



Royal
Botanical
Gardens
CANADA

Environmental Status of Grassland Restoration Sites at Rock Chapel 2025



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April 2026
RBG Report No. 2026-4b

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Acknowledgements

This report would not have been possible without the guidance of Tys Theijsmeijer, Senior Director of Ecosystem Stewardship Programs and Policy, as well as Lindsay Barr, Manager of Ecosystem Stewardship Programs and Policy, Reilly Smith, Terrestrial Ecologist Intern and William Jack, Restoration Technician.

Grassland vegetation data collection was completed by Mallory Peirce, William Jack, Reilly Smith, Naida Cavallin, and Julia Minaji. Bird data collection has been primarily collected by Lindsay Barr and Mallory Peirce, as well as former interns and assistants since monitoring began. Butterfly data has been continually collected by Lindsay Barr with the support of Mallory Peirce and previous interns and assistants, as well as volunteers.

Front cover photo: Foxglove Beardtongue (*Penstemon digitalis*) at Rock Chapel's Monarch Meadows, Hamilton, Ontario. Photo by Lindsay Barr.

Recommended Citation

Peirce, M., R. Smith, W. Jack, & T. Theijsmeijer. 2026. Environmental Status of RBG's Grassland Restoration Sites. RBG Report No. 2026-4b. Royal Botanical Gardens. Burlington, ON.

Document Description

This report from the Ecological Stewardship Department of Royal Botanical Gardens has been reviewed internally. Its contents have not yet been subject to an independent peer review. The report is the first edition of Environmental Status of RBG's Grassland Restoration Sites and is one of a series of three documents covering Princess Point, Berry Tract and Rock Chapel. Updated versions will be produced as needed. It is authorized for release by Royal Botanical Gardens subject to acknowledgment that it is being provided for information purposes only, and that its contents may be subject to revision following independent review. References to other agencies, organizations, or officials do not constitute endorsement of this report by those or any other agency.

Executive Summary

Rock Chapel Nature Sanctuary land use was updated in 2016 and 2020 to convert all existing areas to natural areas. Agricultural activities had been ongoing for 17 hectares of Rock Chapels escarpment plateau lands since their original land acquisition in 1942. The subsequent transformation to grasslands has been very successful. The project included four fields now converted to meadows to support broader availability of grassland habitat, as well as improving water quality flowing to Cootes Paradise via Borers Creek. This project complements field renaturalization started in the 1970s in the area adjacent to the visitor parking lot.

Currently, nearly 99% of native grassland habitat across the continent has been destroyed including in Ontario. In Ontario meadows/grasslands exist primarily as habitats in transition after disturbance.

Disturbance events can range from abandoned agricultural practices, overgrown pastureland, to fires or large-scale windstorm events. The lack of grassland habitat makes RBG's grassland restoration sites some of the most unique and important habitat in the Hamilton area for the Biodiversity Action Plan.

Farming activity in the 4.5 ha field adjacent to Borers Falls ended in 2015 and the field was hand seeded with a native grassland seed mix in 2019. In 2020, RBG initiated the conversion of the remaining 13 hectares of agricultural land, consisting of 3 fields, to native grassland habitat starting fall 2020. The grassland seed mix planted included 31+ native species and was installed with the aid of a tractor and seed drill shortly after the last agricultural harvest in November. In addition, a ditched karst creek and associated wet area was enhanced to recreate a wetland feature within field 1 (Monarch Meadows), returning it to a more natural creek and wetland area, and assisting in re-establishment of amphibian breeding habitat.

Early plant community restoration results were typical of newly restored grasslands with a heavy cover of annual weeds. By year two, the plant community shifted to one that was dominated by native grass and wildflowers of the seed mix. Overall, the state of re-naturalization and conversion to native grassland has dramatically improved over time with the establishment of a native plant community. Since transition the actively seeded fields in particular host meadows dominated by native plant species (>85% of the plant species make up). Queen Annes lace is by far the most abundant non-native plant species present while goldenrods and asters dominate the native species. To the east, the field under natural succession by Borers Falls remains dominated by non-native plant species although native goldenrods are abundant. Observations in 2025 for this field show substantial succession of woody plants, and various asters and goldenrods moving into the field, Woody plants include Black Walnut, Balsam Poplar and European Common Buckthorn. At the same time a notable tall grass prairie species Big Bluestem was also present in low abundance and scattered throughout the field initiated by hand seeding previously.

Of the original seed mix installed in fields 1, Monarch Meadow, all but two species were observed, while an additional 11 native species spontaneously appeared, dominated by Canada/Tall Goldenrod. Similar results occurred in fields 2 and 3. When compared to the Princess Pt and Berry Tract grassland sites, Rock Chapel has median level of diversity and abundance of plants, birds and butterflies, and does include unique species to the site. The most striking of these is Foxglove Beardtongue. Also, among the early successes include the immediate establishment of breeding American Toads in the wetland area established in 2024.

The resulting habitat is hosting a variety of wildlife with birds and butterflies counted in number and diversity. Bird monitoring notes about 15 species, dominated by Red-wing Blackbirds and butterfly monitoring found 13 species and a notable increase in numbers, essentially doubling for 2025. Within butterflies, Monarch's while numerous were noted as substantially declined over the past 14 years of monitoring despite the substantial increase in habitat area available. The meadows also now facilitates the flow of much cleaner water infiltrating the escarpment at a headwaters area of Borers Creek, flowing to Cootes Paradise impacting the quality of habitat beyond this thriving meadow. Going forward an ongoing challenge to maintain the grassland and limit invasive plant species will be the primary challenge.

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Introduction

Royal Botanical Gardens (RBG) stewards approximately 50 hectares of grassland habitats across its nature sanctuaries, 45 hectares of which are actively managed to ensure these meadows, prairies, and savannahs continue. Grassland sites are found at RBG's Escarpment properties and Cootes Paradise, each of which have specific ecological end goals. Historically, before North America was colonized by European settlers, grassland habitat spanned nearly 162 million hectares including in Ontario (Samson and Knopf 1994). Currently, nearly 99% of native grassland habitat across the continent has been lost. The lack of grassland habitat in North America makes RBG's grassland restoration sites some of the most unique and important habitat in the Hamilton area and a key area to Hamilton's 2024 Biodiversity Action Plan.

Rock Chapel Nature Sanctuary is part of the original RBG properties established in 1942. The tablelands had largely continued as active agriculture until recently. These lands of the escarpment now contain 13 hectares of grassland habitat as well as a 4.5-hectare scrub successional field adjacent to Borers Falls, still largely meadow like. These areas were farmed for about two centuries and have only recently been converted to grassland habitat, consisting of four unique field sites. Rock Chapel Nature Sanctuary is part of the earliest European settlement area of western Lake Ontario, with a small mill established on Borers Creek at the waterfalls by Moses Morden in the late 1700s and once powered a sawmill in the village of Rock Chapel.



The landscape overall is flat with shallow soils of silty loam, underlain by clay on top of karst escarpment, and include several ephemeral creeks infiltrating into these areas with the water part of Borers Creek headwaters area to Cootes Paradise. The surrounding landscape to the north is rural lands and bordered by Rock Chapel Rd, while to the south is the Niagara Escarpment cliff and forest, addition fallow agricultural lands left to naturalize by RBG in the 1970s. The site management goal for this area is ecological protection with a focus on grassland species ranging from wetland to dry including elements of prairie.

Prior to grassland conversion, RBG rented land to local farmers for the purposes of ongoing agriculture at Rock Chapel. Three of the field restoration sites were established through an active restoration program initiated in 2020, while at the other field adjacent to Borers Falls and gorge, agriculture ended in 2015 and the field allowed to naturally regenerate. Agriculture in this field formerly extended to within several meters of the escarpment edge. Only minor additions of native seed have since been hand scattered there. This field site is a popular visitor destination along the Bruce Trail with Borers Falls one of the top waterfalls to visit in Hamilton area. Starting in 2020, RBG updated land management activities and stewardship of the other three fields with financial support from the Ontario Trillium Foundation and began the transition from 13-hectares of row crop farming to native grassland habitat. A native seed mix was directly installed using a no-till grain drill attached to a tractor with the support of St. Williams Nursery and Ecology Centre. One of the fields also had an agricultural drain within it associated with one of ephemeral/karst creeks and this was also renaturalized, including a more natural wetland feature reestablished in 2024. Extensive invasive species management has occurred since 2020 within and surrounding these 3 fields with a focus on invasive shrubs in the hedge rows and European Alder, Eurasian Manna Grass and Common Reed in the wetland area.

Long before European contact, and still today, grasslands are a vital component of Indigenous Peoples' lives as these habitats provide both medicine and sustenance. In some cases, grasslands were intentionally

managed by Indigenous Peoples using fire to maintain brush and increase browse for ungulates (Black et al. 1999 and Turner 1999). Indigenous-led low-impact agriculture of native species in North America is one example as to how natural and human-induced disturbance have occurred at grassland sites across North America for thousands of years.

Tallgrass prairie habitats, and unique subcategory of grasslands, are primarily composed of deep-rooted native grass species and wildflowers that can withstand disturbance (i.e. grazing or fire), and generally unfavourable growing conditions (i.e. drought). Prairies are considered climax communities and therefore can remain established and robust for many years. Fire is a key component of prairies, controlling not only woody and non-prairie plants, but also by stimulating growth and regeneration of prairie-adapted species. Conceptually, the primary difference between meadows and prairies is the ratio of grass to wildflowers. Prairies contain higher ratios of grass, typically 70% native grasses and 30% native wildflowers.

Native meadows exist primarily as temporary habitats in transition after disturbance. Disturbance events can range from abandoned agricultural practices, overgrown pastureland, or roadsides. Meadows typically contain high levels of goldenrods and asters but can quickly transition once shrubs and trees begin establishing. Meadow maintenance is achieved through occasional mowing when woody species begin to overwhelm the ecosystem. Grass and wildflower ratios are completely opposite to tallgrass prairies in that 70% of the vegetation is comprised of wildflowers and 30% native grasses. With a higher percentage of wildflower presence, they are key habitats for nectar-loving wildlife, such as bees and butterflies.

On the landscape level, grasslands are vital pieces in the ecological matrix and as a tool in combating climate change. Densely and deeply rooted plants store nearly 90% of their carbon underground and assist with soil stabilization (Bai and Cotrufo, 2022). Overall, grasslands store approximately 34% of the world's terrestrial carbon stock, thus playing a vital role in carbon sequestration (Bai and Cotrufo, 2022) and making them superior carbon sinks in comparison to forests (Seastedt and Knapp, 1993). Through their roots, grassland species help to build a robust and healthy soils with diverse microbial communities, which assist in nutrient cycling. The dense plant community in grasslands is a vital asset in water management on the landscape primarily through reducing runoff during major melts and storms and increasing water infiltration. All in all, grasslands are an important habitat type and have climate-mitigating factors that can maintain and improve regional ecological integrity and biodiversity.

These habitats are currently threatened through the presence of invasive species, climate change, and succession to forest. To prevent succession, a key aspect of grassland habitat maintenance is introducing disturbance to the ecosystem, either through grazing, fire, drought, or flooding. RBG's preferred management techniques are controlled burns and mowing. These methods also reduce competition from non-native and invasive species, allowing native species to flourish.

Overall RBG stewards three main grassland habitat areas across the nature sanctuaries, all of which have specific ecological end goals. Each of three sites represent relatively recent restoration projects, converting sites from other land uses. The three areas include Princess Point at Cootes Paradise, Rock Chapel escarpment plateau lands, and Berry Tract along the south facing slope of the escarpment. This report will focus on the restoration outcomes to date at the Rock Chapel plateau area following field conversion to grasslands, with this area's specific habitat goal of being relatively undisturbed habitat.

Methods

This report includes data collected through vegetation monitoring and bird monitoring surveys, of which the methods for each are transcribed below. There are currently three grassland vegetation monitoring plots within Rock Chapel’s grassland sites. These plots are specific to one field region vs the four total fields. This field is adjacent to the Rock Chapel Loop nature trail and is called Monarch Meadows. Other “archived” monitoring plots exist specific to the Borer’s Falls Field but have not been consistently or continually monitored in recent years. The single year of data from Borer’s Field will be included in this report. One long-term bird monitoring plot will also be analyzed within this report as well as data from butterfly monitoring transects.

Site Description

The landscape overall is flat with shallow soils of silty loam and clay on top of karst escarpment and include a number of ephemeral creeks infiltrating into these areas with the water part of Borers Creek headwaters area to Cootes Paradise. The surrounding landscape the north is rural lands and bordered by Rock Chapel Rd, while to the south is a fallow field and the Niagara Escarpment cliff and forest. The site management goal for this area is ecological protection with a focus on grassland species ranging from wetland to dry including elements of prairie. Very little of the plateau area of Rock Chapel was not previously used for agricultural with extensive thickets of Common Buckthorn, and various tree plantations part of the landscape. The field now called Monarch Meadows contains an ephemeral creek buried karst and an associated wetland area and is adjacent to the Rock Chapel Loop Nature Trail

Grassland Restoration Sites at the Royal Botanical Gardens

Monarch Meadows Highlighted Below



Figure 1. Location map for fields, highlighting the principal area of ecological monitoring (Monarch Meadows/ Field 1).

Vegetation Monitoring

Vegetation monitoring in RBG's grassland restoration sites occurs during the peak growing season on an annual basis, save for Rock Chapels Monarch Meadows field which has been monitored biennially since 2022. This site includes four vegetation plots. Overall monitoring within grassland & savannah areas began in 2003 at Princess Point, with slight methodology adjustments made up until 2009. Since that time, a robust monitoring regime has been implemented in all grassland areas. Borers Fall field includes 3 plots last monitored in 2020.

For the purposes of this report, four unique grassland locations will be discussed: Princess Point Prairie (seven monitoring plots), Princess Point Savannah (three plots), Berry Tract South (four plots), and Monarch Meadows (three plots). Restoration timelines vary amongst sites, resulting in datasets containing unequal amounts of data. At each monitoring plot, four methods of data collection are conducted to ensure a detailed representation of the vegetation community is captured: quantitative photo monitoring, quadrat sampling, plot dominance, and transect monitoring.

Quantitative Photo Monitoring

Photo monitoring stations occur in each monitoring plot at both monitoring posts (labelled "a" and "b") set 10 metres apart. Incorporating a "density board" (placed at the opposite monitoring post), photographs are taken in both directions (i.e. from post "a" to post "b" and vice-versa). Photo-documentation is a vital tool to visually track changes in plant diversity, density, and height, and is usually the first data collected at a monitoring station to avoid inadvertently trampling vegetation in and around the posts. The following parameters are required to ensure consistency from year to year:

1. Density board dimensions measure 2.5m tall by 0.3m wide, with alternating black-and-white bands measuring 0.5m in height.
2. At each post, the camera or phone is held at 1.4m off the ground and must include as much land area as possible.
3. Density board must be centred in view finder, both left and right, and top to bottom.
4. The data collector records the estimated percentage of area in each band covered by vegetation while holding their head at 1.4m above ground.
5. The process is repeated at the opposite post.

Transect Data

Each monitoring station has a transect that runs between posts "a" and "b". The transect line is tied at both posts, 0.5m above ground. Species touching the transect line (moving from one post to the other) are recorded in order of occurrence. This data is usually collected second so that observers don't inadvertently trample vegetation as they move around the monitoring station.

Quadrat Sampling

Quadrat sampling occurs at both monitoring posts in each monitoring station.

1. A square 1m x 1m quadrat is placed at equidistance around each monitoring post, with the post in the centre of the quadrat. The side closest to the opposite post must be perpendicular to the hypothetical line between the two posts.
2. Each species with their stem growing within the plot is counted and their associated percent cover (how much physical space the species occupies) is estimated. If a plant is growing outside of the plot, but leans over the three-dimensional space of the quadrat, then the percent cover is estimated only.

Plot Dominance Data

1. The top five (or maximum number in each layer) dominant species are recorded in each structural layer (canopy, shrub, and herbaceous) in the immediate area surrounding the plot.
2. The three structural layers exist within the boundary between plots “a” and “b” at each monitoring station, although some layers may be data deficient (i.e. lacking canopy cover).

Bird Monitoring Protocol

Monitoring Sites

Monitoring sites were initially chosen to correspond with forest monitoring plots which undergo additional vegetation assessments under RBG’s Long-term Forest Monitoring Program. The purpose is to represent the status of terrestrial birds at RBG. These sites focus on terrestrial habitats, including grassland restoration sites. Together, the monitoring plots are scattered amongst RBG’s nature sanctuaries. For the grassland sites at Rock Chapel a total of two plots exist. One of the meadow sites adjacent to the field restoration has been monitored since 2009, and the furthest west meadow has been monitored since 2020.

Point Count Surveys

The sampling window ranged from June 6th- July 2nd 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).

Butterfly Monitoring Protocol

Butterfly index monitoring began in Monarch Meadows at Rock Chapel in 2024 during the month of July by a team of RBG staff and volunteers. A complete sweep of the site is done between the hours of 10:00am and 3:00pm, where every individual butterfly is counted. Butterfly species that can be easily identified without handling are counted, but certain species are generally netted and identified in petri dishes with the aid of a field guide. Total distance of the transect is about 500m.

Results

Vegetation Monitoring – Monarch Meadows Field

Abundance and Species Richness

Abundance

In 2022, the most abundant species was Common Ragweed accounting for 20% of plant coverage, followed by Common Evening-primrose (12%), Unknown Grass Species (10%), Tall/Canada Goldenrod (9%), Queen Anne's Lace (8%), and all other species accounted for 41% of all detections (Figure 1). During the most recent sampling window, unidentifiable Aster species had become the most abundant species detected accounting for 24% of all observations. This was followed by Queen Anne's Lace (19%), Black-eyed Susan (14%), Tall/Canada Goldenrod (11%), Unknown Goldenrod seedling species (10%), and all other species accounted for 22% of observations.

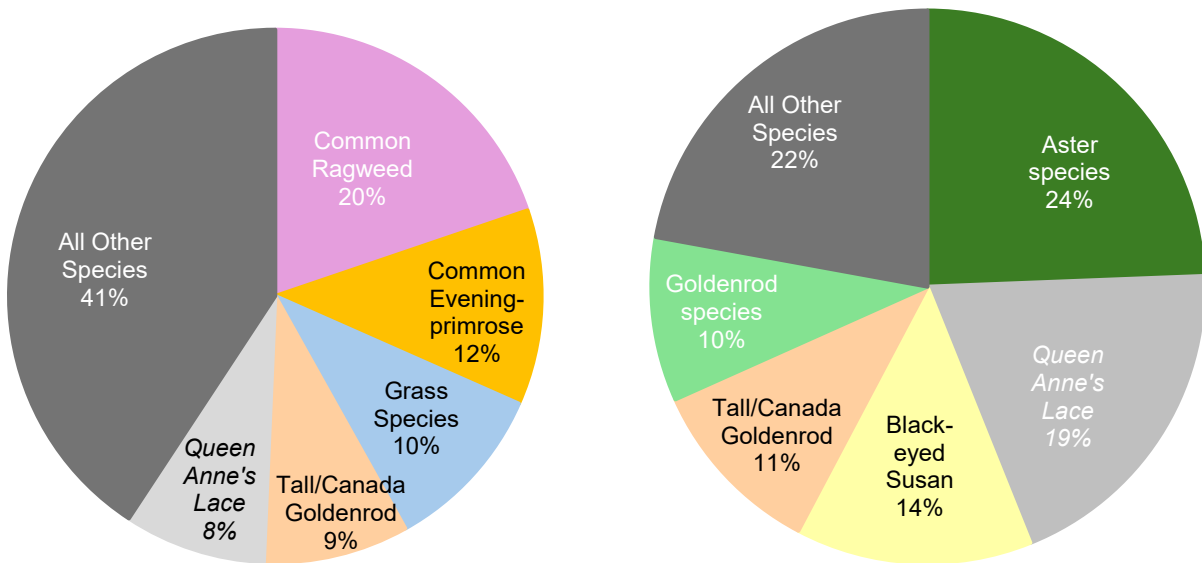


Figure 2. Most abundant species observed in quadrat monitoring at Monarch Meadows in 2022 (left) and 2024 (right).

Relative Cover

After two years of growth, post seeding, the vegetation at Monarch Meadows was surveyed for the first time. At that time, the species that had the highest relative cover was Tall/Canada Goldenrod (22%), followed by Lance-leaved Aster (14%), Virginia Wild Rye (10%), Black-eyed Susan (5.9%), Foxglove Beard-tongue (5.7%), and all other species accounted for 42% of all observations (Figure 2). During the most recent sampling window in 2024, the most abundant species observed at Monarch Meadows was Tall/Canada Goldenrod (25%), followed by Black-eye Susan (16%), Lance-leaved Aster (9%), Foxglove Beard-tongue (8%), Wild Carrot (6%), and all other species accounted for 36% of the total observations. Resulting in Tall/Canada Goldenrod increasing by 3%, Black-eyed Susan by 10%, and Foxglove Beard-tongue by 2%. Lance-leaved Aster dropped in relative abundance by 5%. In 2024, Queen Anne's Lace was the first non-native species to appear in the top five most abundant species (6%).

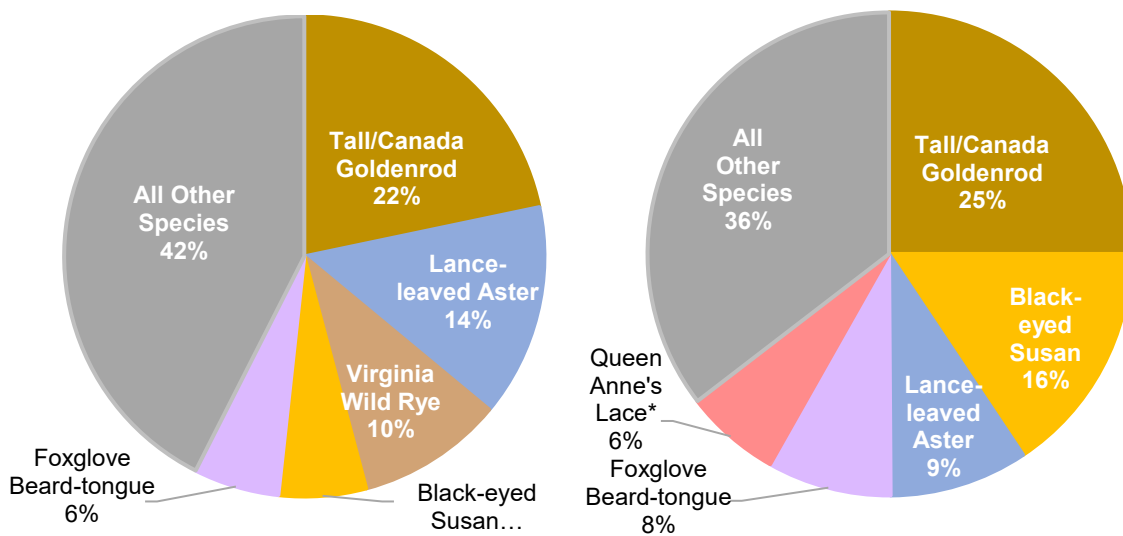


Figure 3. Top five most abundant species observed in quadrat monitoring at Monarch Meadows during the first monitoring window in 2022 (left) and the most recent survey in 2024 (right), averaged/plot.

Species Richness

Species richness at Monarch Meadows has increased and maintained its richness since monitoring began in 2022 (Figure 3). In 2022, 32 species were observed, which then increased to 42 species in both 2023 and 2024. Again, despite a small dataset, increases in species richness have been detected.

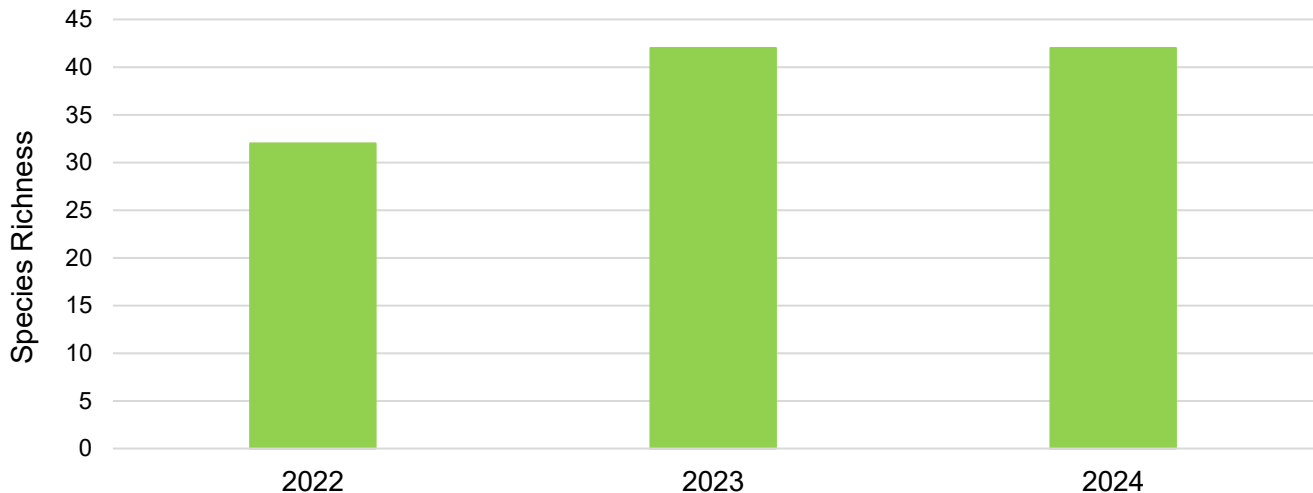


Figure 4. Plant community total species richness at Monarch Meadows Rock Chapel from 2022 to 2024.

Grasses

Abundance

Relative abundance of grass species has varied since monitoring began in 2022. Virginia Wild Rye was the most abundant grass species in 2022 at 4.7% then increasing to 5.1% in 2023 and then declined to 2.5% in 2024 (Figure 4). Yellow Savannah Grass has hovered between approximately 1% and 2% in the three monitoring sessions. Switch Grass has continually declined in relative abundance since monitoring began in 2022.

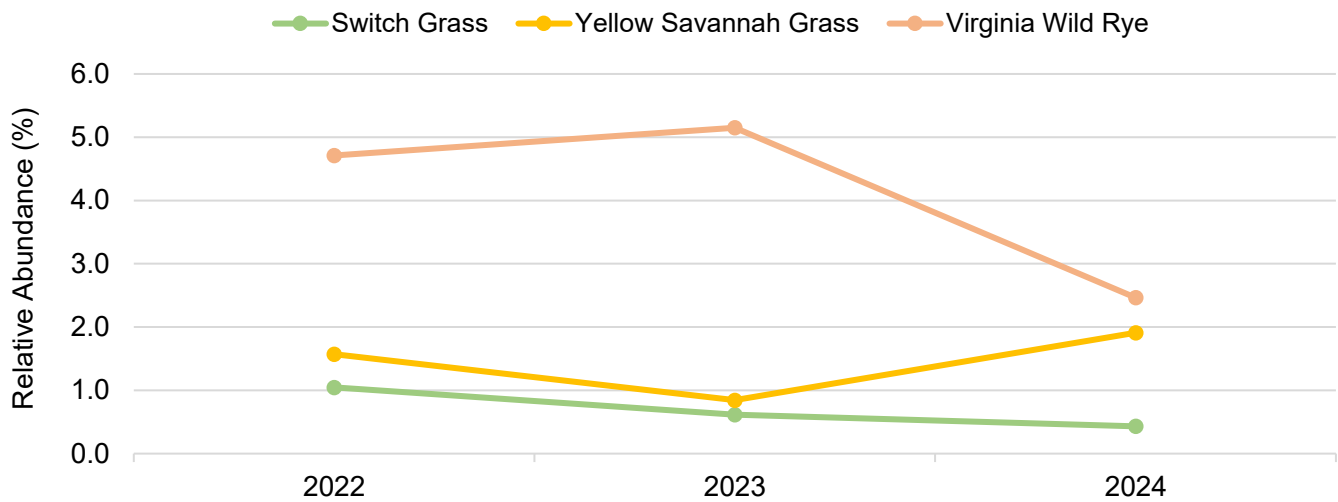


Figure 5. Relative abundance avg/plot of grass species found in quadrat surveys at Monarch Meadows 2022 to 2024.

Relative Cover

Relative cover of grass species at Monarch Meadows has varied since monitoring began in 2022. Initially, Virginia Wild Rye had the highest relative cover of native grasses (11%) but has continually declined since monitoring began (Figure 5). Conversely Yellow Savannah Grass has increased from 1.7% in 2022 to 6.9% in 2024. Switch Grass had remained relatively stable ranging from 1.9% in 2022 to 1.6% in 2024. Big Bluestem remains at extremely low cover ranging from 0.3% relative cover in 2022 to 0% in 2024. Only one non-native grass has been observed during quadrat surveys at Monarch Meadows, that being Canada Blue Grass, which was detected in 2023 at 3.8% relative cover and 2024 at 4.5% (Figure 5).

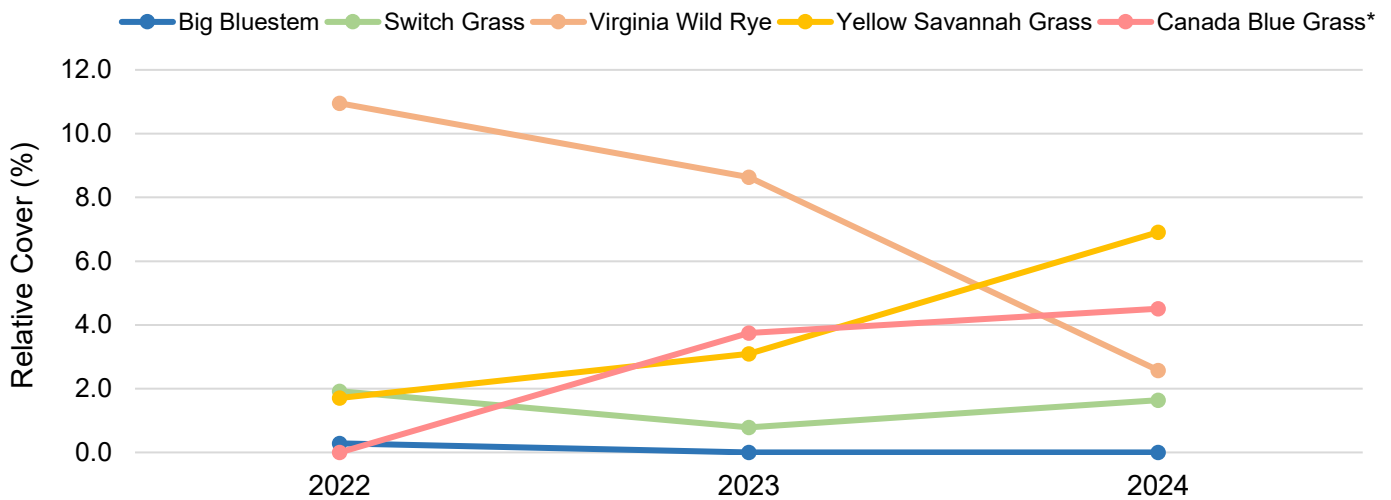


Figure 6. Relative cover avg/plot of grass species at Monarch Meadows from 2022 to 2024.

Forb Species

Abundance

The most abundant herbaceous species observed in 2022 was Common Ragweed, accounting for 19.8% of all herbaceous plants observed (Figure 6). In 2024, Common Ragweed declined to 0.4% relative abundance. Common Evening-primrose has experienced a similar decline in abundance since 2022; Evening-primrose accounted for 11.8% relative abundance in 2022 and declined to 0.2% in 2024.

Two species have increased in abundance since 2022; Tall/Canada Goldenrod and Queen Anne's Lace (Figure 6). Queen Anne's Lace has increased from 8.6% in 2022 to 18.1% in 2024. Tall/Canada Goldenrod has generally maintained its abundance, starting from 8.3% in 2022 to 10.3% in 2023, and dropping to 9.8% in 2024.

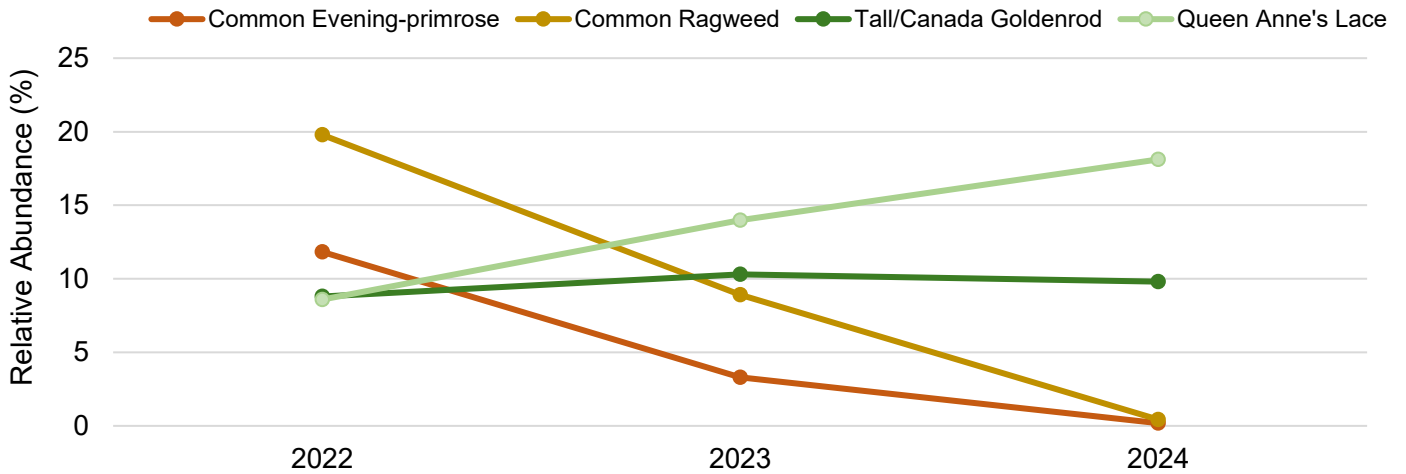


Figure 7. Relative abundance avg/plot of common herbaceous plant species at Monarch Meadows 2022 - 2024.

Relative Cover

The herbaceous plant with the highest relative cover across all three survey sessions is Tall/Canada Goldenrod, maintaining relative cover between 20% and 25% (Figure 7). Black-eyed Susan has increased from 2023 to 2024, reaching a maximum coverage of 17.2% in 2024. Lance-leaved Aster has declined in cover since 2022 from 15.9% to 10.2 in 2024. Foxglove Beardtongue has increased its coverage from 6.4% to 9.1% from 2022 to 2024.

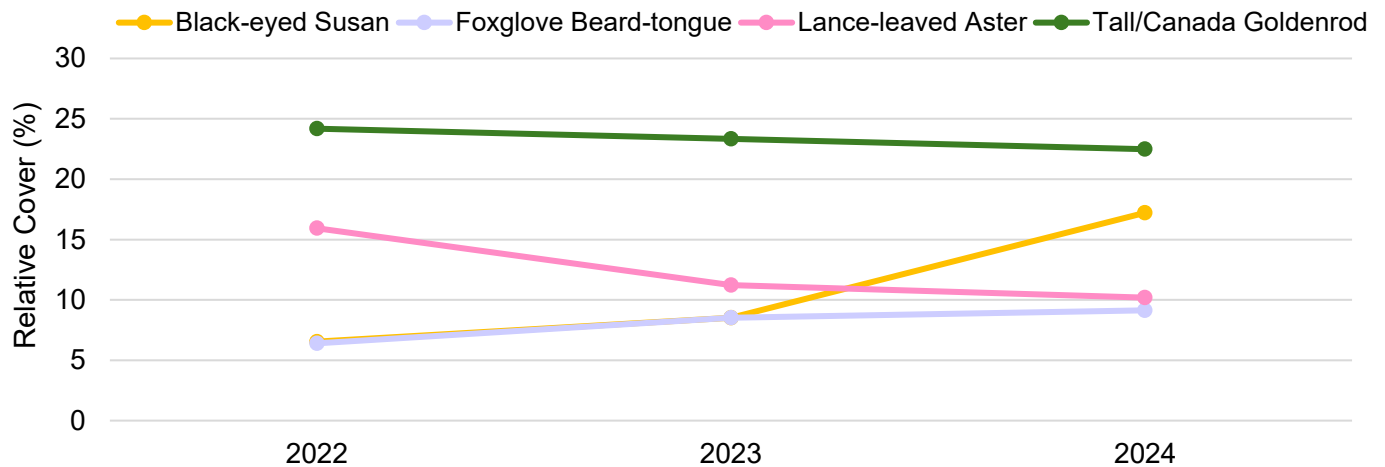


Figure 8. Relative cover avg/plot of most common herbaceous plants at Monarch Meadows from 2022 to 2024.

Non-native Plants

Abundance

Abundance of non-native species at Monarch Meadows has varied over time, with Queen Anne's Lace being the most abundant species detected during surveys (Figure 8). The relative abundance of Queen Anne's Lace has ranged from 778.8% in 2022 to 76.8% in 2023 and increasing to 89.6% in 2024. Both Black Medick and Common Dandelion have accounted for between 0% and 10% since monitoring began. Black

Medick peaked in 2022 at 10.6% but has since dropped to only 1.5% relative abundance. Similarly, Common Dandelion had a relative abundance of 6.7% in 2022 and has since dropped to 3.4%.

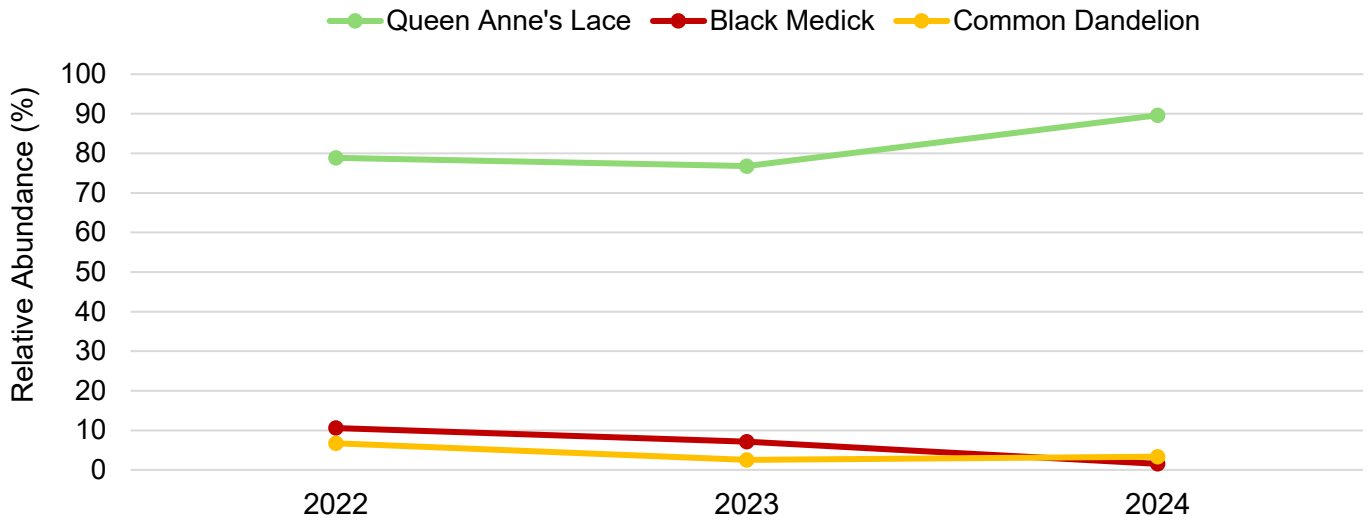


Figure 9. Non-native plant relative abundance avg/plot of common species at Monarch Meadows from 2022 to 2024.

Relative Cover

Native plant cover at Monarch Meadows has remained exceptionally high since monitoring began in 2022, when native plant cover accounted for 90.4% and non-native plant cover accounted for 9.6% (Figure 9). In 2023 native plant cover dropped to 81.5% but then increased in 2024 to 86.5%. Overall, native plant cover remains high at Monarch Meadows.

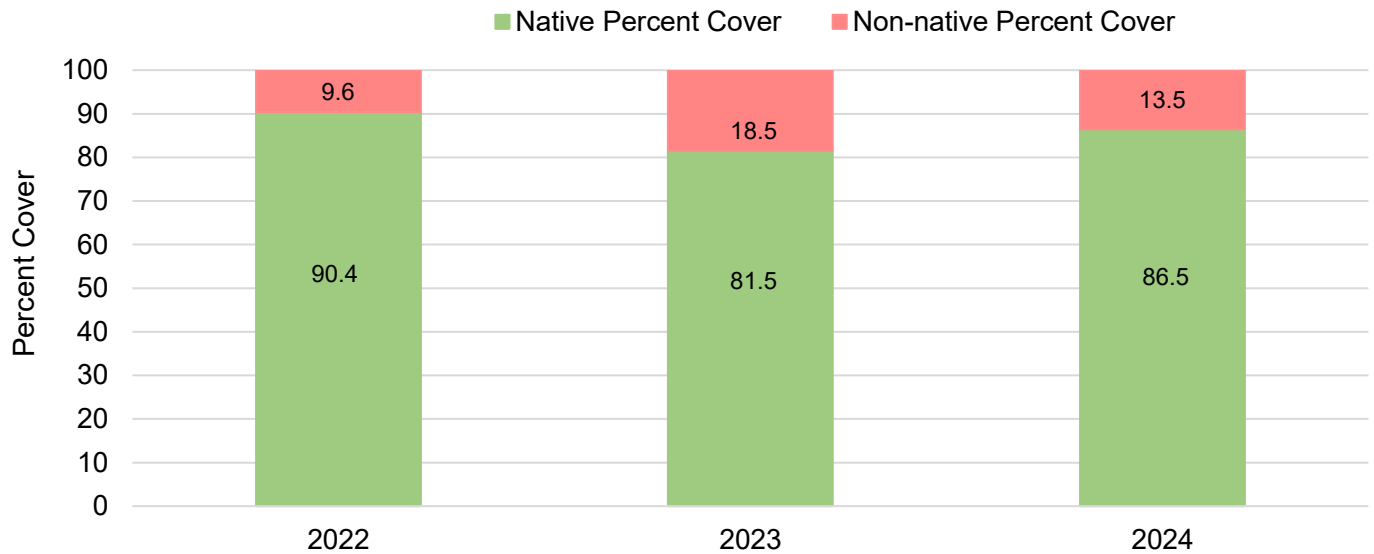


Figure 10. Native versus non-native percent cover from 2022 to 2024 at Monarch Meadows.

Species Form: Native versus Non-native Form

Looking at the form of non-native and native species, can help guide management practices going forward. At Monarch Meadows, much of the non-native species are herbaceous plants, accounting for nearly all plant cover in 2022, nearly 80% in 2023, but dropping to just under 65% in 2024 (Table 1). Non-native graminoids increased in abundance from 0% in 2022 to 4.5% in 2024. Non-native shrubs and trees only account for less than 0.5% during the most recent sampling window.

For native species, herbaceous plants account for the most cover and have remained stable in their coverage since 2022 – ranging from 75.5% in 2022, then dropping to 69% in 2023, and then increasing back to 75% in 2024 (Table 1). Graminoids have fluctuated more than herbaceous native species, ranging from 14.9% in 2022 (its peak) to a low of 11.1% in 2024. No native rushes, shrubs, or trees have been noted in Monarch Meadows since monitoring began in 2022.

Table 1. Native vs non-native species based on form at Monarch Meadows in 2022, 2023, & 2024 (quadrat monitoring).

Form Type	2022	2023	2024
Non-native	9.6%	18.5%	13.5%
Graminoid	0.0%	3.8%	4.5%
Herb	9.5%	14.6%	8.6%
Rush	0.0%	0.0%	0.0%
Shrub	0.1%	0.1%	0.2%
Tree	0.0%	0.0%	0.2%
Native	90.4%	81.5%	86.5%
Graminoid	14.9%	12.5%	11.1%
Herb	75.5%	69.0%	75.0%
Rush	0.0%	0.0%	0.0%
Shrub	0.0%	0.0%	0.0%
Tree	0.0%	0.0%	0.0%

Photo Monitoring

Despite only three monitoring sessions at Monarch Meadows, photo monitoring displays a general growth in vegetation height and density (Figure 10). In 2020, vegetation height barely reach 2 metres in height, but by 2024, vegetation height reached and surpassed 2 metres. Vegetation in the lower strata (0.0m – 1.0m) has continued to become denser as the plant community continues to establish.

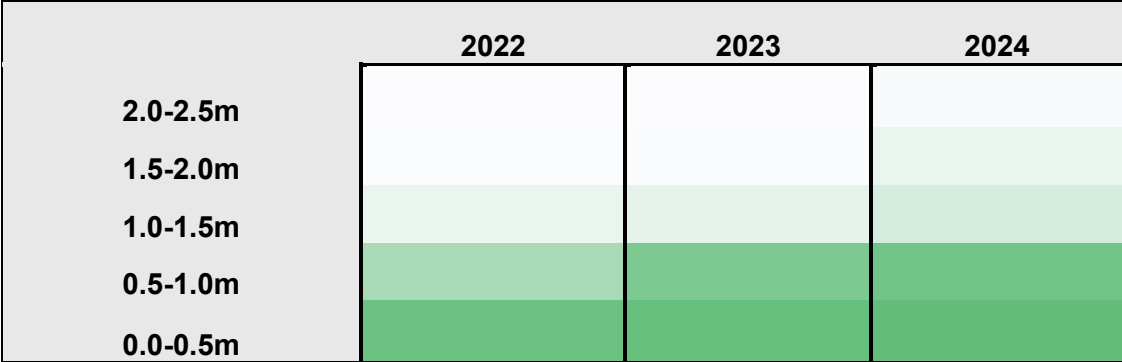


Figure 11. Photo monitoring results at Monarch Meadows from 2022 until the most recent sampling window (2024). Dark colouration represents denser vegetation growth in comparison to light colouration.

Vegetation Monitoring – Borer’s Falls Field

Relative Abundance and Cover

Overall, 18 species were observed during vegetation monitoring at Borer’s Falls in 2020. Vegetation monitoring at Borer’s Falls field was conducted only during one season (2020). At that time, unknown moss species and Tall/Canada Goldenrod were the species accounting for the greatest vegetative cover, each at 27%, Orchard Grass (13%), Timothy Grass (16%), Frost Aster (5%), and New England Aster (4%). All other species accounted for 18% relative cover.

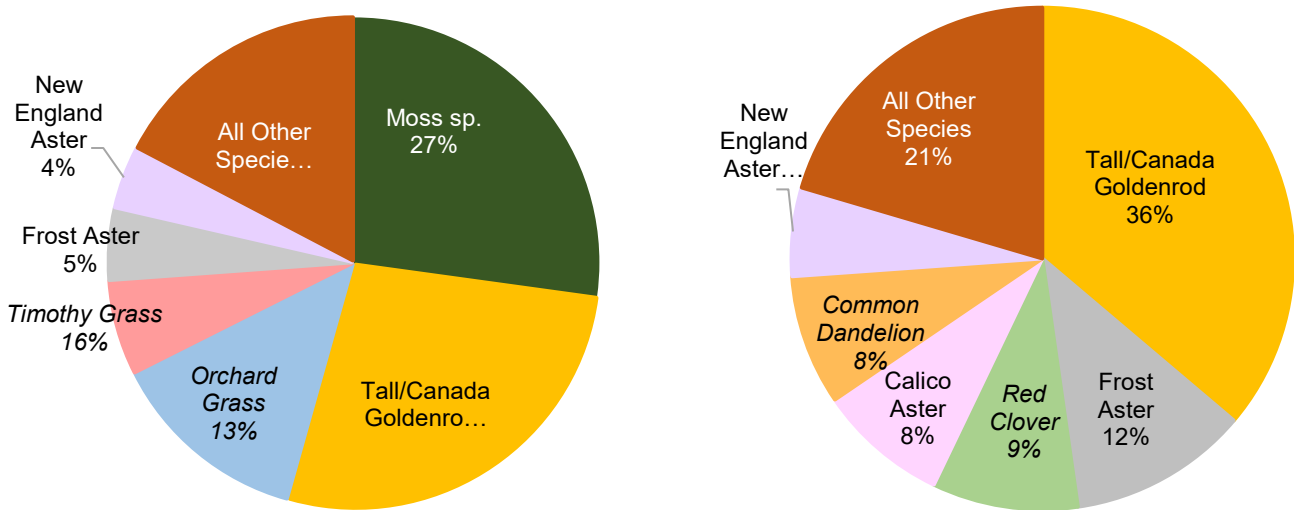


Figure 12. Relative cover of top five species (left) and relative abundance (right) at Borer’s Field in 2020.

Bird Monitoring

Species Richness

Bird species richness at Rock Chapel shows a slight decline over the past six monitoring years, with a peak in 2021 at 21 species, and a low of just 12 species in 2025 this past year (Figure 11). When comparing against the two other nature sanctuaries, Rock Chapel has the lowest species richness overall.

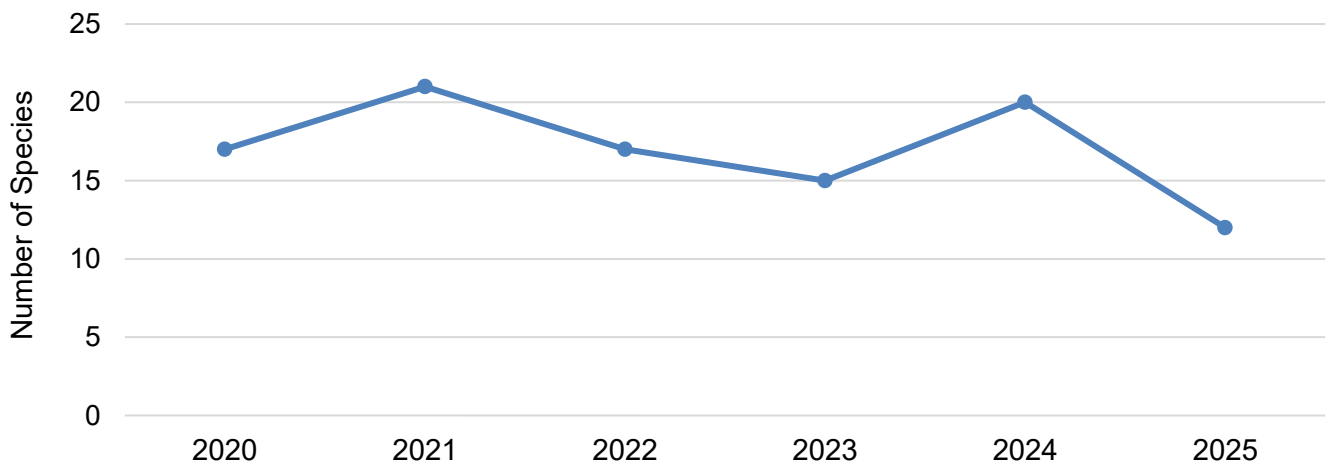


Figure 13. Total bird species richness at Rock Chapel from 2020 to 2025.

Relative Abundance

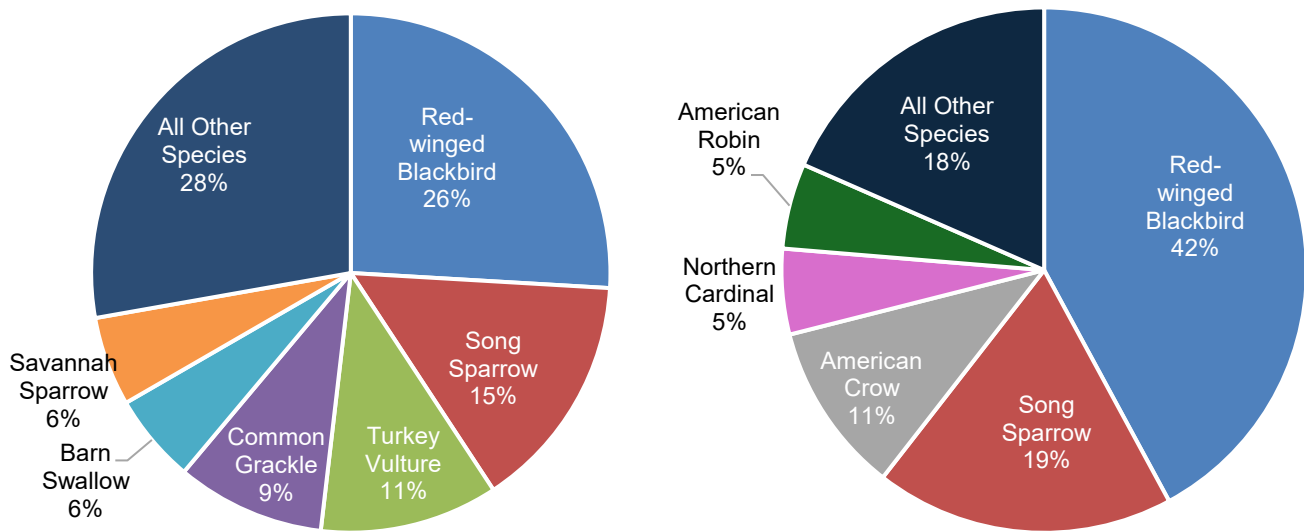


Figure 14. Relative bird abundance at Rock Chapel avg/plot in 2018 (left) and the most recent in 2025 (right).

In 2025, the most abundant species was the Red-winged Blackbird (42%), followed by Song Sparrow (19%) and American Crow (11%). The third most abundant was a tie between Northern Cardinal and American Robin at 5%, and all other species account for 18% (Figure 12). When comparing to 2018, the most abundant bird was also the Red-winged Blackbird but at (26%), followed by Song Sparrow (15%) and Turkey Vulture in third (11%). The fourth most abundant was Common Grackle (9%), and a tie for fifth was Barn Swallow and Savannah Sparrow (6%). All other species account for 28%.

Detections

Detections at Rock Chapel display strong variability since 2020, lacking any sort of directional trend (Figure 13). The year 2024 had the highest detections at 32, and the lowest number of detections occurred in 2025 with 19. Overall, an average of approximately 24 individual birds are observed each year.

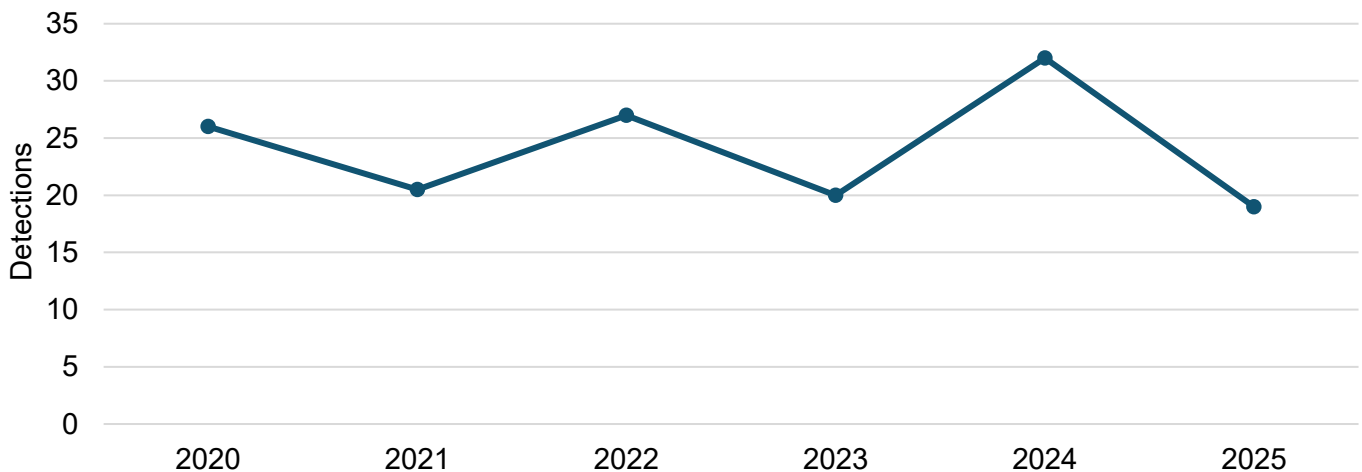


Figure 15. Averaged Bird detections per visit at Rock Chapel from 2020 to 2025.

Butterfly Monitoring

Species Richness and Detections

While it is still in the early stages of monitoring Monarch Meadows 2025 encountered substantially more butterflies than 2024, with an increase of 54 more detections and 2 more species observed, as seen in Table 2. Further monitoring at this site will help reveal any trends.

Table 2. Species richness and detections at Monarch Meadows in 2024 & 2025.

Year	2024	2025
Detections	61	115
Species Richness	11	13

Relative Abundance

In 2025, the top five most abundant species were: Cabbage white (29%), Cresent sp (19%), followed by a tie for third with the Monarch and Common wood nymph at 9% each (Figure 16). The fourth most abundant was Pearl Crescent with 7% and all other species account for 27%.

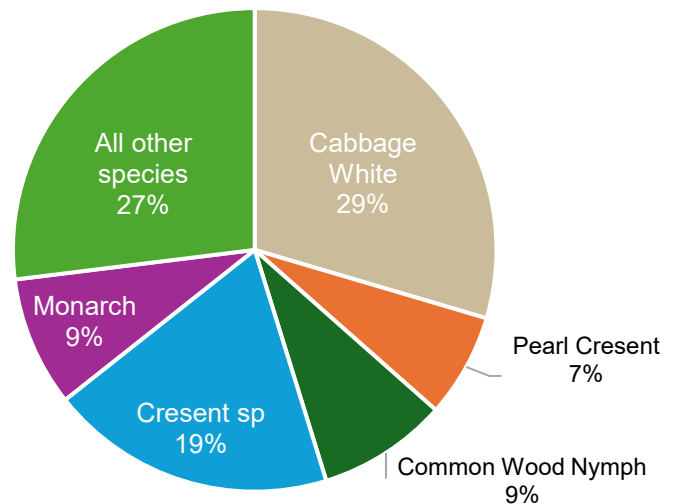


Figure 16. Top five most abundant butterfly species at Rock Chapel in 2025

Specific species

Monarch butterfly observations were increasing since monitoring began in 2011 up until 2023 which had the highest record of 48 individuals. The past two years have seen a significant decrease, with just 22 observations in 2025 (Figure 17).

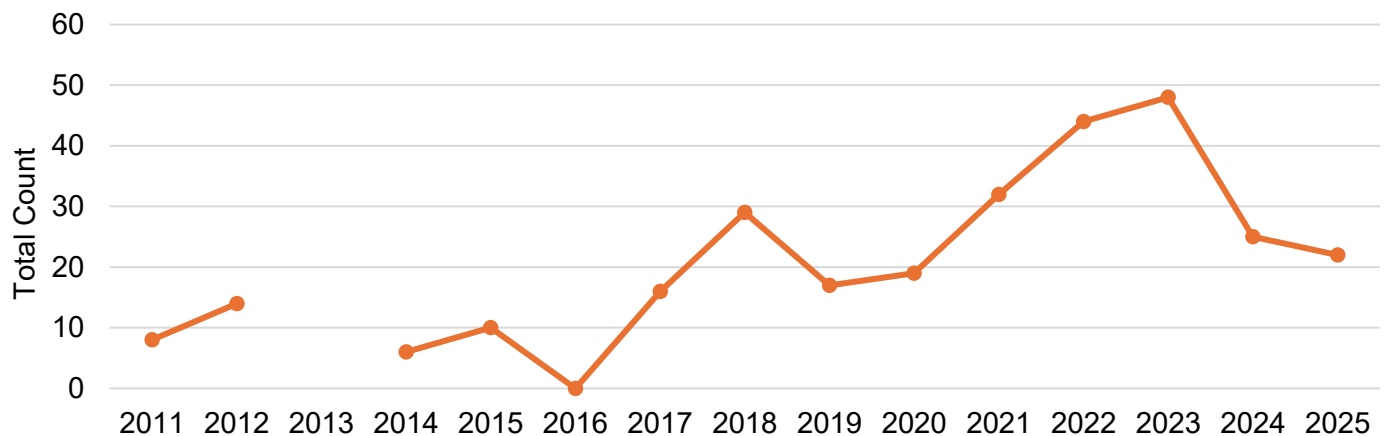


Figure 17. Monarch butterfly detections at Rock Chapel, 2011-2025.

Amphibians Observations

Since RBG regained land management of the Escarpment Fields and Monarch Meadows, it was noted that the ditched ephemeral creek pooled in low-lying areas during the wet seasons and subsequently soaked into the karst. These areas were wide and the water level remained shallow and short lived. In November 2024, minor land contouring was done in this field to eliminate the ditching and resculpt wetland features to better retain water on the landscape. Ideally, water remain throughout the amphibian breeding season.



Figure 18. Young American Toad emerging (*Anaxryus americanus*) at Monarch Meadows 2025.

During 2025 the first spring season in the new wetland at Monarch Meadows, American Toads were heard and observed using the new habitat for breeding with a collect of young toads produced (Figure 18). Other wildlife observations using the wetland include Mallards, Killdeer, and multiple dragonfly species. Continued monitoring of the wetland is required to ensure amphibian populations are utilizing the habitat in the future. Due to the extremely dry conditions much of the wetland reseeding failed.

Comparison Across RBG’s Grassland Sites

Vegetation Monitoring Comparison

Rock Chapel’s Monarch Meadow site is significant for its steady improvement in species numbers. Figure 20 shows species richness trends across three sites – Monarch Meadows, Princess Point, and Berry Tract South – from 2021 to 2025. Princess Point maintains consistently high with species richness throughout the monitoring period, fluctuating only slightly between 34 and 35 species, indicating a relatively stable and well-established community. In contrast, Monarch Meadows shows a steady upward trend, increasing from 25 species in 2022 to 34 species by 2024, suggesting successful habitat development or restoration efforts contributing to increased plant biodiversity.

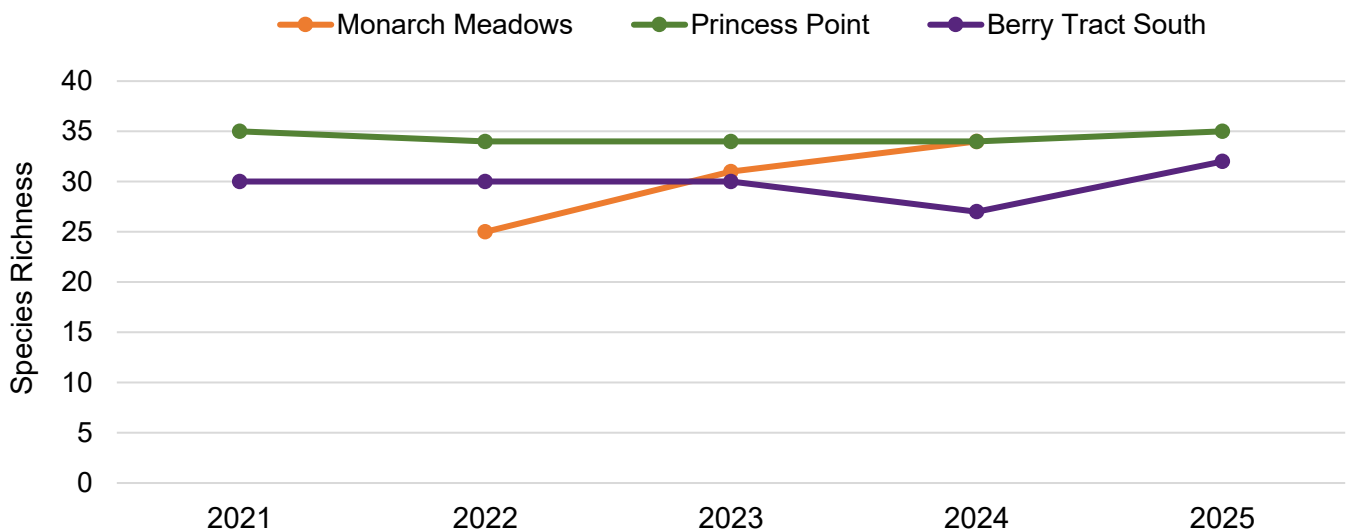


Figure 19. Species richness across all three grassland restoration sites from 2021 - 2025.

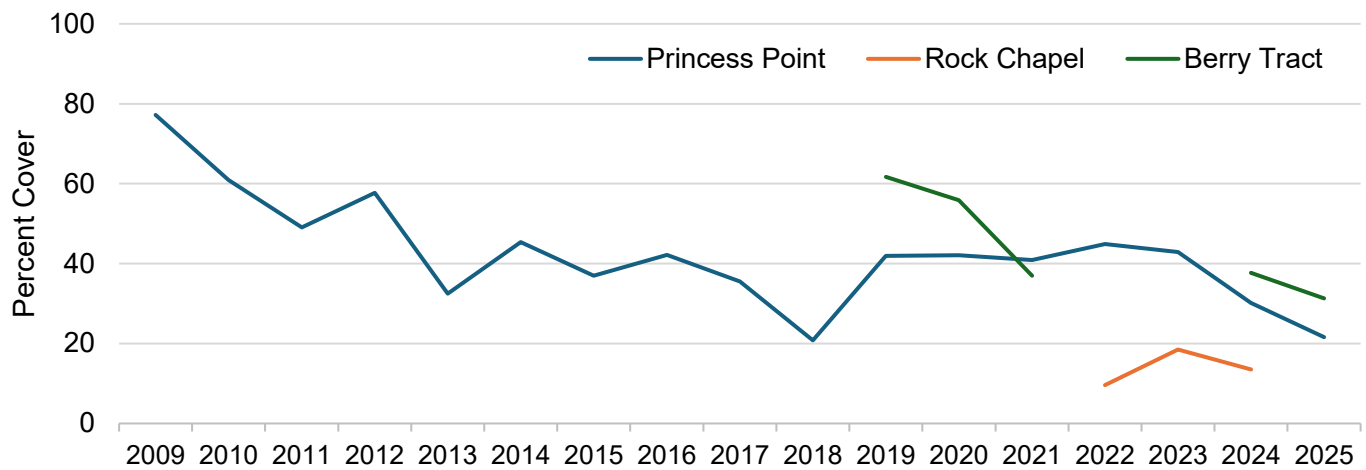


Figure 20. Averaged non-native species coverage trends at Rock Chapel, Princess Point and Berry Tract Grasslands

A comparison in the trend over time illustrates a general decline for all sites, with the principal plant community being dominated by native plant species. The Rock Chapel site faced far lower early challenges with non-native plants during the early part of establishment of seed species with non-native plant species never occupy more than 20% of the plant cover. Rock Chapel's principle non-native plant is Queen Annes Lace (*Daucus carota*), Princess Points non-native species have shifted dramatically overtime, currently most affected by Cow Vetch (*Vicia cracca*), while Berry Tract continues to have challenges with bar Soil and a currently identified grass species (*Poa sp*).

Bird Monitoring Comparison

Rock Chapel is moderate in its comparison to the other sites and appears to indicate a downward trend. Princess Point almost exclusively has the greatest number of bird detections per visit, except for 2020 when a large flock of gulls flew over the monitoring plot thus inflating the average number of detections per visit. Since then, Princess Point has the greatest number of bird detections in the grassland site. Bird detections at Berry Tract South have been declining slightly, ranging from 30 detections per visit in 2020 to around 20 detections in 2025.

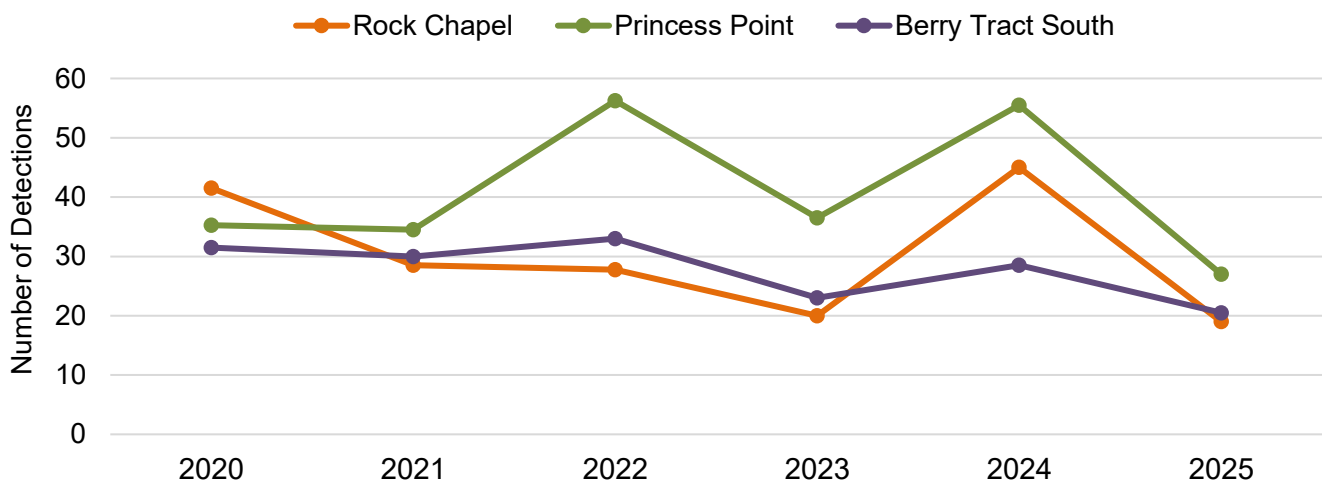


Figure 21. Averaged bird detections per visit for plots across all three grassland restoration sites 2020 - 2025.

Because Princess Point consistently has the highest number of detections, it is not surprising that it also generally supports the greatest species richness (Figure 22). However, species richness at Princess Point

has been declining since 2021, and in 2024, Berry Tract South recorded the highest number of observed species. At Rock Chapel, species richness has not yet returned to its 2021 peak of 21 species. Ongoing monitoring of species richness is important to ensure that this downward trend does not persist.

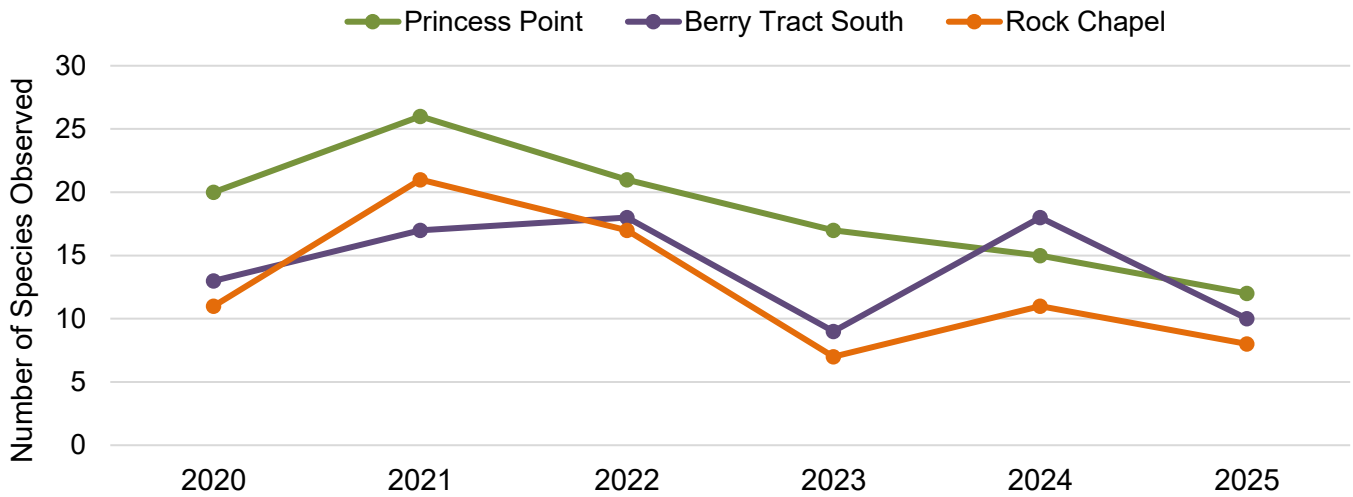


Figure 22. Averaged bird species richness per plot from 2020 - 2025 at three grassland monitoring sites at RBG.

Butterfly Monitoring Comparison

Distinct temporal trends in species richness have occurred over the past three monitoring years at Princess Point, Rock Chapel, and Berry Tract South (Figure 23). At Princess Point, species richness increases steadily from 2021 to 2024, rising from a relatively low starting point to a peak, before then stabilizing at a similarly high value in 2025. Rock Chapel follows a different pattern, with a slight dip in 2022 followed by a sharp increase to its highest value in 2024. A notable decline occurred at Rock Chapel in 2025. In contrast, Berry Tract South begins with the highest species richness in 2021 but experiences a consistent decline over time, with only a brief stabilization between 2022 and 2023 before continuing the downward trend through 2025. Overall, while Princess Point and Rock Chapel display gains in species richness in 2023 and 2024 before stabilizing or declining, Berry Tract South exhibits a clear downward trend, highlighting shifting patterns in biodiversity across the site over the five-year window.

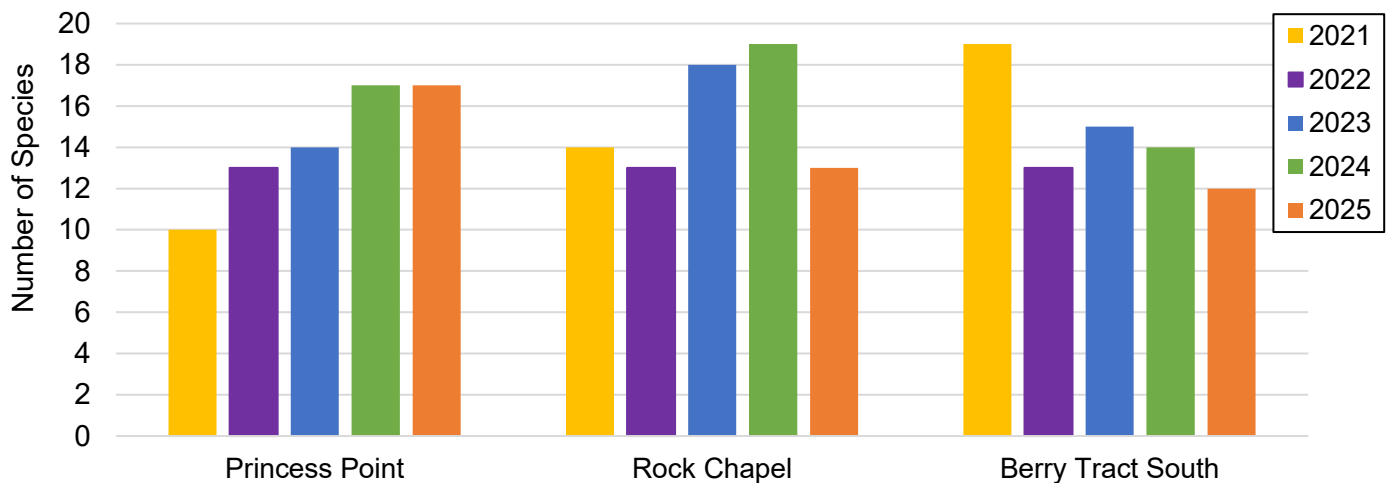


Figure 23. Butterfly species richness trends at Princess Point, Rock Chapel, and Berry Tract South from 2021 to 2025. Rock Chapels Transect length is substantially larger than the other two locations about 1km.

A clear difference can be observed in butterfly detections across Princess Point, Rock Chapel, and Berry Tract South from 2021 to 2025, with each site exhibiting distinct trends. Berry Tract South recorded the highest detections overall, peaking sharply in 2022 at just over 300 observations before declining substantially to its lowest point in 2024, followed by a rebound in detections in 2025. Rock Chapel showed a steady increase from 2021 to a peak in 2023, where it had the highest detections among all sites that year, before declining in the subsequent years. In contrast, Princess Point consistently had the lowest number of detections, with a gradual increase reaching a peak in 2023, followed by a decline through 2025. Overall, 2023 appears to be a significant year, marking the peak detections more two of the three sites over the last five monitoring years, followed by a general decreasing trend in detections. This suggests possible broader landscape environmental or ecological factors influencing butterfly presence across the sites.

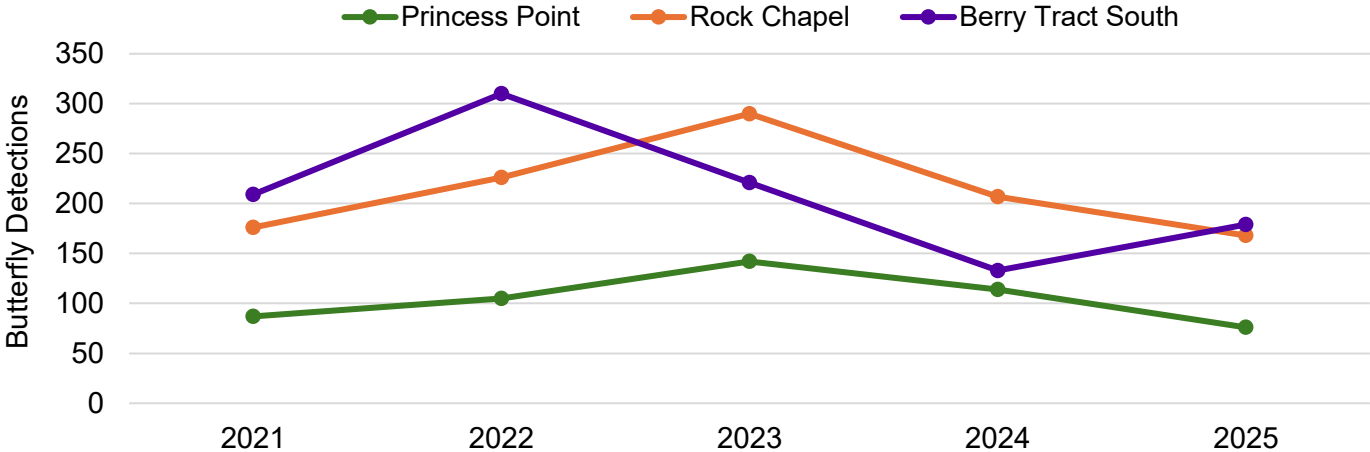


Figure 24. Butterfly detections across Princess Point, Rock Chapel, and Berry Tract South from 2021 - 2025. Rock Chapels transects combine to a substantially larger sample than Princess Pt and Berry Tract.

Discussion

Overall, the state of re-naturalization and conversion to native grassland habitat within the Rock Chapel agricultural fields has dramatically improved over time with the establishment of a native plant community. Since transition began in 2016 (Borers Falls Field) and 2020, Fields 1 to 3/Monarch Meadows, the actively seeded fields in particular have reestablished as native plant dominated sites (>85% of the plant species make up). Queen Annes lace is by far the most abundant non-native plant species present. At the same time the field under natural success by Borers Falls remains dominated by non-native plant species although native goldenrod is abundant. Observations in 2025 for this field show substantial succession of woody plants various asters and goldenrods moving into the field with the woody plants including Black Walnut, Balsam Poplar and European Buckthorn. At the same time a notable tall grass prairie species Big Bluestem was also present in low abundance and scattered throughout the field initiated by seeding.

For the other fields seeded in 2020, native plant species including both wildflowers and grasses dominate and continue to build their size and mature with time. Of the original seed mix, all but two species were not observed, while an addition 11 native species spontaneously appeared, dominated by Canada/Tall Goldenrod. When compared to the Princess Pt and Berry Tract grassland sites, Rock Chapel has a median level of diversity and abundance of plants, birds and butterflies, and does include unique species to the site. The most striking of these is Foxglove Beardtongue. Also, among the early successes includes the immediate establishment of breeding American Toads in the newly updated wetland area of 2024.

The resulting habitat is hosting a variety of wildlife with birds and butterflies counted in number and diversity. Bird monitoring averaged about 15 species dominated by Red-wing Blackbirds and butterfly monitoring found 13 species and a notable increase in numbers, essentially doubling for 2025. Within this however Monarch Butterflies while numerous were noted as substantially declined over the past 14 years despite the substantial increase in habitat area available. In addition, the reestablished wetland area manage to attract and support successful breeding of American Toads despite the broader region having very few wetland ponds to provide amphibian source populations. The meadows also now facilitate the flow of much cleaner water infiltrating the escarpment at this headwaters area of Borers Creek, flowing to Cootes Paradise.

Going forward the grasslands still face challenges of invasive species as well as ongoing visitor disturbance and in particular noise from adjacent Rock Chapel Rd.

Plant Community

Forbs

Notable shifts in forb composition (wildflowers) were observed, reflecting changes in competitive dynamics, successional stage, and possibly site conditions. Tall/Canada Goldenrod, a species not actively seeded, remains the dominant species throughout the study period, maintaining consistently high relative cover, with only a slight decline detected between 2022 and 2024. This stability in cover suggests that it is well established and competitively strong at the site. Its persistence at high abundance may also be limiting the establishment or expansion of other species through shading or subsurface competition.

Black-eyed Susan demonstrates a clear increase at Monarch Meadows field, particularly between 2023 and 2024, where it comes one of the more prominent forbs. This species can be associated with early – to mid-successional grassland habitat succession, and its expansion suggests that portions of the site may still be in a relatively transitional state.

In contrast, Lance-leaved Aster shows a steady decline over time, decreasing from relatively high cover in 2022 to lower levels in 2024. This trend may indicate that it is being outcompeted as the density within the

plant community becomes higher or that the site conditions are shifting from those that originally supported its establishment.

Overall, the forb community appears to be transitioning from one dominated by a few species, particularly goldenrod and aster species, toward a more balanced assemblage of native meadow species with increasing presence of species like Black-eyed Susan and Foxglove Beardtongue. However, the continued dominance of goldenrod suggests that competitive exclusion may still be influencing community structure. These trends suggest an intermediate stage of succession, where diversity is increasing but a complete balance of species composition must be reached. Continued monitoring will help determine whether balance is achieved, or if dominance by a few species persists.

Grasses

Meadow succession occurred within grass species community composition as well. There are clear shifts in the grass species community from 2022 until 2024, which suggests ongoing ecological succession and changing competitive dynamics within the community. One of the most drastic trends is the sharp decline in Virginia Wild Rye, which drops from relatively high cover in 2022 to much lower coverage in 2024. This observed pattern is consistent with its role as an early-successional species: it establishes quickly following disturbance but is often out-competed over time by longer-lived tall grass species. Its decline suggests the site is transitioning from early establishment conditions.

In contrast, Yellow Savannah Grass shows a strong and steady increase, particularly between 2023 and 2024, where it becomes one of the dominant grass species at Monarch Meadows. This upward trend indicates successful establishment, likely due to its ability to outcompete early establishing species. Non-native Canada Blue Grass increases from completely absent in 2022 to more substantial cover in 2024. Canada Blue Grass is not a desired species at the site, and efforts to remove such species should be considered to protect long-term ecological integrity of the site.

Switchgrass shows some fluctuation, but remains relatively stable at low abundance, with a slight decrease in 2023, but then increases in cover in 2024. This might suggest Switchgrass is a late-successional colonizing species. Another native grass species that was seeded at the site is Big Bluestem, which remains nearly absent throughout the study period. Its absence is notable given its importance in grassland habitats. Its lack of increase may suggest certain site limitations such as soil conditions, interspecific competition, or perhaps, insufficient time to establish.

Vegetation Structure

Photo monitoring captures shifts in vertical density across height classes. Overall, the progression from light to darker colouration between 2022 and 2024 indicates an increase in vegetation density, suggesting that the site is maturing and accumulating plant biomass as succession proceeds.

In 2022, vegetation appears relatively sparse across most height classes, particularly in the mid- and upper layers. This is expected, as early-stage restoration supports plant establishment, and the vertical plant community is limited. However, in 2023, there is a noticeable increase in density, particularly within the mid-height ranges (0.5 – 1.0m). This suggests that previously established plants are growing taller and that structural complexity is being established. Increased density in these layers can increase and improve habitat quality by providing more cover and foraging opportunities for insect and bird species.

In 2024, darker colouration across multiple height classes, especially from 0.5-2.0m, indicates a continued increase in vegetation density and a more fully developed vertical vegetation profile. The expansion of vegetation into taller height classes suggests successful establishment of robust forbs and grasses.

Structural diversification is an important factor in meadow establishment and development, as it supports greater biodiversity and ecological function.

Overall, the photo monitoring results show a clear pattern of increasing vegetation density and vertical stratification over time. Continued monitoring will be vital to ensure that this structural complexity is maintained.

Wildlife Community

Breeding Bird Surveys

During the 2025 bird monitoring season there were 19 overall detections and 12 different species at Rock Chapel, which is the lowest since monitoring began at this site. There have not been any noticeable species specific or species-at-risk trends although future years may reveal this. The most recent decline is no doubt reflective of the habitat modification of the plant community were a more formalized version of the wetland area was just initiating reestablishment from seed resulting in a notable bare and open area in the early season when monitoring for birds was occurring.

It's also important to note that declines in detections of certain bird species should not be interpreted as evidence that restoration efforts are ineffective as more broadly bird species associated with grasslands are in significant decline due to loss of habitat (State of Canada's Birds 2024) While local habitat restoration can improve breeding or stopover conditions, bird populations are influenced by many factors across their full annual cycle. Mortality during migration—such as collisions with windows and buildings, exposure to poor air quality, and other environmental stresses—can reduce the number of birds that ultimately reach these restored sites. In addition, conditions on their overwintering grounds, including habitat loss or food scarcity, may also affect survival and population size. As a result, even when restoration is improving local habitat quality, broader pressures occurring during migration or on wintering grounds can still lead to declines in detections. This highlights the importance of considering the entire migratory lifecycle when interpreting monitoring data.

Butterfly Surveys

For the butterfly surveys at Monarch Meadows in 2025, there were a total of 115 detections and 13 different species, with the most abundant being the Cabbage White. There have only been two years of monitoring at this site, and future years can help to identify any trends. The sites result compared to the other meadows is biased slightly by a longer transect, and thus does have fewer butterflies than Berry Tract and Princess Pt.

As for butterflies, factors such as pesticide exposure, weather, and limited connectivity between suitable habitats can affect survival and movement. In addition, the availability of host plants needed for larval development in surrounding areas may influence whether they establish or persist at restored sites. Similar to birds, butterflies also migrate annually into the southern U.S and Mexico where deforestation and increasing heat and drought conditions are threatening their populations. As a result, detections may decline even when local habitat quality is improving, highlighting the importance of considering landscape-level factors when interpreting these monitoring results.

Considering Monarch Meadows was formerly agricultural land with limited native plant diversity and few suitable resources for nesting or larval development, the site has undergone substantial ecological improvement. Restoration efforts have supported the return of a greater diversity of species than observed in decades prior, an important context when interpreting years with lower observations. Despite natural fluctuations, the site continues to provide valuable habitat, and ongoing efforts aim to support a wide range

of species. In the face of broader global stressors, we hope species of all kinds find Monarch Meadows as a refuge where they can find suitable habitat and resources.

Emerging Threats

Grassland Pests, Climate Change, and Diseases

Native grasslands are generally less affected by large-scale pest and disease outbreaks than forest ecosystems, which may make them more resilient under future climate conditions. Forests are often dominated by a relatively small number of tree species, increasing their vulnerability to species-specific pests and pathogens, many of which are expanding their ranges and intensifying as temperatures rise. In contrast, grasslands typically support a high diversity of plant species, reducing the likelihood that any single pest or disease could cause widespread damage.

Grassland plants also tend to be shorter-lived and more adaptable, allowing them to recover more quickly from disturbance compared to forests, which often respond more slowly to environmental change (Zhu et al., 2024). However, it is important to recognize that the lower reported incidence of pests and diseases in grasslands may partly reflect a lack of research and monitoring, as these impacts are more extensively studied in forest ecosystems.

In the context of Rock Chapel, these characteristics suggest that maintaining and restoring native grassland habitat could support a more stable and resilient ecosystem under changing climate conditions (Zhu et al., 2024). As pressures from pests, heat, and drought continue to increase, grasslands may remain less susceptible to large-scale biological disturbances.

At the same time, climate change is expected to significantly alter species composition across ecosystems. While exact outcomes remain uncertain, projections can be explored using climate modeling scenarios, which estimate how different greenhouse gas emission pathways may affect species and habitats over time. Tools such as Natural Resources Canada's 'Plant Hardiness Zone Maps' help identify which species are likely to persist under future conditions and which may shift their ranges.

These scenarios vary in severity. A low-emissions pathway (e.g., SSP1-2.6) assumes strong mitigation efforts, limiting warming and allowing many species to remain within their current ranges. A moderate scenario (e.g., SSP2-4.5) projects intermediate change, where some species may shift or face new stressors. A high-emissions scenario (e.g., SSP5-8.5) anticipates continued increases in emissions, resulting in greater warming, more extreme weather, and heightened risks such as habitat loss and population declines.

Climate models also distinguish between "core" and "range" habitats. Core habitat refers to the most critical areas required for a species' long-term survival, while range habitat encompasses the broader area a species occupies, including regions of less frequent use. Understanding these distinctions helps guide restoration and conservation planning under future climate conditions.

To assess potential changes at Rock Chapel, we applied a moderate climate scenario (SSP2-4.5), representing approximately 2°C of warming. By examining native plant and bird species at each site, we can evaluate whether these areas are likely to remain within species' core habitats or if range shifts may occur, informing more resilient management and restoration strategies.

As shown in Table 3, many grassland plant species are projected to retain their core habitat at Rock Chapel in a 2°C increase climate scenario, except for Flat-topped White Aster, Hairy Beard-tongue and Virginia Mountain Mint which will be moved to range habitat. This pattern highlights the relative resilience of grasslands to increasing temperatures compared to tree species found in a forest ecosystem, as seen in the

2024 Rock Chapel Forest Status Report. These findings suggest that maintaining and restoring grassland habitats at Rock Chapel may support greater ecological stability under future climate conditions.

Table 3. Plant species currently present in Rock Chapel monitoring plots 2025, and their current and forecasted core habitat presence on site, based on climate modelling scenarios (scenario 245, 2071-2100).

Species Name	Latin Name	Current Range	Present at RBG in Forecasted Range Shift
Big Bluestem	<i>Andropogon gerardii</i>	✓	✓
Black-eyed Susan	<i>Rudbeckia hirta</i>	✓	✓
Common Evening-primrose	<i>Oenothera biennis</i>	✓	✓
Common Milkweed	<i>Asclepias syriaca</i>	✓	✓
Common Ragweed	<i>Ambrosia artemisiifolia</i>	✓	✓
Daisy Fleabane	<i>Erigeron annuus</i>	✓	✓
Flat-topped White Aster	<i>Doellingeria umbellata</i>	✓	✗
Foxglove beardtongue	<i>Penstemon digitalis</i>	✓	✓
Frost Aster	<i>Solidago pilosum</i>	✓	✓
Grass-leaved Goldenrod	<i>Euthamia graminifolia</i>	✓	✓
Hairy Beard-tongue	<i>Penstemon hirsutus</i>	✓	✗
Heath Aster	<i>Symphyotrichum ericoides</i>	✓	✓
Lance-leaved Aster	<i>Symphyotrichum lanceolatum</i>	✓	✓
New-England Aster	<i>Symphyotrichum novae-angliae</i>	✓	✓
Prairie Aster/Upland White Goldenrod	<i>Solidago ptarmicoides</i>	✓	✓
Purple-leaf Willowherb	<i>Epilobium coloratum</i>	✓	✓
Rugels Plantain	<i>Plantago rugelii</i>	✓	✓
Slender rush	<i>Juncus tenuis</i>	✓	✓
Smooth Aster	<i>Symphyotrichum laeve</i>	✓	✓
Switch Grass	<i>Panicum virgatum</i>	✓	✓
Tall/Canada Goldenrod	<i>Solidago canadensis</i>	✓	✓
Virginia Mountain Mint	<i>Pycnanthemum virginianum</i>	✓	✗
Virginia Wild Rye	<i>Elymus virginicus</i>	✓	✓
Yellow Savannah Grass	<i>Sorghastrum nutans</i>	✓	✓

The same forecasting has been produced by the National Audubon Society, a tool known as Audubon's Climate Change Interactive Map. For this, scientists took 140 million observations to delineate the range of 604 North American bird species and then used the latest climate change models to project how each species range will shift under different scenarios. We used the + 2 °C increase scenario to match the models we used for grassland plants. With this, we were able to see how the grassland bird species that inhabit Rock Chapel may change in the future.

Table 4. Bird species present in Rock Chapel monitoring 2025, and their current and forecasted range using climate modeling scenario (+ 2°C by 2050). Check mark represents present/forecasted and x indicates loss of suitable habitat.

Species Name	Present in Current Range	Climate Change Range Shift by 2050 (+ 2 °C)
American Crow (<i>Corvus brachyrhychos</i>)	✓	✓
American Robin (<i>Turdus migratorius</i>)	✓	✓
Baltimore Oriole (<i>Icterus galbula</i>)	✓	✓
Blue Jay (<i>Cyanocitta cristata</i>)	✓	✓
Common Yellowthroat (<i>Geothlypis trichas</i>)	✓	✓
Eastern Kingbird (<i>Tyrannus tyrannus</i>)	✓	✓
Eastern Wood-Pewee (<i>Contopus virens</i>)	✓	x
European Starling (<i>Sturnus vulgaris</i>)	✓	✓
Northern Cardinal (<i>Cardinalis cardinalis</i>)	✓	✓
Northern Yellow Warbler (<i>Setophaga aestiva</i>)	✓	x
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	✓	✓
Song Sparrow (<i>Melospiza melodia</i>)	✓	x

Grassland bird species that will be most affected by a 2°C increase and will lose this area as a suitable habitat are Eastern Wood-pewee, Northern Yellow Warbler and Song Sparrow (Table 4). That is roughly 1/4th of the species seen here during the 2025 season. The temperature changes of this climate scenario will lead to more extreme weather events such a droughts or flooding and research suggests that grassland birds are sensitive to temperature warming and increased variability in precipitation (Nelson et al., 2024).

Climate change is reshaping ecosystems worldwide by altering temperatures and precipitation patterns and increasing the frequency and severity of extreme events such as droughts and heat waves (Hoover et al., 2014). Grasslands are well adapted to these changing conditions, making them valuable as climate pressures intensify. Many species allocate substantial biomass below ground, enabling access to deeper soil moisture and supporting ecosystem stability during moderate drought conditions

Research has also shown that when a certain plant species declines under climate stress, others can quickly expand to fill in the gaps, helping maintain ecosystem function (Hoover et al., 2014). This process tends to occur much more quickly in grasslands, where fast-growing herbaceous species dominate, compared to forests with slower-growing trees. However, this resilience has limits: prolonged or extreme drought can reduce productivity and diminish biodiversity, including long-term impacts on seed banks (Basto et al., 2018).

Grasslands also serve as one of the important carbon reservoirs in terrestrial ecosystems, storing about one third of the global terrestrial carbon (Lui et al., 2024). This means they don't just survive drought but also help mitigate climate change itself. Further the specific fields of the Rock Chapel plateau contain several headwater tributaries of Borer's Creek, with several passing through the town of Dundas as buried creeks as well as passing under the CN rail corridor.

Grasslands provide a range of important ecosystem services, including water management to alleviate flood risk (Marley et al., 2024). They contribute to flood mitigation by absorbing rainfall and slowing the movement of water across the landscape. However, their effectiveness depends on maintaining healthy soil conditions, as they are more resilient to flooding and soil loss when degradation like compaction is minimized (Marley et al., 2024). This highlights the importance of trail users staying on designated paths.

The deep, dense root systems of grassland plants enhance soil structure and create pore spaces that allow water to infiltrate the ground. This process reduces surface runoff, which can otherwise overwhelm streams and drainage systems during heavy rainfall events. In addition, grasslands can temporarily store excess water and release it gradually, helping to reduce peak flows and lessen the severity of flooding downstream.

Wildfires

Across many of the bird species richness and detection graphs, there is a clear decline in 2023 and 2025. Air quality indices identify these years as having some of the worst wildfire smoke conditions in Ontario and across Canada in recent decades. Our records from those seasons show at least 16 survey days affected by wildfire smoke, resulting in hazy conditions and poor air quality – far exceeding and previous monitoring year. Existing research suggests that birds can be negatively impacted by smoke exposure, experiencing health effects similar to those observed in humans.

Following the 2023 wildfires, a recent study examined the vocal activity of grassland birds in New York in response to smoke response to smoke exposure. The study found that higher smoke levels were associated with reduced bird vocal activity, with the most pronounced declines observed in species such as Bobolink, Eastern Meadowlark, Field Sparrow and Savannah Sparrow (Simamora et al. 2026). Because vocalizations are critical during the breeding season for mate attraction, territory defense, and parent-offspring communication – reductions in these behaviors may lower overall fitness.

Together these findings suggest that wildfire smoke may represent an additional stressor for grassland bird populations. Although it remains a new and relatively understudied area, it's important to consider when interpreting the patterns observed in the above graphs. Further research is needed, particularly as wildfire frequency and intensity are expected to increase with rising global temperatures.

Increased Anthropogenic Pressures and Visitor Behaviour

Visitation is expected to increase at Rock Chapel in the coming years, especially once an improved parking lot is added to the site. Rock Chapel is surrounded by an increasingly urban environment, making it a top tier nature recreation destination in the Hamilton area. One of the most popular nearby natural features in the Rock Chapel Nature Sanctuary is Borer's Falls, as waterfall visitation in Hamilton is a major tourism draw for residents and visitors to the city. Increased visitor use has direct and indirect consequences for grassland ecosystems – with one of the most significant impacts resulting from off-trail use.

Off trail Use and Vegetation Destruction

Off trail use negatively impacts grassland ecosystems by compacting soil. Soil compaction reduces soil porosity, limits water absorption, and restricts root growth, which ultimately results in decreased plant growth and vigor. Grassland plant species are sensitive to disturbance, with trampling being a primary threat to their survival. Grassland vegetation communities are greatly threatened to repeated disturbance that can reduce native plant cover, expose bare soil, and shift the vegetation community to one dominated by non-native plant cover. The expansion of off trail use fragments habitats, increasing edge effects that can facilitate and support the establishment of invasive species spread.

Trail expansion and widening also poses a threat to plants that grow along the edges of trails. Unsanctioned trail expansion often occurs to due trail user error: failing to walk single file when passing fellow trail users and wearing improper footwear during wet seasons (avoiding minor water pooling on trails). RBG's accessibility to urban environments might attract inexperienced hikers, and therefore, many inexperienced trail users often utilize RBG trails resulting in poor trail use behaviour. Proper trail etiquette should be outlined at trailheads to ensure trail users are aware of the expectations while on the trail.

In addition to physical impacts on the plant community, increased human presence off-trail elevates disturbance to wildlife. Ground-nesting birds and other sensitive species that rely on grassland habitats to breed are particularly vulnerable to frequent human activity, noise, and presence of pets. Even low levels of repeated off-trail disturbance can alter behaviour, reduce reproductive success, and lead to habitat avoidance. This is considerably concerning as many grassland bird species are Species-at-Risk.

An additional way that the plant community can be negatively impacted by increased visitation is through poaching of wildflowers. Poaching wildflowers from a meadow can have cascading ecological impacts that extend well beyond the immediate loss of individual plants. The removal of flowering individuals reduces reproductive capacity by interrupting seed production and therefore, dispersal, ultimately leading to declines in plant population size and overall genetic diversity. This is particularly concerning as all grassland plant species rely on pollinators – even the loss of a few plant species can disrupt pollinator interactions by reducing nectar and pollen availability for insects. Repeated poaching can also shift community compositions by selectively removing the most conspicuous or desirable species, allowing invasive species potential establishment.

Increased Litter

With increased visitation comes increased levels of litter and graffiti, of which are already a current issue at Rock Chapel. Litter poses a threat to local wildlife in various ways including potential ingestion of litter, attracting wildlife to roadsides, and altering wildlife behaviour – potentially attracting increased levels of predators into the surrounding environment.

Accumulated litter – especially plastics, paper, and food waste – can block sunlight, reduce photosynthesis, and limit seed germination. This is particularly problematic in native grassland habitats where many species depend on open soil and specific light conditions for successful establishment. Over time, this can shift plant community composition and reduce native biodiversity.

Litter can also alter soil conditions. As garbage decompose or fails to (in the case of plastics), it can introduce contaminants or change soil chemistry. Food waste may increase localized nutrient levels, favouring fast-growing, often invasive species over native grasses and forbs adapted to low-nutrient conditions. Additionally, non-native biodegradable materials can contribute to soil contamination and long-term habitat degradation.

Wildlife can directly impact as animals may ingest litter or become entangled in it, leading to major injury or death. Ground-nesting birds and small mammals are particularly vulnerable. Litter can also attract predators or subsidize generalist species (e.g. raccoons, crows, etc.) which can increase predation pressure on sensitive or declining grassland wildlife.

Overall, litter contributes to a broader pattern of site degradation. Visible waste can signal a lack of land management or stewardship, encouraging further misuse of the nature sanctuary. This can lead to increased off-trail use, trampling, and other undesirable visitor behaviours that result in significant ecological damage. Therefore, managing litter, not just in grassland habitats but across all nature sanctuaries, is an important component of maintaining habitat quality, protecting biodiversity, and supporting long-term restoration goals.

Environmental Stewardship Recommendations

Invasive Plant Species

Poa spp.

Management of *Poa spp.* (*invasive grass species*) is required to maintain the ecological integrity and desired species composition of Monarch Meadows field. *Poa spp.* is most effectively managed through regular

prescribed burns. This promotes native warm-season grasses and forbs while limiting the establishment of cool-season species. Mechanical and chemical control methods are generally not practical or effective management options for *Poa spp.* within these habitats. To date, Monarch Meadows has yet to be burned. It is strongly recommended to implement an appropriate burn regime for the site to support long-term grassland health and structure.

Dog-strangling Vine

Vincetoxicum spp., commonly referred to as Dog-strangling Vine, is a perennial herbaceous vine introduced to Canada to 1899 that has since become widespread throughout southern Ontario. The species poses a significant threat to grassland and old field restoration initiatives due its prolific seed production, and ability to function as a habitat generalist. Dog-strangling Vine has the capacity to establish rapidly and form dense monocultures, thereby displacing native vegetation and undoing restoration progress. At Rock Chapel, Dog-strangling Vine does not currently exist within the grassland habitat. However, there is a significant population of Dog-strangling Vine along the forested, talus slope of Rock Chapel. Satellite populations have been found growing adjacent to Monarch Meadows— likely originating from the slope populations.

It is recommended to manage the Dog-strangling Vine found growing elsewhere on Rock Chapel property. Management of Dog-strangling Vine should follow the operational procedures outlined in the RBG Dog-strangling Vine management plan. Manual removal is recommended for small, localized infestations within grassland habitats. For larger, or more established patches, targeted herbicide application is required to achieve effective control. Prescribed burns are not sufficient for eradication; however, they may be incorporated as one component of an integrated management strategy.

Early detection and rapid response are critical to limiting establishment and spread. Inspections for Dog-strangling Vine should therefore be integrated into routine field activities to enable timely treatment of emerging populations.

Common Reed

Common Reed (*Phragmites australis*) has been recognized as one of Canada's worst invasive species by Agriculture and Agri-Food Canada. It currently occurs within Monarch Meadows and neighboring properties. Within Monarch Meadows, it is most dense near the wetland and has been treated annually since 2020 which has significantly reduced the population. On the opposite side of Rock Chapel Rd is a large stand of Common Reed – likely the source population. It is unlikely this population will be eradicated, thus consistent monitoring for Common Reed at Monarch Meadows is required to catch any early establishment.

Prescribed burns can be used to help slow the spread of Common Reed but is not adequate for complete eradication. As eradication is the goal for Monarch Meadows, it is recommended to treat any stems with glyphosate. This treatment can occur during treatment of other invasive species at Monarch Meadows if the glyphosate is mixed at a 5% solution.

Reed Canary Grass

Invasive Reed Canary Grass (*Phalaris arundinacea subsp. arundinacea*) exhibits substantially greater growth and competitive ability than traditional, native grassland species. It has only been found to exist as an isolated small population (approx. 4x4 meters) within Monarch Meadows. It was treated along with Common Reed and Reed Managrass, however, additional treatments may be necessary. Reed Canary Grass has also been found to occur nearby along the Southern border of the escarpment fields. Early detection and rapid response are essential to preventing the establishment and spread of Reed Canary Grass. Inspections should be incorporated into routine field activities to prevent it from establishing within Monarch Meadows.

Due to the low density of Reed Canary Grass within the Rock Chapel property, management options are chosen for small, targeted treatments. For effective eradication of Reed Canary Grass, it is recommended to perform a foliar herbicide applications using glyphosate. Prescribed burns can be used as part of a management strategy if performed during appropriate seasonal windows (September and August). This will only be effective if it is found that Reed Canary Grass is spreading into a burnable area.

Reed Manna Grass

Invasive Manna Grass (*Glyceria maxima*) is found within and surrounding Monarch Meadows. The management of Manna Grass began in 2021 through treatment performed by an external contractor. RBG staff have continued to treat the Manna Grass and have significantly reduced the dominance of the species. It is recommended that this treatment is continued as the likelihood of Manna Grass eradication is high.

Prescribed burns can be implemented as part of the overall management strategy to help control Manna Grass. However, it alone is insufficient to control the population and should be combined with chemical treatment to achieve the desired restoration outcomes.

Woody Invasive Species Management

Continuing management of invasive woody species is critical to maintaining the ecological classification and native species composition of Monarch Meadows.

Common Buckthorn and European Black Alder can both be found along the border of the grassland. These species are known for their rapid spread and ability to form dense monocultures. If allowed to establish, these species will critically change the ecological classification of Monarch Meadows. Management has occurred in the past for these species in which significant herbicide treatment was performed by an external contractor. Additionally, RBG staff have continued to perform chemical treatments of these species. It is recommended that chemical treatments continue as part of the management of Monarch Meadows.

Visitor and Neighbour Behaviour

Off-leash Pets

Rock Chapel is the nature sanctuary with the highest frequency of off-leash pets, particularly dogs, due to repeat offenders. Both free-roaming cats and dogs are frequently observed across Rock Chapel's trail system, as well as off-trail. Off-leash dogs pose a threat to grasslands in various ways, such as disturbance and predatory behaviour towards wildlife, native plant community destruction (through digging, etc.), and promotion of off-trail use to other trail users (trampling of vegetation). In Australia, there are restrictions on dog visitation in natural areas and national parks, with some areas prohibiting dogs year-round and others prohibiting dogs during sensitive ecological time periods (i.e. bird nesting season) (Eeden et al.



Figure 25. Example of off-leash dog (left foreground), well off-trail, in the forest at Rock Chapel Nature Sanctuary with RBG staff in the background.

2022). It has also been shown that compliance rates are not necessarily related to levels of enforcement (Carter, 2016. Schneider et al. 2020). In-depth behaviour analysis suggests that dog-owner beliefs that off-leash exploration is beneficial to dogs, specifically in noncompliant demographics (young men) (Eeden et al. 2022). Therefore, targeted communication and educational opportunities exist to provide evidence-based

reasoning for leashing dogs in nature sanctuaries – not only for the protection of the ecosystem, but also for the safety of dogs.

Off-leash cats pose one of the greatest threats to local small mammal species and low-nesting or ground-nesting birds. Free-ranging, or off-leash, cats have been listed among the 100 worst invasive species in the world (Lowe et al. 2000). Their impacts include local reduction in terrestrial bird populations and account for a substantial proportion of wildlife mortality (Crooks & Soule, 1999; van Heezik et al. 2010; Churcher & Lawton, 1987; Baker et al. 2008). Estimates by Loss et al. (2013) suggest that free-roaming domestic cats kill between 1.3 – 4 billion birds and 6.3 – 22.3 billion mammals annually. Free-roaming cats frequent the western end of Rock Chapel Nature Sanctuary, only 65 metres from the nearest grassland restoration site and less than 5 metres from the entrance to Rock Chapel’s forest.



Figure 26. Free-roaming cat beside Rock Chapel Nature Sanctuary.

Unsanctioned Trails

On the former meadow restoration site, Borer’s Falls Field, neighbouring property owners have mowed a strip of grassland habitat to use as their own walking path. This has been an ongoing issue for at least 13 years. This unsanctioned mowing and path creation distinctly fragments meadow habitat, reducing plant survival and proliferation, compacts soil limiting water infiltration and plant root growth, increases potential for invasive species’ spread, and disrupting vital microhabitats which affects insects and ground-nesting birds. Borer’s Field is already a small meadow, and therefore, fragmenting the habitat even further can increase edge effects – introducing more sunlight and wind to the ecosystem, and inflating predation rates on ground-nesting birds as ease of access throughout the habitat increases with fragmentation.

Encroachment and Yard Waste Dumping

A small suburban neighbourhood directly abuts the furthest west end of Rock Chapel Nature Sanctuary. The neighbours that line these few streets often dump their yard waste (grass clippings, annual plants, etc.) into the adjacent nature sanctuary and nearby to its grassland restoration sites. Many negative ecological impacts caused by this activity exist, including suppression of native plant growth, introduction of non-native and potentially invasive plants, introduction of non-native pests and disease, nutrient enrichment in ecosystems adapted to low nutrient conditions, mounds of yard waste compost, and introduction of horticultural waste (i.e. plastic garden pots). This outdated and ecologically detrimental practice greatly threatens the ecology of RBG’s grassland restoration sites. Therefore, on-going communication to neighbours should be initiated to ensure awareness of the threat this activity poses to the grassland and forest ecosystems.

In addition to yard waste dumping at Rock Chapel Nature Sanctuary, the immediate adjacent neighbours often encroach on RBG property by illegally extending their property boundaries onto RBG property. Neighbours have been observed clearing low-growing plants and placing furniture and installing play structures on RBG’s property. Communication attempts have been made to remedy the situation to no avail. A fence exists on the property line north of the trail, but not on the southern portion. Therefore, installing a fence on the property line splitting the two properties is encouraged to ensure that encroachment ceases.

Ecological Management and Restoration

Controlled Burns

Although controlled burns have not yet been used as a restoration tool at Rock Chapel, it is most certainly a tool to consider in the future. Indications of prevalent invasive species colonizing of the site have yet to be detected during vegetation monitoring, it is expected that invasive species will infiltrate the site to some degree. Small-scale eradication of establishing invasive populations will be conducted as needed. If non-native species abundance approaches equilibrium with native plant cover, despite on-going management, then a controlled burn is recommended to control non-native plant growth.

Preventing Off-trail Use

The re-routed trail at Rock Chapel and the associated parking lot re-location will bring significantly higher trail user traffic close to the newly restored Monarch Meadows grassland site. The picturesque grassland will be in view from the trail, and trail users will likely be tempted to veer from the trail to get a closer look at the native wildflowers. As has been continually experienced at Princess Point, and especially with the evolution of social media and picture-sharing, unsanctioned off-trail paths can quickly develop if visitors aren't directed to a spot where photographs can be taken. Off trail sanctioned use and unofficial paths enhance vegetation trampling and soil compaction leading to increasing invasive species spread, increase disturbance to wildlife such as ground-nesting birds, and fragmenting habitat. Off trail use often leads to a feedback loop; initial disturbance makes an area appear more intriguing and accessible, encouraging further use and accelerating habitat degradation. Therefore, built structures are highly encouraged to guide trail users to designated viewing platforms will prevent extensive off trail use from occurring at Monarch Meadows.

Land Acquisition and Grassland Transformation

Property acquisition is a key component of grassland restoration, enabling the protection and active management of priority lands while facilitating their ecological re-connection over time. Strategically acquiring parcels adjacent to existing grassland restoration sites strengthens the ecological integrity of individual systems and supports the development of larger, more continuous grassland habitats across the landscape. Many grassland bird species require large swaths of continuous habitat, and therefore, RBG should prioritize land acquisition of nearby fields to enhance and expand current grassland habitats.

These interconnected or closely situated patches also improve habitat connectivity, promote species' movement – particularly where wildlife-supporting infrastructure structures such as culverts are present – and enhance genetic diversity, all of which contribute to greater ecosystem function and resilience. At a broader scale, a network of connected grassland ecosystems can buffer against disturbances such as climate change and invasive species, making restoration efforts more impactful across the landscape.

Opportunities for Future Research

Pollinator Inventory Study

Although butterflies have been monitored over the long term, a full pollinator inventory has yet to be completed at Rock Chapel. Establishing this baseline is critical for understanding, and ultimately protecting, the ecological relationships within grassland communities. This work would reveal trends, highlight emerging threats, and identify conservation opportunities over time, thereby supporting broader stewardship efforts and helping ensure that essential pollination services continue to sustain plant and wildlife communities, and overall ecosystem resilience.

Additionally, conducting a more comprehensive insect inventory would deepen understanding of the food web that supports local bird populations. Many bird species depend heavily on insects, especially during the breeding season when protein demands are high. Gathering this information would offer valuable insight into

local food web interactions and help guide future land management decisions aimed at maintaining local robust pollinator populations and preserving the ecological interactions that underpin the ecosystem.

Plant-Pollinator Interaction Study

Future research could prioritize identifying the plant species that play the largest role in sustaining diverse and resilient pollinator communities across the growing season. This could include examining flowering phenology and assessing how plant resources are distributed over time to meet pollinator demands from early spring to late fall. Identifying gaps in nectar and pollen availability is especially important, as such shortages can strongly affect pollinator survival. Gaining insight into these seasonal dynamics is key to informing effective habitat management.

Another area of study could explore the level of specialization within the ecosystem, determining whether certain pollinators depend heavily on species plant species or if interactions reflect a more generalist preference. This information is particularly valuable for restoration efforts, as highly specialized relationships may be more susceptible to disturbance or species loss, with implications for overall ecosystem stability. Investigating how invasive species influence these interactions would also be a critical piece of information, given their competitive and aggressive impacts on native plant and pollinator communities.

Further research could involve evaluating pollination effectiveness – measuring not just visitation rates, but how successfully different pollinators contribute to plant reproduction. Such findings would help identify which species are more functionally important within grassland plant and insect communities. Collectively, these research topics would provide a more comprehensive understanding of the interconnectedness between pollinators and plants. Results would also support more informed restoration practices, improved species selection for planting and seeds, and long-term management strategies that promote both biodiversity and ecological function.

Soil Analysis Study

A soil chemical analysis study is extremely important for grassland sites because restoration depends heavily on rebuilding the microbiome within the soil profile. This study is critical because agricultural practices often leave a lasting imprint on soil chemistry. Years of fertilizer application, pesticide use, and soil disturbance can greatly alter nutrient levels, pH, and microbial processes. These changes tend to persist long after farming practices have ceased – creating conditions that differ greatly from those needed to support native grassland ecosystems. Detailed understanding of these residual effects can greatly improve restoration efforts.

Soil chemical analysis also provides a baseline for tracking site recovery over time. Since agricultural soil is often left in a highly altered state, monitoring changes in nutrient levels, organic matter, and other chemical indicator levels helps measure progress toward restoration goals. This information supports adaptive management, allowing land managers to refine and alter their strategies as the ecosystem develops.

Conclusion

When considering the vegetation community transformation at Rock Chapel to date, the ecological change is remarkable. Starting from ecologically unproductive agricultural fields to native meadows that support a variety of bird and butterfly species is an accomplishment in restoring biodiversity. Monarch Meadows showcases this restoration work – featuring a restored wetland and native vegetation of interest, including an abundance of Foxglove Beardtongue in early summer to native grasses in late summer - a striking site.

Monarch Meadows boasts a relatively high native plant cover compared to other restored fields at RBG such as Berry Tract South and Princess Point. Taking advantage of timing and seeding native species directly after agriculture use was key to the success and establishment of grasslands at Rock Chapel. The biggest benefit being that the non-native perennial species haven't had time to re-establish post agriculture, but as we can see through monitoring, they are emerging and annual site surveys are required to detect patches of invasive species and control them before they become a difficult problem. Overall, when compared to the Princess Pt and Berry Tract grassland sites, Rock Chapel has similar although sometimes slightly high diversity and abundance of plants, birds, but less butterflies, and does include unique species to the site. The fields also provide much cleaning water from the ephemeral creeks soaking into the karst in these re-naturalized fields.

Most invasive species challenges are associated with the rehabilitated wetland situated in the centre of Monarch Meadows. This area was not used for agriculture and sat untouched for many years where highly invasive species like Common Reed, Reed Manna Grass and European Black Alder thrived. While much effort was made to control these species, they will continue to be a challenge the site. Challenges also continue with the desire for public access and use the site and as such an updated trail experience is in process to allow visitors to experience the field while aligning the adjacent trail (Rock Chapel Loop) to provide the maximum space available for wildlife habitat.

Monarch Meadows is still a more recently established grassland. Bird, butterfly and amphibian populations are expected to improve over time, as the vegetation matures. Monarch Meadows which is relatively small in size compared to Berry Tract South may not have the capacity to support grassland birds who need more space. There is an opportunity further expand the native grassland into another area of regenerating field to the south within Rock Chapel. Invasive grasses and succession are two main issues in establishing a healthy grassland here, but it is good shorter-term opportunity to expand the grassland within the property. A refined site management plan, including invasive species management will be developed to prioritize restoration practices going forward as part of the RBGs Terrestrial Habitats Management Projects Plan.

In Ontario meadows/grasslands exist primarily as temporary habitats in transition after disturbance. Disturbance events can range from abandoned agricultural practices, overgrown pastureland, to fires or large-scale windstorm blow down events. Currently, nearly 99% of native grassland habitat across the continent has been destroyed. The lack of grassland habitat makes RBG's grassland restoration sites some of the most unique and important habitat in the Hamilton area and key site into the future in support of Hamilton's Biodiversity Action Plan (2025).

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Appendix

Table 5. List of native species found at Monarch Meadows, indicating which arrived by seeding or established naturally

Species (Common)	Species (Scientific)	In Seed Mix & Observed	Seed Mix & Not Observed	Spontaneous
Big Bluestem	<i>Andropogon gerardii</i>	✓		
Common Milkweed	<i>Asclepias syriaca</i>	✓		
Tall coreopsis	<i>Coreopsis tripteris</i>	✓		
Flat-topped White Aster	<i>Doellingeria umbellata</i>	✓		
Virginia Wild Rye	<i>Elymus virginicus var. virginicus</i>	✓		
Wild Bergamot	<i>Monarda fistulosa</i>	✓		
Common Evening-primrose	<i>Oenothera biennis</i>	✓		
Switch Grass	<i>Panicum virgatum</i>	✓		
Foxglove Beardtongue	<i>Penstemon digitalis</i>	✓		
Hairy Beard-tongue	<i>Penstemon hirsutus</i>	✓		
Tall cinquefoil	<i>Potentilla arguta</i>	✓		
Virginia Mountain Mint	<i>Pycnanthemum virginianum</i>	✓		
Black-eyed Susan	<i>Rudbeckia hirta</i>	✓		
Grey goldenrod	<i>Solidago nemoralis</i>	✓		
Upland White Goldenrod	<i>Solidago ptarmicoides</i>	✓		
Yellow Savannah grass	<i>Sorghastrum nutans</i>	✓		
Smooth Aster	<i>Symphyotrichum laeve</i>	✓		
Riverbank Wild Rye	<i>Elymus riparius</i>		✓	
Sand Dropseed	<i>Sporobolus cryptandrus</i>		✓	
Devils Beggarstick	<i>Bidens frondosa</i>			✓
Horseweed	<i>Conyza canadensis</i>			✓
Purple-leaf willowherb	<i>Epilobum coloratum</i>			✓
Grass-leaved goldenrod	<i>Euthamia graminifolia</i>			✓
Slender rush	<i>Juncus tenuis</i>			✓
Rugel's Plantain	<i>Plantago rugelii</i>			✓
Tall/Canada Goldenrod	<i>Solidago altissima/canadensis</i>			✓
Heath Aster	<i>Symphyotrichum ericoides</i>			✓
Lance-leaved Aster	<i>Symphyotrichum lanceolatum</i>			✓
New England Aster	<i>Symphyotrichum novae-angliae</i>			✓
Frost Aster	<i>Symphyotrichum pilosum</i>			✓

Table 6. Bird species seen at Berry Tract South from 2017-2025. Note: protocol change after 2022, from 4 to 2 visits/site.

Species Name	2018	2020	2021	2022	2023	2024	2025
American Crow (<i>Corvus brachyrhynchos</i>)	x	x	x		x		x
American Goldfinch (<i>Spinus tritis</i>)	x	x	x	x	x		
American Robin (<i>Turdus migratorius</i>)	x	x	x	x	x	x	x
Baltimore Oriole (<i>Icterus galbula</i>)		x	x	x	x	x	x
Barn Swallow (<i>Hirundo rustica</i>)	x	x		x			
Black-billed Cuckoo (<i>Coccyzus erythrophthalmus</i>)			x				
Black-capped Chickadee (<i>Poecile atricapillus</i>)			x	x		x	
Blue Jay (<i>Cyanocitta cristata</i>)	x	x	x	x	x	x	x
Brown Thrasher (<i>Toxostoma rufum</i>)						x	
Brown-headed Cowbird (<i>Molothrus ater</i>)			x		x	x	
Canada Goose (<i>Branta canadensis</i>)			x			x	
Cedar Waxwing (<i>Bombycilla cedrorum</i>)		x	x	x		x	
Chipping Sparrow (<i>Spizella passerina</i>)	x		x				
Common Grackle (<i>Quiscalus quiscula</i>)	x	x		x			
Common Yellowthroat (<i>Geothypis trichas</i>)				x	x	x	x
Double-crested Cormorant (<i>Nannopterum auritum</i>)			x			x	
Downy Woodpecker (<i>Dryobates pubescens</i>)			x			x	
Eastern Kingbird (<i>Tyrannus tyrannus</i>)							x
Eastern Towhee (<i>Pipilo erythrophthalmus</i>)	x		x				
Eastern Wood-Pewee (<i>Contopus virens</i>)				x		x	x
European Starling (<i>Sturnus vulgaris</i>)		x	x	x			x
Gray Catbird (<i>Dumetella carolinensis</i>)	x		x		x		
Great Blue Heron (<i>Ardea Herodias</i>)		x		x			
Great Crested Flycatcher (<i>Myiarchus crinitus</i>)		x		x			
House Sparrow (<i>Passer domesticus</i>)			x				
Indigo Bunting (<i>Passerina cyanea</i>)	x		x				
Killdeer (<i>Charadrius vociferus</i>)	x						
Mourning Dove (<i>Zenaida macroura</i>)			x	x	x		
Northern Cardinal (<i>Cardinalis cardinalis</i>)	x	x	x	x		x	x
Northern Flicker (<i>Colaptes auratus</i>)				x	x	x	
Northern House Wren (<i>Troglodytes aedon</i>)		x	x				
Northern Yellow Warbler (<i>Setophaga aestiva</i>)				x			x
Red-bellied Woodpecker (<i>Melanerpes carolinus</i>)	x					x	
Red-eyed Vireo (<i>Vireo olivaceus</i>)	x			x	x		
Red-tailed Hawk (<i>Buteo jamaicensis</i>)			x			x	
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	x	x	x	x	x	x	x
Rock Pigeon (<i>Columbia livia</i>)			x	x			
Rose-breasted Grosbeak (<i>Pheucticus ludovicianus</i>)						x	
Savannah Sparrow (<i>Passerculus sandwichensis</i>)	x		x				
Song Sparrow (<i>Melospiza melodia</i>)	x	x	x	x	x	x	x
Tree Swallow (<i>Tachycineta bicolor</i>)		x					
Turkey Vulture (<i>Cathartes aura</i>)	x		x	x	x	x	
Unknown Accipiter species				x			
Unknown Gull species		x	x		x		
Unknown Sparrow species			x				
Wood Thrush (<i>Hylocichla mustelina</i>)				x			
Total	54	83	114	111	40	90	38

Table 7. Butterfly species at Rock Chapel in 2024 and 2025

Species Common Name	Scientific Name	2024	2025
American Painted Lady	<i>Vanessa virginiensis</i>		
Banded Hairstreak	<i>Satyrium calanus</i>	x	
Black Swallowtail	<i>Papilio polyxenes</i>		x
Cabbage White	<i>Pieris rapae</i>	x	x
Canada x Eastern Swallowtail hybrid			
Clouded Sulphur	<i>Colias philodice</i>	x	x
Swallowtail spp. (black)	<i>Papilio or Battus sp.</i>		
Common Wood Nymph	<i>Cercyonis pegala</i>	x	x
Crescent sp.		x	x
Delaware Skipper	<i>Atrytone logan</i>	x	
Dun Skipper	<i>Euphyes vestris</i>		
Columbine Dusky Wing	<i>Erynnis lucilius</i>		
Eastern-tailed Blue	<i>Everes comyntas</i>	x	x
European Skipper	<i>Thymelicus lineola</i>		
Fritillary sp.		x	
Giant Swallowtail	<i>Papilio cressphontes</i>		
Great Spangled Fritillary	<i>Speyeria cybele</i>		x
Juvenal's Duskywing	<i>Erynnis juvenalis</i>		
Least Skipper	<i>Ancyloxypha numitor</i>		
Little Glassy Wing	<i>Pompeius verna</i>		
Little Wood Satyr	<i>Megisto cymela</i>		
Monarch	<i>Danaus plexippus</i>	x	x
Mourning Cloak	<i>Nymphalis antiopa</i>		
Hairstreak spp.			
Northern Broken Dash	<i>Wallengrenia egeremet</i>		
Northern Cloudy Wing	<i>Thorybes pylades</i>		
Northern Crescent	<i>Phyciodes morpheus</i>		
Northern Pearly Eye	<i>Enodia anthedon</i>		x
Orange Sulphur	<i>Colias eurytheme</i>		
Painted Lady or American Painted Lady	<i>Vanessa sp.</i>		
Pearl Crescent	<i>Phyciodes tharos</i>		x
Question Mark or Comma sp.			
Question Mark	<i>Polygonia interrogationis</i>		
Red Admiral	<i>Vanessa atalanta</i>	x	
Red Spotted Purple	<i>Speyeria cybele</i>		
Silver Spotted Skipper	<i>Epargyreus clarus</i>	x	
Skipper sp.			x
Sulphur sp			
Summer Azure	<i>Celastrina neglecta</i>		
Tiger Swallowtail sp.	<i>Papilio sp.</i>		
Virginia Ctenucha (moth)	<i>Ctenucha virginica</i>		
Wild Indigo Duskywing	<i>Erynnis baptisae</i>		x
	Total Detections	61	115
	Species Richness	11	13