within Rock Chapel's forest. RBG should continue to focus their restoration efforts across its nature sanctuaries to reduce the negative ecological impacts of edge effects (i.e. promote forest edge expansion where possible to increase and improve the quality of interior forest habitat.

## Visitor and Neighbour Behaviour

### *Off-leash Pets*

Rock Chapel undoubtably is a popular location to hike with pets, however, the proper respect and appreciation that these trails pass through a nature sanctuary is not always observed. Off-leash pets are one of the most harmful stressors in a nature sanctuary, as they pose a large threat to birds and small mammals and uproot and destroy plants growing on the forest floor. There is also the risk of off-leash pets acting as vectors for invasive species spread, as seeds or insects attach themselves to the fur of pets and travel far distances before falling off.

Off-leash cats are among the significant threats to birds, as it is well documented that free-wandering cats negatively impact bird populations. In Canada alone, cats kill more than 100 million birds each year, which is the second-largest source of bird mortality in Canada (behind habitat loss) (Birds Canada, 2025). Two off-leash cats are often observed at the west end of Rock Chapel, likely residents of nearby houses. Communication with neighbouring houses should be conducted to inform residents regarding the dangerous risk to bird populations that off-leash cats pose.

# Environmental Stewardship Recommendations

## **Invasive Species**

### *Black Locust*

Black Locust (*Robina pseudoacacia*) while a native Eastern North American tree has been a long-contested plant at RBG, as its native range reaching central Pennsylvania but its arrival in Ontario was due to human introduction. The nitrogen fixing element unfortunately favours the success of many of the most invasive colonizing plants species preferred conditions. Its fast-growing nature made it a popular choice for reforestation projects in the early 1900s. Invasions beyond the plantations have made this tree problematic for Ontario's ecosystems and Species-at-Risk. Prolific spread through suckering can occur in trees as young as 4 years of age (Warne, 2016), which is of great concern at certain restoration sites at RBG.

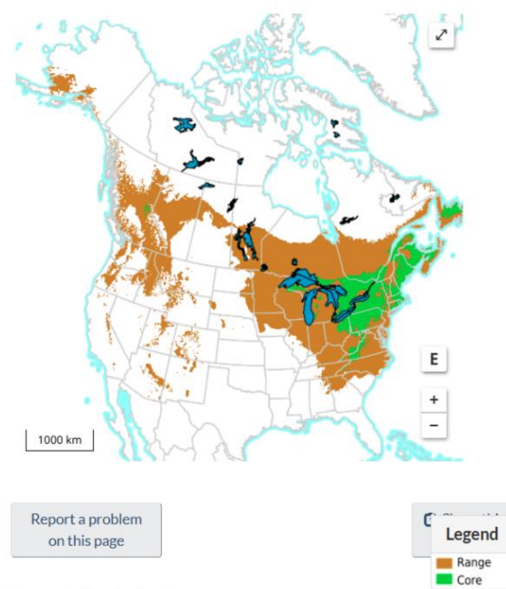


*Figure 13. Forecasted climate change-induced range shift for Black Locust for the years 2071-2100 under scenario 4.5.*

As climate changes in Ontario, current modelling predicts that most of the geographical area of Ontario, including RBG, will be core habitat for Black Locust. Therefore, in aligning with RBG's Canopy Strategy, careful consideration must be undertaken when deciding how to manage current invasions of Black Locust in the forested community. It is understood that despite the shift of core habitat range in the future, Black Locust will still be managed on certain areas of RBG property due to the desire to maintain specific habitats.

### *Dog-strangling Vine*

Despite not being detected in the Long-term Forest Monitoring plots at Rock Chapel, it is well known that Rock Chapel is home to a significant population of invasive Dog-strangling Vine (DSV). This invasive plant has detrimental effects on the flora community within the forest floor and understory layers, and targeted action is recommended to reduce the spread and density of this invasive plant.

DSV is unpalatable to wildlife, such as White-tailed Deer, which can therefore put increased browse pressure on native plants. With nearby restored grassland habitats, it is also feared that the DSV population could expand beyond the limits of Rock Chapel's forest and invade into RBG's restored grassland habitats, which currently are free of DSV. This would be detrimental as DSV poses a large threat to Monarch butterfly populations, as butterflies often mistake DSV for milkweed and lay their eggs on DSV instead of their host plant. This results in Monarch larvae being deprived of vital nutrients needed for proper development, leading to further declines in the already plummeting Monarch population. Therefore, the containment and removal of DSV from within Rock Chapel's forest is vital to reduce browse pressure on native forest plants and to protect and support Monarch butterfly populations at RBG.

Effective eradication of DSV from Rock Chapel requires ground-truthing and precise mapping within the nature sanctuary. This will provide the baseline for effective and targeted removal efforts, including herbicide application. The principal source of this plant is the rail corridor with the passing trains blowing large amounts of seed along the rail corridor. A control challenge that exists regarding DSV removal at Rock Chapel is that there are large swaths of DSV on the steep slope of the escarpment. This results in accessibility challenges for managing these patches of DSV, as scouring the face of the Escarpment slope is not possible. Therefore, potentially using drones for mapping via a partnership with Mohawk College, who has a long-standing relationship with RBG, should be considered to investigate potential solutions. This could also include treating DSV on the slope with herbicide using a drone if regulatory approvals could be resolved. This would be a tremendous opportunity to use state-of-the-art chemical treatment to solve a challenging problem.

On-going effort and communication with CN Rail regarding managing the DSV on their property (railway edge) is encouraged. If DSV in the rail corridor continues to be ignored and allowed to proliferate, then RBG will never be successful in its attempt to eradicate DSV from Rock Chapel. Therefore, encouragement to manage invasive species along railways should be continued.

### *Norway Maple and Common Buckthorn*

As noted in the results from Forest Monitoring surveys in 2024, Norway Maple and Common Buckthorn are an on-going problem within Rock Chapel's forested ecosystem. Continued threats to native tree and shrub species provide the perfect opportunity for highly invasive species, such as Norway Maple and Common Buckthorn, to thrive and proliferate within the forest. Therefore, targeted removal of these two species is required to maintain and ideally increase native plant diversity.

Depending on the size of the shrub, it is likely that a large portion of the Common Buckthorn present can be removed manually. Utilization of RBG's volunteer core will be a key aspect in the success of this endeavour. However, large, mature Norway Maples will require chemical treatment to eliminate them from the landscape. Inspection and identification of maple seedlings will be required in the future to ensure Norway Maple does not regenerate in the forest.

### *Targeted Invasive Species Removal on Plateau*

Targeted removal of invasive species within Rock Chapel's forest on the plateau of the Escarpment has occurred for many years. Extensive removal efforts have been conducted targeting troublesome invasive species in Rock Chapel's forest. One example of on-going invasive species removal includes a section of forest at the very west end of Rock Chapel where large swaths of Common Buckthorn have been removed since 2021 from the forest. After these shrub removal efforts, follow-up visits during the following growing season showed Garlic Mustard and Common Buckthorn seedlings scattered across the removal site. Therefore, continued attention and removal efforts must be supported at this site to encourage native plant regeneration. The consideration of long-term invasive species management and continuous effort at one removal site must be implemented to ensure desired results (native plant regeneration) are achieved.

### *Targeted Invasive Species Removal Around Species-at-Risk*

For a number of years targeted invasive species removal around Species-at-Risk (SAR) occurred on RBG property. One of the SAR that was scheduled to receive invasive plant removal was Red Mulberry, of which occurs within Rock Chapel's forest. Every identifiable invasive species within a 25-metre radius from a Red Mulberry was removed. During the 2023 project that involved multiple staff, RBG's Invasive Species Technicians dedicated 266 effort hours to remove 10,823 invasive plants of 14 species. More than half of the plants removed were Dog-strangling Vine.

Although no formal surveys have been conducted to assess the success of the work, an incidental observation from 2024 provides a glimpse into the response of Red Mulberry to the results of this project. However, growth response was anecdotally noted in 2024. A Red Mulberry (genetically confirmed) measured 7.3cm in diameter-at-breast-height (DBH) in 2013. This DBH was maintained until at least 2021 (i.e. the tree did not grow). In 2024, after invasive plants were removed from the root zone of the tree, it grew to 8.1cm DBH, after not growing at all in nearly a decade suggesting that one or more of the invasive plants were allelopathically suppressing the growth.

As per the RBG Red Mulberry site management plan, it is recommended that the critical habitat zone (25m) continue to be cleared of invasive species for the numerous trees present, with the trees response is likely to be positive.

## Ecosystem Management and Restoration

### *Forest Expansion Restoration Plantings*

Rock Chapel's ribbon forest that wraps around the edge of the Niagara Escarpment is vital habitat for many plant and wildlife species. However, due to its shape and expansive edge and former agricultural use often right to the cliff edge, it experiences challenges spurred by edge effects, such as encroachment, introduction and proliferation of invasive species, and human disturbance. Therefore, closing gaps and reducing edges within the forest community is of utmost importance to managing the ecological integrity of the forest.

The areas that are provides an excellent opportunity for expanding the forest and reducing edge effects include two areas that are currently meadow habitat. A key measure of potential area, often used as a standard within Ontario's Greenbelt is a simple buffer of 75m to 100m of forested area as measured from the escarpment cliff edge. Invasive species management will be required before planting begins, including species such as Dog-strangling Vine and Common Buckthorn. By converting portions of meadow habitat into forest, the forest edge will become more resilient to disturbance. The two main sites that are key reforestation locations are 4.39 hectares (Borer's Field) and 0.23 hectares (Escarpment Fields) (Figure 14). Reforesting large tracts of land, such as the Borer's Field site, will take many years and proper planting plans and species lists will need to be developed to suit the landscape and forecasted future climactic scenarios.

*Figure 14. Map of potential near term reforestation sites at Rock Chapel Nature Sanctuary. Borer's Field (4.39 hectares) and a border of the West escarpment fields (0.23 hectares).*

# Emerging Threats

Climate Change - As our planet continues to navigate the unknown impacts of Climate Change, it cannot be determined what Rock Chapel might experience in the future. However, there are threats to its ecological integrity at its doorstep that will place increased pressure on its ability to function as a thriving ecosystem. Threats can be placed into three main categories: Forest Pests and Diseases, Extreme Weather Events, and Increased Anthropogenic Pressures. These main categories are outlined in more detail below.

## Forest Pests and Diseases

Forest pests and diseases pose serious threats to the ecological integrity of a forest. As land managers and stewards, RBG must prepare for up-and-coming threats, as well as threats that already exist on the landscape, to maintain the vigor of its forested ecosystems. Proactive response to forest pests ensures the longevity and vitality of RBG's nature sanctuaries.

In 2021, Spongy Moth (*Lymantria dispar dispar*) infestations were forecasted to cause severe defoliation at Rock Chapel and on the South Shore of Cootes Paradise, if no management was undertaken. This would cause unneeded stress on tree species such as oak, birch, cherry, and maple. To reduce stress on these tree species, RBG decided to intervene and plan a strategy to control

Spongy Moth at Rock Chapel. The most effective control measure for treating Spong Moth is spraying the canopy of trees with a biological pesticide, Btk. Due to the expanse of the forest, aerial spray is the most effective method of Spongy Moth control is to conduct an aerial spray of Btk. RBG hired a contractor to conduct this control measure against Spongy Moth. The treatment was highly successful in knocking back the ever-increasing population of Spongy Moth. Eradication of this forest pest is extremely unlikely, as province-wide treatment would need to occur. Therefore, continued population monitoring is required to detect when severe defoliation might next occur.

One aspect of forest ecology that is constantly changing is that of forest pests and diseases. As one pest enters, decimates, and leaves a forest, the next threat is knocking at the door. In the case of Rock Chapel, two main threats that are moving northward are Oak Wilt (*Ceratocystis fagacearum*) and Spotted Lanternfly (*Lycorma delicatula*).

Oak Wilt poses the most serious threat to the integrity of the forest canopy at Rock Chapel. As mentioned earlier, Red Oak is one of the prominent tree species at Rock Chapel, in both basal area and abundance, therefore the threat level of Oak Wilt is high. As opposed to Spongy Moth, which is easily treated with pesticide, Oak Wilt is more difficult to treat. Fungicide treatment (propincoazole) exists but is more often used as a preventative measure than therapeutic treatment. Propincoazole does not prevent infection of oaks, but it has been reported to reduce tree mortality and slow symptom development (Koch et al. 2010). RBG staff should be vigilant with proper Oak Wilt prevention measures (i.e. not pruning oak trees between April and October to prevent spore spread), as well as collaborating with other agencies (i.e. Canadian Food Inspection Agency and the Invasive Species Centre) on surveying opportunities for early detection.

## Extreme Weather Events

As Climate Change continues, Southern Ontario will not be exempt from more frequent and extreme weather events as time progresses. Some of these extreme weather events have already occurred and have caused damage to Rock Chapel's ecological balance in the form of both wind and extreme rain.

In July of 2024, a massive rain event poured on the Hamilton region, which received over 40mm of rain in just over the period of one hour (Government of Canada 2024). Localized flooding and intense flash floods resulted in damage to housing and the environment. Due to Rock Chapel's unique location, spanning the plateau / cliff of the Niagara Escarpment, it also experienced the pressure of the storm.

After the storm subsided, RBG ecologists discovered a large blow-out at the base of escarpment in the Rock Chapel Nature Sanctuary. This large surge of limestone rubble had been eroded from the face of the Escarpment during the intensity of water flowing over the escarpment during the storm. Thankfully the damage to the surrounding forest and stream habitats was minimal, and debris was cleared from base of surrounding trees to alleviate pressure on the trees' trunk and root systems. The blowout could have been more disastrous because Rock Chapel contains part of RBG's population of Red Mulberry (*Morus rubra*), but there were no Red Mulberry mortalities from this event. However, this does not leave Red Mulberry, or any other plant species, exempt from the next rain-induced rubble scouring event, with the area having a number of small ephemeral creeks passing through. Coincidentally in the upper portion of one, RBG has since contoured the landscape to recreate a lost wetland in one of the grassland sites to better hold water during times of high-water levels. This feature might not account for massive rainstorms, like the one experienced in 2024, however it will help with rapid snowmelt and decrease the pressure on the underground creeks found within the Escarpment. Easing the pressure, intensity, and speed of snowmelt throughout the underground creeks will help reduce long-term erosion of the Escarpment.

Increased periods of drought are also predicted with a changing climate, which adds pressure on the already stressed Rock Chapel forest. In the past few decades, both regional and large-scale forest decline has been linked to drought (Allen et al. 2010). It can be assumed that RBG's nature sanctuaries will experience some level of prolonged drought periods, on and off, in the coming decades. This is not only challenging for mature canopy trees, but also poses a threat to natural tree regeneration, as younger trees are more susceptible to succumbing to changes in weather patterns, such as drought.

Another weather-related threat to the forest at Rock Chapel is wind. The Niagara Escarpment is extremely exposed to all weather events, as its elevation puts it at the leading edge of intense storms. Windstorms are expected to intensify with Climate Change, which could have detrimental impacts on the forest at Rock Chapel as the likelihood of tree blowdowns increases with the intensity of windstorms.

### Increased Anthropogenic Pressures and Visitor Behaviour

Over the course of the next quarter century, Hamilton's population is expected to increase by from just over 600,000 residents to 820,000 by 2051 (City of Hamilton, 2024). As the population grows, there will inevitably be increased desire to leave the urban city to escape to nature. Rock Chapel's proximity to Hamilton's urban core will make the nature sanctuary a prime location for residents to experience nature. Therefore, increased activity will lead to heightened anthropogenic pressure to the nature sanctuary. The list of impacts includes, but is not limited to, increased traffic (therefore compaction) on RBG's nature trail systems, elevated levels of litter and graffiti, higher levels of disturbance to wildlife, and unsanctioned off-trail use by visitors. These actions by trail users have the potential to degrade the existing ecosystems present at Rock Chapel, and therefore continued education of proper trail behaviour is needed, along with continuous flora and fauna monitoring.

# Conclusion

Rock Chapel Nature Sanctuary provides visitors with the opportunity to explore and reconnect with natural ecosystems and escape the city without long-distance travel. Rock Chapel' s forest provides refuge for Ontario's native plants and wildlife, including species at risk of extirpation or extinction. Long-term monitoring programs, such as RBG's bird monitoring and forest monitoring programs, assist RBG's ecologists in detecting changes in ecosystem diversity and passing information on to the broader community. This report identifies a number of notable changes both positive and negative during just a 12 year period including capturing the effects of loss of ash tree canopy and temporary canopy cover loss due to spongy month defoliation as well as advancing invasive plant species. A notable change in the forest bird community was also captured. Continued monitoring efforts will increase the validity and statistical significance of RBG's long-term dataset, which will only provide more accurate and detailed insights into changes occurring within the nature sanctuary. Emerging threats such as Climate Change, introduction and spread of invasive species and diseases, increasing severe weather events, and increasing anthropogenic pressures only emphasize the importance of proper stewardship and land management. Community engagement, partnerships, education, and collaboration surrounding communities, Rock Chapel will remain an ecologically diverse habitat for plants, wildlife, and people to prosper.

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