Toronto and Region Conservation Authority

Oak Ridges Corridor Conservation Reserve: Changes in Natural Heritage Conditions 2008-2021

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EXECUTIVE SUMMARY

Oak Ridges Corridor Conservation Reserve (ORCCR) is a 428 ha parcel of land located just south of the community of Oak Ridges in the City of Richmond Hill. Several natural heritage objectives were outlined in the Oak Ridges Corridor Park Management Plan. To track progress towards meeting these objectives, Toronto and Region Conservation Authority (TRCA) initiated a terrestrial long-term monitoring program at ORCCR in 2008. This report summarizes results from the monitoring program from 2008 to 2021. It is not a full characterization describing all the natural heritage features and biodiversity.

Flora and fauna communities at the ORCCR have changed between 2008 and 2021 and some of these changes may be related to natural succession, restoration activities, or adjacent residential development.

The forest vegetation plot is experiencing natural succession towards a more mature forest community as observed by high mortality rates of pin cherry (a mid-successional species). The forest has also lost mature ash trees as a result of Emerald Ash Borer (*Agrilus planipennis*) which has affected trees across the jurisdiction. Forest bird communities have not changed over time (since formal monitoring began in 2008) and consist of a mixture of species representing both forest/generalist/edge environments. Veery was detected for the first time in 2018 at station 2 and is an area-sensitive species known to occur in disturbed or regenerating forests.

Changes in wetland hydrology occurred between 2008 and 2021. Two wetlands in the west end had no water in 2021 while in other years had considerable water depths. Two wetlands in the north had considerably greater water depths in recent years than in the past. These changes in hydrology affected wetland vegetation and are expected to also affect fauna communities in subsequent years.

Wetland vegetation was most heavily affected by changes in water levels. There was a decrease in the amount of woody vegetation on transects where water levels increased while transects that lost water subsequently lost floating and submergent species. Common buckthorn continues to spread in one transect; however, has decreased in cover and abundance on two other transects. Wetland bird communities have been similar over time consisting of several generalist and wetland-dependent species.

Six frog species were found using the park and the number of species has not changed over time at any of the stations. Frequency of occurrence of Spring Peeper (*Pseudacris crucifer crucifer*) was the highest occurring at all stations, while Wood Frog (*Lithobates sylvatica*) at station 1 in the west end have only been detected in low numbers in recent years and could be an early warning sign of an issue for the local population.

Several species of regional concern were detected at meadow bird stations including most notably Bobolink (*Dolichonyx oryzivorus*) although numbers of this species, along with several other meadow bird metrics (such as meadow-dependent bird species richness, proportion of birds using meadow habitat), have been declining at stations in the west end. These declines may be occurring due to the recent nearby residential development or re-forestation efforts.

In additional to biodiversity monitoring, several forms of recreation-related impacts have been noted such as informal trails, mountain biking off trails, litter, and intentionally broken branches, and these impacts appear to have increased since the start of the covid-19 pandemic.

Overall, terrestrial monitoring has highlighted that ORCCR has been subject to changes in biodiversity reflecting both regional patterns (e.g. Emerald Ash Borer) and more localized changes (e.g. water levels). Changes in biodiversity in response to localized changes should be carefully considered within the context of the overall natural heritage vision and objectives and used to guide future management of ORCCR.

INTRODUCTION

Oak Ridges Corridor Conservation Reserve (ORCCR) is a 428 ha parcel of land located just south of the community of Oak Ridges in the Town of Richmond Hill (Figure 1). Historically this land was used by First Nations but more recently has been used for farming, recreation, and residential purposes. The site contains numerous ecological features including wetlands and kettle lakes and represents one of the most diverse collections of wildlife, plant species, and habitats found on the Oak Ridges Moraine (TRC 2006).

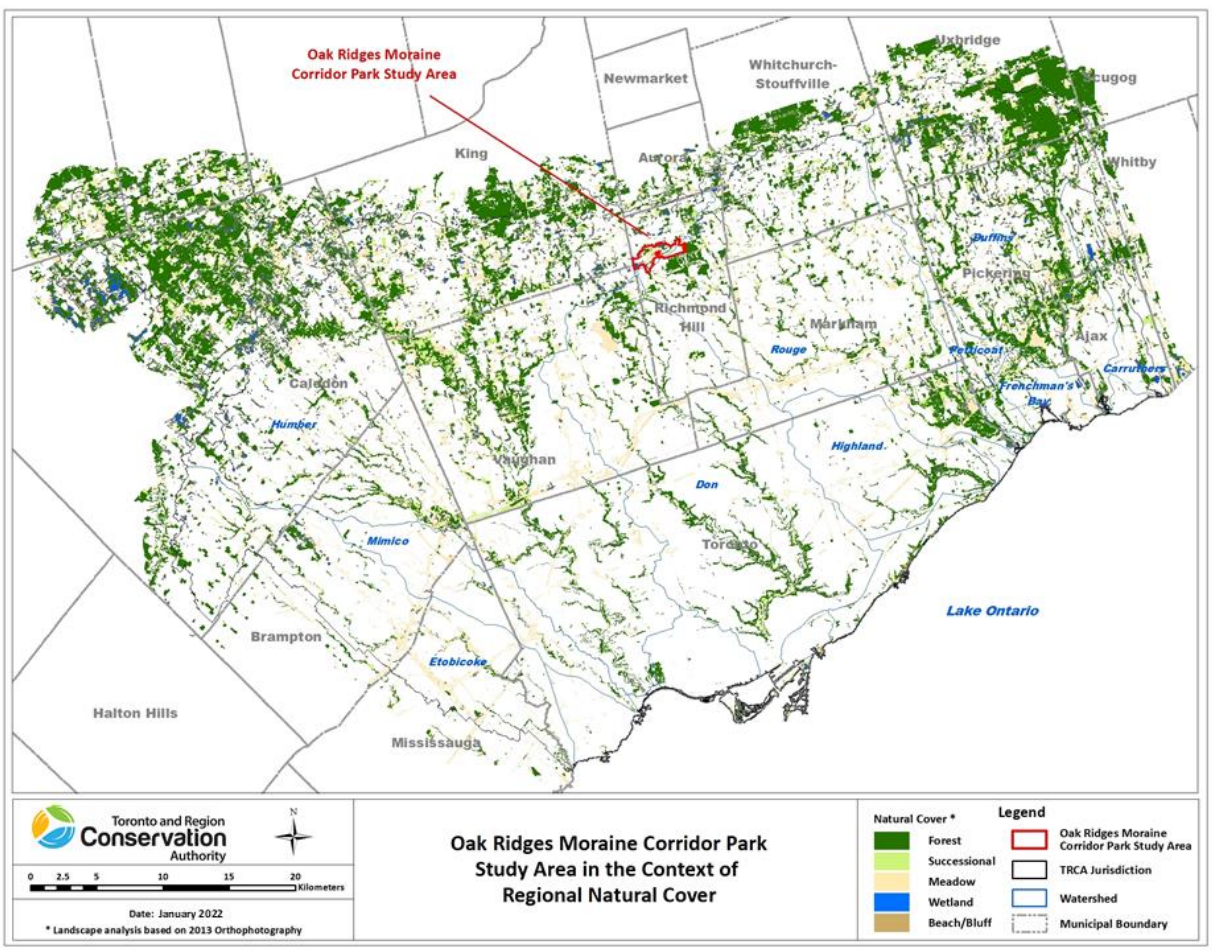


Figure 1. Oak Ridges Moraine Corridor Park study area in the context of regional natural cover.

The vision of ORCCR is to 1) create and maintain a sanctuary for nature while providing an important ecological linkage on the Oak Ridges Moraine and 2) provide opportunities for visitors to learn about ecosystem features, functions, wildlife, and human activities while enjoying recreational activities compatible with park values. There are numerous objectives related to reaching this vision outlined in the Oak Ridges Corridor Park Management Plan (TRC 2006), and several are directly related to terrestrial flora and fauna. These include:

Natural Heritage

- Protect, restore, and enhance the forests, kettle lakes and wetlands of the park as a functioning natural heritage system including natural features and processes, wildlife habitats, wildlife movement, and linkages to other natural systems on the Oak Ridges Moraine and the watersheds of the Humber and Rouge Rivers.

Environmental Sustainability

- Protect the park from negative external influences such as invasive species, encroachment, pets, traffic, and changes to the hydrology.

Monitoring

- Collaborate with agencies, universities, NGOs, and other institutions to ensure long-term monitoring of the park's resources and environmental functions, and to provide guidance for any changes to park policies and operations.

In addition to these vision related goals, there are more specific goals for protection and restoration at the site including:

- Protect existing natural habitats
- Increase the amount of forested habitats
- Provide interior forest habitat
- Enhance wetland and forest distribution for connectivity
- Provide grassland habitats

To assess progress towards meeting these objectives, Toronto and Region Conservation Authority (TRCA) developed a monitoring program to track changes in communities and species over time. The monitoring methodology follows the same regional monitoring protocols used in the regional (TRCA jurisdiction) program.

Achieving the vision of the park through restoration is a long-term plan. While this report will not directly assess progress from a restoration perspective, it will examine short-term changes in flora and fauna and these changes may be attributable to local, short-term changes in vegetation resulting from restoration activities. This report will examine changes in forest and wetland flora, forest, wetland and meadow bird communities, and wetland frog communities between 2008 and 2021. Recommendations for management and restoration will also be made based on observations of flora and fauna.

METHODOLOGY

The monitoring methodology employed by TRCA is very closely based on that which was endorsed by Environment Canada in its Ecological Monitoring and Assessment Network (EMAN) and currently used by Credit Valley Conservation (CVC) (EMAN 2004a, EMAN 2004b, CVC 2010). For the full monitoring methodology used by TRCA for its forest, wetland, and meadow stations refer to TRCA (2016a-g). The monitoring at ORCCR is on a 3-year cycle whereas the regional sites are collected annually. The schedule and location of flora and fauna monitoring stations/plots are shown in Table 1 and Figure 2.

Selection of site quality indicators

Long-term monitoring plots were established to identify the health and condition of key biological communities (i.e. vegetation, bird, and frog) associated with forest, wetland, and meadow habitat features and to track changes in their condition over time. Ecosystem health can be measured with various indicators, including tree health, flora and fauna species richness, the representation of native versus exotic species, and the presence and abundance of sensitive species (those of conservation concern). Objectives based on such indicators, specific to each habitat type, are outlined below.

Forest monitoring plots were designed to:

- Determine the health of forests
- Determine regeneration rate and species composition of understorey saplings and shrubs
- Determine if the population and abundance of flora species, including those of conservation concern and invasive species, are changing over time
- Determine the floristic quality of the site

Wetland monitoring plots were designed to:

- Determine the health of wetlands
- Determine if the population and abundance of flora and fauna species, including those of conservation concern, are changing over time
- Determine the floristic quality of the site

Meadow monitoring plots were designed to:

- Assess overall trends in meadow bird species richness and abundance

Indicators were selected in accordance with these monitoring objectives prior to plot set-up. Table 2 provides an overview of the indicators chosen to interpret site quality.

Table 1. Schedule of TRCA long-term monitoring at ORCCR, 2008-2018. Regional stations are monitored annually and project sites on a 3-year cycle.

			Year Monitored													
Monitoring Type	**Monitoring Plot / Transect / Station Type**	**Station Code**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Project	forest bird	FB-26A #1	x	x			x			x			x			x
		FB-26A #2	x	x			x			x			x			x
		FB-26A #3	x	x			x			x			x			x
	forest vegetation	FV-26A	x[a]	x			x			x			x			x
	meadow bird	MB-8A #3	x	x			x			x			x			x
		MB-8A #4	x	x			x			x			x			x
	wetland bird	WB-7A #2	x	x		x	x	x	x	x	x	x	x	x	x	x
		WB-7A #3	x	x		x	x	x	x	x	x	x	x	x	x	x
	wetland frog	WF-7A #2		x	x	x	x	x	x	x	x	x	x	x	x	x
		WF-7A #3		x	x	x	x	x	x	x	x	x	x	x	x	x
	wetland vegetation	WV-7A	x[b]	x			x			x			x			x
		WV-7B	x[b]	x			x			x			x			x
		WV-7C	x	x	discontinued											
		WV-7D	x[b]	x			x			x			x			x
		WV-7E	x[b]	x			x			x			x			x
Regional	meadow bird	MB-8 #1	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		MB-8 #2	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	wetland bird	WB-7 #1	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	wetland frog	WF-7 #1		x	x	x	x	x	x	x	x	x	x	x	x	x
	wetland vegetation	WV-7	x[b]	x	x	x	x	x	x	x	x	x	x	x	x	x

[a] FV 26A in 2008 only had tree health data collected because the plots were set-up late in the season.
[b] Woody regeneration was not measured at WV 7-7E in 2008.

Figure 2. Terrestrial monitoring plots at Oak Ridges Corridor Conservation Reserve.

Table 2. List of monitoring high-level indicators chosen for monitoring and analysis.

Habitat type	Monitoring indicator(s)	Description
Forest	Tree health	Proportion healthy trees
	Floristic quality index (FQI)	Proportion of habitat sensitive species
	Flora species richness	Number of species of urban concern
	Bird species richness	Presence of forest guild species
		Number of species of urban concern
Wetland	Mean floristic quality index (FQI)	Proportion of habitat sensitive species
	Flora species richness	Number of species of regional concern
	Bird species richness	Presence of wetland guild species
		Number of species of regional and urban concern
	Amphibian species richness	Presence of frog species
Meadow	Bird species richness	Presence of meadow guild species
		Number of species of regional and urban concern
	Bobolinks	Number of bobolinks

The assessment of tree health provides a wealth of information on the condition and resilience of forest communities. Variables such as tree mortality and crown vigour are measures of tree health that are standard monitoring variables used throughout the world. While there is a long history of assessing tree health, the measurement and interpretation of species richness and biodiversity are a more recent development and some clarification is provided here.

Species richness (i.e. the number of different species) and the relative dominance of native or exotic species are important indicators of ecosystem health. A closer look at the native flora and fauna present at any given site reveals that they vary in their degrees of tolerance to disturbance. Some are indicators of high-quality remnant habitat, thus of successful preservation or restoration efforts. They are of greater regional conservation concern. Others occur in a wide range of disturbed habitats. Various methods of assessment can be used to interpret any observed changes in composition of plants or animals. Toronto and Region Conservation Authority has developed a local ranking system for flora and fauna species; this ranking system was designed to reflect the ability of each species to thrive in the changing landscape of the Toronto region. The ranks range from the extremely sensitive species (L1) to the largely urban tolerant species (L5), with an additional L-rank for exotic (non-native) species (L+). Ranks are reviewed annually and subject to updates (TRCA 2017). Species with ranks of L1 to L3 are considered to be of concern throughout the TRCA jurisdiction, while those ranked L4 are of intermediate sensitivity and are of conservation concern within urban and suburban landscapes only.

An additional ranking system for plants, the coefficient of conservatism (CC) was used for calculating Floristic Quality Index (FQI) of the plots. The CC is assigned to native plants and is a measure of a plant's fidelity to high-quality remnant habitats (with 10 being the most sensitive score and 0 the lowest). This system is used for various regions across North America (Masters 1997). It therefore provides us with a continent-wide standard for assessing site biodiversity and quality. The CC values used by the TRCA are those assigned for southern Ontario plants by Oldham et al. (1995).

Breeding bird diversity is tracked by referring to habitat preferences; these preferences are listed in the Appendix (Table A.1) and were produced primarily through staff understanding of the various species' nesting requirements.

Other variables measured include the number of Bobolinks on meadow plots. Bobolinks are a meadow-dependent species that require large patches of meadow for breeding (Johnson and Igl 2001). They are listed as threatened at the provincial level and are recommended by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be listed as threatened under the federal Species-at-Risk Act (SARA). This makes the species a good indicator of meadow habitat quality.

Forest monitoring methodology

Forest vegetation plots

Forest plots were set up according to standards developed by Environment Canada's Ecological Monitoring and Assessment Network (EMAN 2004a, EMAN 2004b, Roberts-Pichette and Gillespie 1999), with slight modifications. This protocol is almost identical to that used by the Credit Valley Conservation in its forest vegetation plot monitoring, although there are differences in sapling assessment (CVC 2010).

Detailed information on plot set-up can be found in TRCA (2016a). In summary, each forest vegetation plot consists of one 20 x 20 m square plot (i.e. 400 m^2) for monitoring tree health; and five 2 x 2 m subplots (i.e. 4 m^2) for monitoring woody regeneration (tree saplings, shrubs and woody vines). Four of the subplots are placed 1 m outside the perimeter of the 20 x 20 m tree health plot, and the fifth is located in its centre. Ground vegetation is measured in a 1 x 1 m subsection (1 m^2) of each subplot at its southwest quarter. Two visits are conducted per year: in the spring and in early-to-mid summer.

Forest bird stations

Forest birds were monitored using the Ontario Forest Bird Monitoring Program (FBMP) protocol designed by the Canadian Wildlife Service (TRCA 2016b). The forest bird stations are monitored twice per year at times considered optimum for recording forest breeding bird species. The first count is conducted between May 24th and June 17th; the second count is conducted no sooner than 10 days after the first visit and between the dates June 15th and July 10th. Many species that are recorded before the first week of June may still be passing through the area as migrants, therefore registering a second observation in late June or July supports the indication of a territorial and likely breeding individual. All counts are completed between 05:00 a.m. and 10:00 a.m. The second visit is completed at the same time of day as the first visit and an attempt is made to maintain the same timing schedule of visits in subsequent years.

Counts are conducted in weather conditions that optimize the detection of songbird species. Ideally there should be very little to no wind, and precipitation should be at most a light rain. The FBMP requires the biologist to plot every individual bird observed and heard within a 100 m circle centred on the point station over a 10 minute period. In addition, any birds identified at distances beyond the 100 m circle are mapped at their approximate position. For the purposes of analysis, it was decided to consider only those individuals and species located within the 100 m count circle.

Wetland monitoring methodology

Vegetation transects

Wetland vegetation is monitored along a 50 m transect, capturing a gradient of conditions (terrestrial to aquatic) that occur in most wetlands (TRCA 2016d). Where possible, the transect starts immediately outside the wetland in an adjacent terrestrial system, while the remainder of the transect lies within the wetland proper. Posts (lengths of white polyvinyl chloride or “PVC” pipe) are placed at 10 m intervals along the transect, and vegetation monitoring subplots occur 5 m on either side of each post. Thus, there are paired subplots at the 0, 10, 20, 30, 40 and 50 m points along the transect: 12 in total. Subplots for woody regeneration (tree saplings, shrubs and woody vines) are 2 x 2 m (4 m^2), while the rear outer quarter (1 x 1 m subplot) of each 4 m^2 subplot is used for ground vegetation). Detailed information on wetland transect layout can be found in TRCA (2016d).

All wetland vegetation data are collected concurrently, in mid-to-late summer (late July to mid-September). This corresponds with full vegetation expansion before autumnal die-back and with relatively low water levels. The timing also harmonizes with the schedule for the forest plots, which are sampled earlier in the season.

Wetland bird stations

Monitoring stations were set-up following the Marsh Monitoring Program (MMP) protocol that was established by Bird Studies Canada (TRCA 2016e). Observations and counts are undertaken in a 100 m-radius semi-circle from the station marker since in general, stations are located at the edge of the wetland. Multiple stations within the same site were separated by 250 m in order to avoid double-counting the same individual. The wetland stations are monitored twice per year at times considered optimum for recording wetland bird breeding species. The first count is conducted between May 20th and July 5th; the second count is conducted no sooner than 10 days after the first visit.

Counts are conducted in weather conditions that optimize the opportunity for the biologist to hear and observe wetland bird species. Ideally, there should be no wind (very light wind is acceptable), and precipitation should be light rain at the very most. The surveys are conducted in the morning hours a half hour before sunrise and end by 10:00 a.m. during appropriate weather conditions for bird activity. The field protocol for monitoring wetland birds requires counts to be made of individuals located only within the 100 m-radius semi-circle.

Frog stations

Stations were set-up and monitored following the MMP in the same manner as wetland birds (TRCA 2016f). The frog stations are 100 m semi-circles with orientation noted and maintained on each visit; these frog stations need to be at least 500 m apart. Temperature guidelines change with each visit. For the first visit in the spring, night temperatures should be above 5°C, at least 10°C for the second visit and at least 17°C for the third and final visit. Surveys begin one half hour after sunset and end before midnight. Frogs were recorded as present and the observer estimated the number of individuals present along with the call code (1=no overlap of calls and an exact measurement of abundance of frogs calling can be determined, 2=calls begin to overlap and an estimate of abundance of frogs can be determined, 3=full chorus and the number of individuals cannot be counted).

Meadow monitoring methodology

Meadow bird stations

In the absence of any bird monitoring protocols designed specifically for meadow habitat it was decided to simply use the FBMP protocol and to adjust the suite of target species during analysis (TRCA 2016g). Each station is sampled twice per year with the first visit occurring between May 15th and May 30th, and the second visit between May 30th and June 15th, with at least 10 days between visits. Counts are conducted between 05:00 a.m. and 10:00 a.m., and at approximately the same time of day on subsequent visits from year to year. The field protocol for monitoring meadow birds is adapted from the forest bird protocol which requires counts to be made of individuals located both within and beyond the 100 m count circle. For the analysis of results, as with the forest and wetland results, it was decided to consider only those individuals and species located within the 100 m count circle.

RESULTS

Forest monitoring

Forest vegetation

Floristic Quality Index, Percent Native Species and Number of L1-L4 Species

Between 2009 and 2021, the number of flora species in the forest plot varied minimally from 25 species in 2012 to 32 species in 2021 (Table 3). The composition of species also remained relatively similar among years. Several new non-native species were found in 2015 that had not been found previously including garlic mustard (*Alliaria petiolata*), shrub honeysuckle (*Lonicera x bella*) and Manitoba maple (*Acer negundo*). Both shrub honeysuckle and Manitoba maple were not found in 2018 or 2021. Seven new species were found in 2018 that had previously not been found including four native species: smooth serviceberry (*Amelanchier laevis*), red osier dogwood (*Cornus sericea*), sticky willow herb (*Epilobium ciliatum* ssp. *ciliatum*), calico aster (*Symphyotrichum lateriflorum* var. *lateriflorum*), and three non-native species: bittersweet nightshade (*Solanum dulcamara*), creeping thistle (*Cirsium arvense*) and urban avens (*Geum urbanum*). All of these new species, except for calico aster, were noted as being found along an informal trail that was created in the southwest corner of the monitoring plot since 2015. In 2021, three new native species were found including common milkweed (*Asclepias syriaca*), Virginia stickseed (*Hackelia virginiana*), and wild red raspberry (*Rubus idaeus* ssp. *strigosus*). Lamb's quarters (*Chenopodium album*), an exotic species, was found for the first time in 2021. Even with these changes in composition and increases in the total number of flora species, the % native flora species, FQI, and % L1-L4 species has remained relatively constant.

Table 3. Temporal changes in forest flora species metrics between 2009 and 2021.

Metric	Year				
	2009	2012	2015	2018	2021
Total number of flora species	26	25	27	30	32
% native flora species	81	76	74	77	81
Floristic quality index	19.0	17.7	18.3	19.0	19.2
% L1-L4 flora species*	27	20	22	20	22

* No L1-L3 species were found in the plot.

Tree Composition

As of 2021, a total of 27 live trees were being monitored in the forest vegetation plot. Between 2008 and 2021, six species were found in the plot including sugar maple (*Acer saccharum* ssp. *saccharum*), white ash (*Fraxinus americana*), pin cherry (*Prunus pensylvanica*), American beech (*Fagus grandifolia*), black cherry (*Prunus serotina*) and Norway maple (*Acer platanoides*; a non-native species; Figure 3). The number of live trees has declined from 32 in 2009 to 27 in 2021 due to the death of 5 trees including sugar maple, pin cherry, and white ash. There was a small increase in the relative abundance of sugar maple between 2008 (72%) and 2021 (85%). Pin cherry decreased in relative abundance and was no longer found in the plot by 2015. Mortality in this species could be due to its shade intolerance and the direct competition with shade tolerant trees such as sugar maple. One pin cherry did have an open wound and signs of a fungal infection in 2008 and died by 2012.

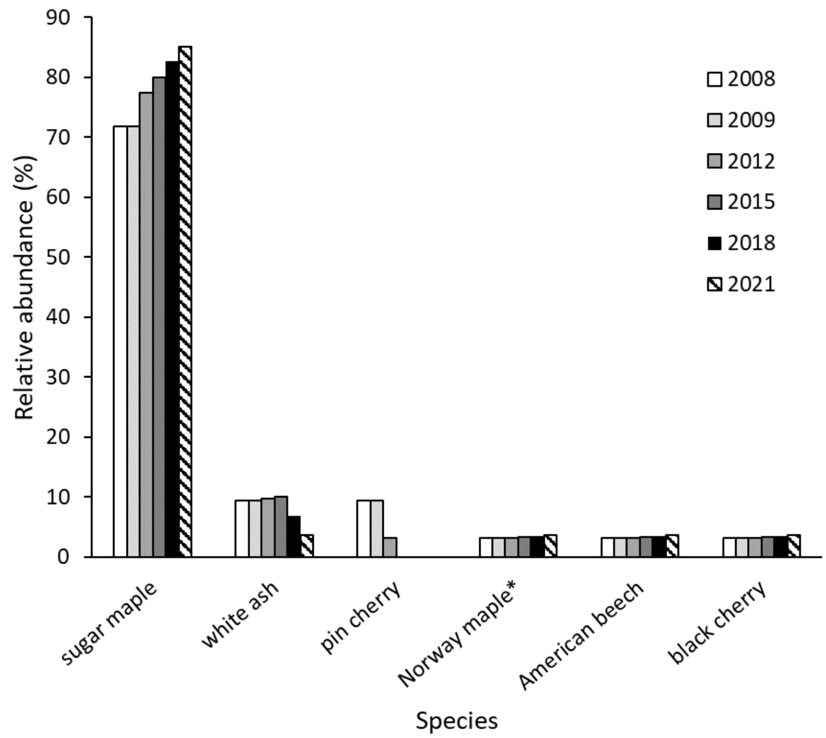
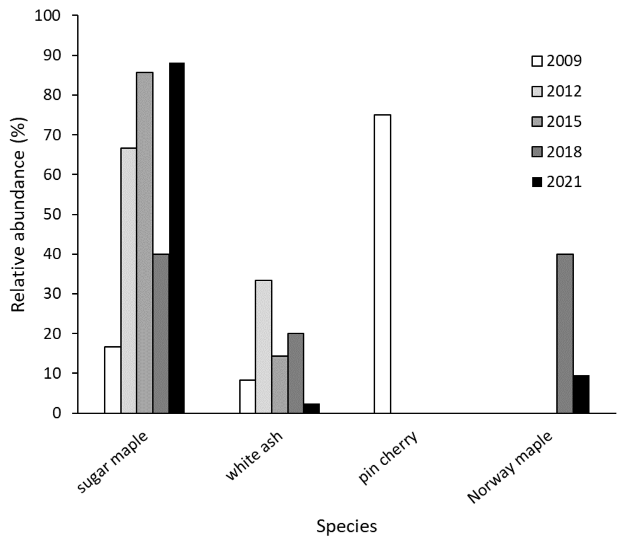


Figure 3. Relative abundance of live tree species in the forest vegetation plot (2008-2021). Exotic species are indicated with an asterisk (*).

Forest Sapling and Shrub Composition

A total of four woody species were found in the regeneration layer of FV 26A including sugar maple, white ash, pin cherry, and Norway maple (Figure 4). Relative cover in all years was dominated by sugar maple because the plots consisted primarily of larger individuals (>2m in height), except for in 2015 where three smaller individuals were establishing. Pin cherry dominated in 2009 based on relative abundance with nine individuals present. All of these individuals were less than 55cm in height and appear to have died out between 2009 and 2012. Again, pin cherry is shade-intolerant making establishment difficult in all but early successional conditions (open canopy, high light levels). Norway maple was recorded for the first time within the regeneration layer in 2018 and should be cause for concern because this species is invasive and regenerating within the plot. Norway maple continues to be present in 2021 but with a cover of <1%. The relative abundance of white ash was the highest in 2012 and decreased by 2021; however, the cover of the two remaining white ash trees has increased.



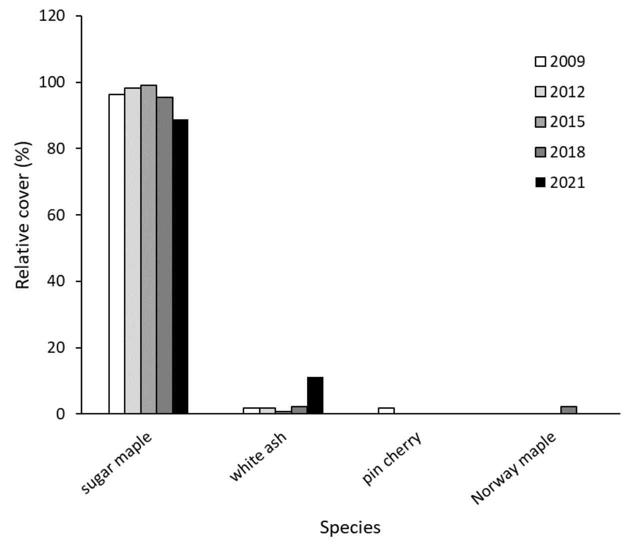


Figure 4. Relative abundance and relative cover of woody species in the forest regeneration layer (2009, 2012, 2015, 2018, 2021).

Forest Ground Vegetation Composition

Ground vegetation at FV 26A between 2009 and 2021 consisted of 15 species including 3 L4 species (long-styled blue cohosh (*Caulophyllum giganteum*), pin cherry, and red oak (*Quercus rubra*)), 8 L5 species (black cherry, enchanter's nightshade (*Circaea canadensis* ssp. *canadensis*), ironwood (*Ostrya virginiana*), Jack-in-the-pulpit (*Arisaema triphyllum*), riverbank grape (*Vitis riparia*), sugar maple, white ash, and yellow trout-lily (*Erythronium americanum* ssp. *americanum*)), and 4 non-native species (Manitoba maple (*Acer negundo*), Norway maple, dandelion (*Taraxacum officinale*), and bittersweet nightshade; Figure 5). Yellow trout lily had the greatest maximum relative cover in all years followed by long-styled blue cohosh, sugar maple, enchanter's nightshade, Jack-in-the-pulpit, and Norway maple. All other species had a maximum relative cover of <1%. Norway maple seedlings were found for the first time in 2018 in the ground vegetation layer sub-plots. One new species, red oak, was found in the ground vegetation layer in 2021.

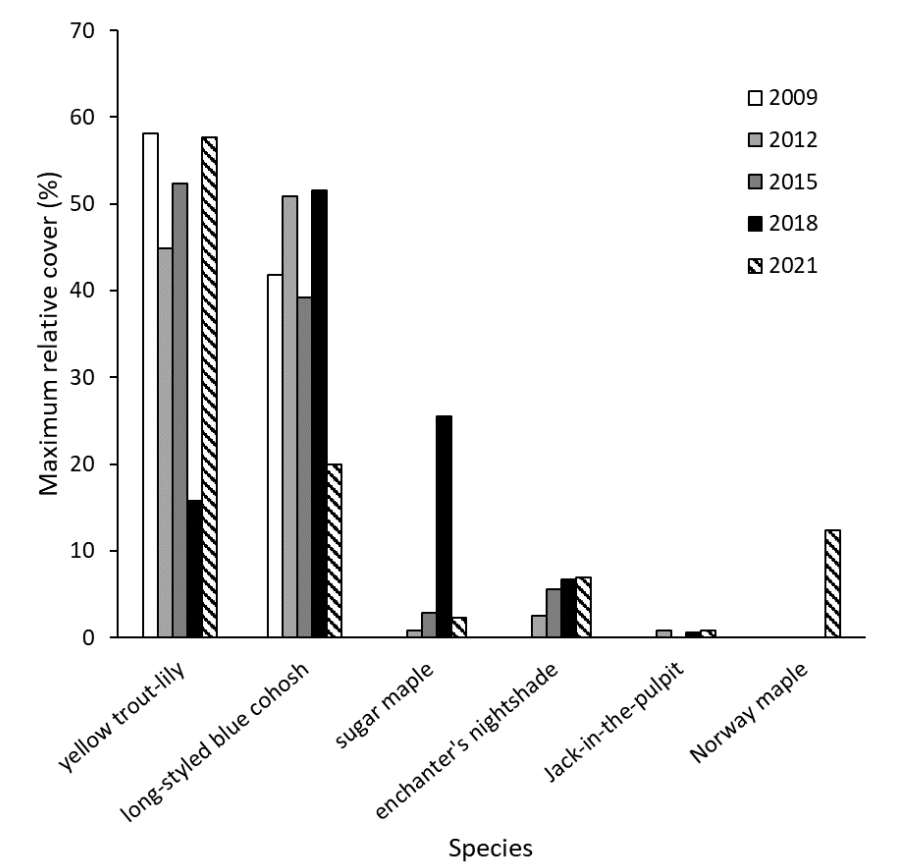


Figure 5. Maximum relative percent cover of species in the ground vegetation layer with covers of >1% (2009, 2012, 2015, 2018, 2021).

Tree Health

Crown Vigour – Crown Classes Dominant and Co-dominant

The position of trees in the forest canopy (crown class) affects the overall health (crown vigour) because trees with crowns that are dominant and co-dominant are naturally less stressed as they receive more sunlight than crowns that are intermediate or suppressed. For this reason, crown vigour was analyzed using only live trees with crown classes of dominant and co-dominant (classes 1 and 2).

Crown vigour of dominant and co-dominant trees consisted primarily of healthy trees (95.4% on average between 2008 and 2021; Figure 6). On average 1.9% of trees were in light to moderate decline and 2.7% were in severe decline. The percent of living trees with crowns in severe decline reached the highest value in 2009 and consisted only of pin cherry; however, in 2021 one white ash tree was in severe decline.

There was variation in crown vigour among tree species with only white ash and pin cherry showing signs of decline (Figure 7). Pin cherry showed higher average values of decline than any other species in 2008, 2009 and 2012. American beech is only shown in 2009 and 2012 because it switched from a crown class of 3 (intermediate) in 2008 to 2 (co-dominant) in 2009/2012 and then back to 3 in 2015 and 2018. White ash continue to decline due to the impacts of Emerald Ash Borer.

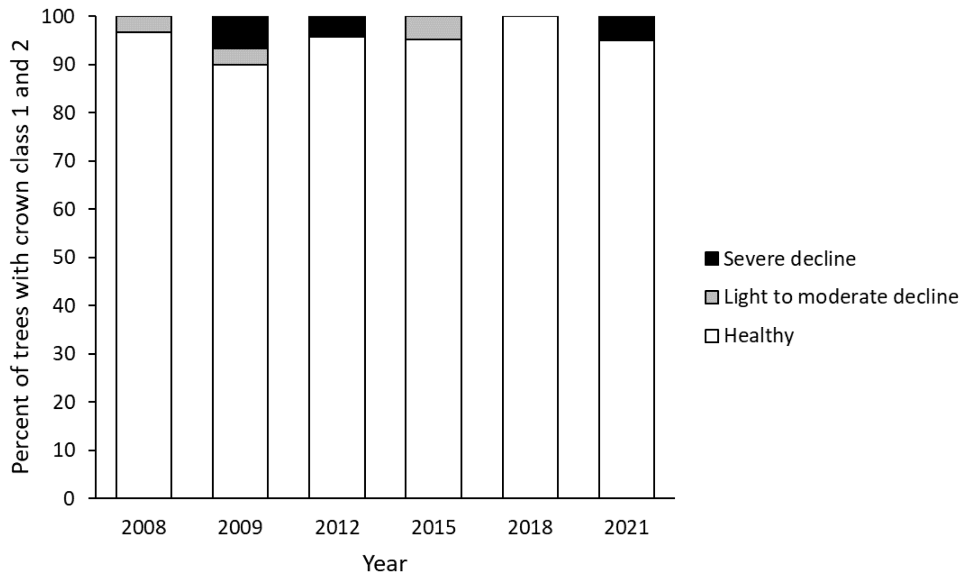


Figure 6. Temporal changes in crown vigour of living trees with crown classes 1 and 2 (dominant and co-dominant).

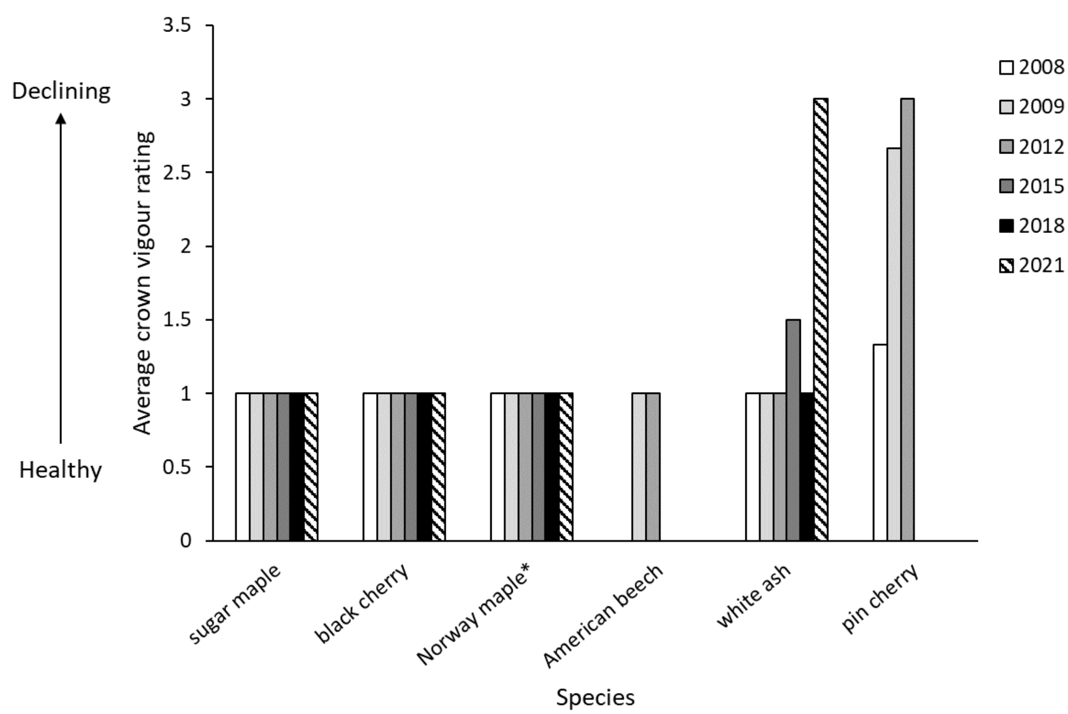


Figure 7. Temporal trends in average crown vigour of dominant and co-dominant trees for selected tree species between 2008 and 2021. For each species, bars on the graph run left to right chronologically by year.

Anecdotal observations by flora biologists in 2016 suggested that informal trails now surround the periphery of the forest vegetation plot and there is evidence of garbage/litter near these trails. There has also been damage to trees near trails (e.g. intentionally broken branches) due to human activity. By 2018, the informal trails were expanded into the vegetation plot although evidence of garbage/litter was not noted. By 2021, there were more obvious signs of human use such as forts and informal trails including a large increase in informal mountain biking trails.

Mortality

Mortality was measured by determining the number of trees that changed in status from living to dead between two consecutive years. Trees in all crown classes were included (dominant, co-dominant, intermediate, and suppressed). There was no mortality between 2008 and 2009; however, 2012, 2015, 2018, and 2021 all had mortality occur (Table 4). The majority of species dying were pin cherry but two sugar maple and two white ash also died.

Sajan (2006) suggests further research into the cause of mortality if average annual mortality exceeds 5% in dominant and co-dominant trees. When only dominant and co-dominant trees were included in mortality analyses, mortality rose to 7% for both 2009-2012 and 2012-2015 but remained below 5% for 2015-2018 and 2018-2021. This higher mortality in dominant and co-dominant trees is not a result of more trees dying but because fewer trees were included as the total sample size (i.e. intermediate and suppressed trees were excluded). Plots were not surveyed annually so it is difficult to determine if this mortality rate is of concern based on mortality rates calculated over a 3-year time span. As discussed previously, pin cherry is an early successional species requiring ample sunlight to be successful and the increasing shaded conditions in the plot over the years is the likely cause of pin cherry mortality. These mortality events were also forecast in the analysis of average crown vigour with pin cherry showing signs of decline over all years. The sugar maple that died between 2012-2015 had shown structural damage and the presence of *Eutypella* canker (*Eutypella parasitica*) in the years prior to 2015. The sugar maple that died between 2018-2021 was affected by an unknown borer. The white ash trees that died between 2015-2018 and 2018-2021 were affected by Emerald Ash Borer.

Table 4. Annual tree mortality of trees of all crown classes between 2008 and 2021.

Years	Mortality (% of trees that died)	Species
2008-2009	0	-
2009-2012	5.71	Two pin cherry trees
2012-2015	5.56	One sugar maple and one pin cherry
2015-2018	2.78	One white ash
2018-2021	6.9	One sugar maple and one white ash

Alive Trees vs. Snags

Tree snags were counted as long as they remained standing. The percentage of snags remained relatively constant (on average 5.5%) between 2008 and 2021. There was a slight drop in 2009 due to one of the snags from the previous year falling but there was also an increase between 2018 and 2021 from two to three snags resulting in a higher percentage of snags (10%; Figure 8). Snag species composition varied annually but included white ash and pin cherry in 2008, white ash in 2009, two new pin cherry individuals in 2012, a sugar maple and new pin cherry in 2015, a sugar maple and a new white ash in 2018, and a new white ash and sugar maple in 2021. Many of the snags created in a year had fallen by the following year leading to high turnover in the individuals comprising the snags.

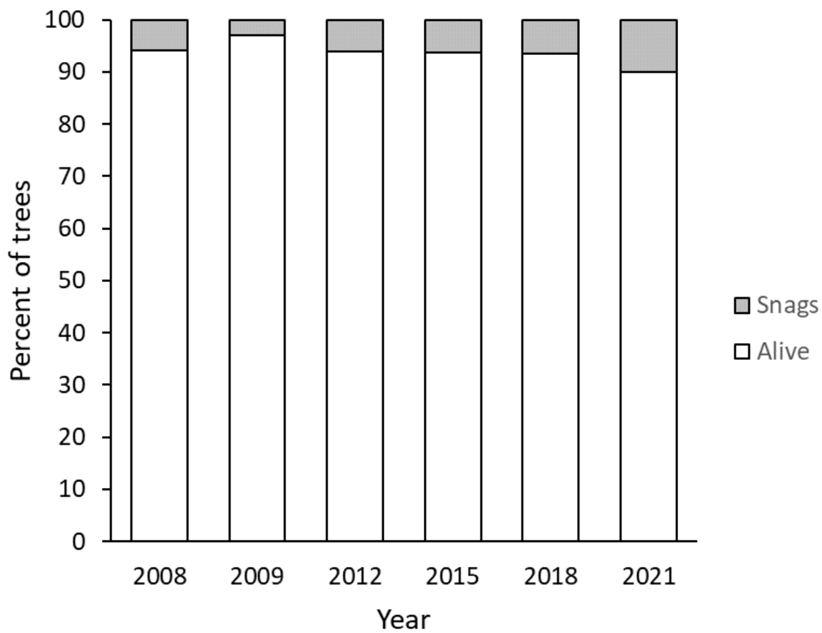


Figure 8. Percent of trees classified as snags or alive.

Pests and Disease

Incidences of pests and diseases were generally low across years (Table 5). Spongy Moth (*Lymantria dispar*) was documented on one sugar maple tree in 2015 but the number of trees affected rose to 25 trees (93%) in 2021. Individuals of almost all species were affected: American beech, black cherry, sugar maple, and even Norway maple were affected. Beech Scale (*Cryptococcus fagisuga*), an insect vector of beech bark disease, was observed on the one beech tree in the plot in 2008 and continues to affect the same tree in 2021. *Eutypella* canker was found on one sugar maple tree only in 2008. Sugar maple is most susceptible to the disease which usually does not kill the tree but may cause limbs or the trunk to break where the canker is present. It appears that the disease did lead to the death of this sugar maple as structural damage to the tree was observed before the tree died between 2012 and 2015. Two sugar maples had several exit holes noted in 2018 and 2021 indicating a wood boring pest. Evidence of a wood boring pest was also found on a black cherry in 2021 along with frass. Two white ash trees were being affected by Emerald Ash Borer in 2018 and 2021 with D-shaped holes observed.

Table 5. Occurrence of identified pests and diseases at FV 26A between 2008 and 2021.

Pathogen	All live trees	2008	2009	2012	2015	2018	2021
Spongy Moth	# live stems affected				1		25
	% live stems affected				3		93
Beech Scale	# live stems affected	1				1	1
	% live stems affected	100				100	100
Eutypella canker	# live stems affected	1					0
	% live stems affected	4					0
EAB	# live stems affected					1	1
	% live stems affected					50	100
Other (unknown borer)	# live stems affected					1	1
	% live stems affected					3	4

Forest birds

Forest bird communities differed based on station location (Figure 9). Red-eyed Vireo (*Vireo olivaceus*) dominated both station 1 and 3 while Black-capped Chickadee (*Parus atricapillus*) dominated station 2. Nesting habitat preference (e.g. forest upper-level nester, generalist mid-level nester, etc.) varied slightly among station locations although there may be temporal shifts in species composition based on habitat preference at stations 1 and 2 (Figures 10, 11, 12). These stations appear to have had increases in the percent composition of forest mid-level nesters and forest-edge mid-level nesters along with potential declines in generalist mid-level nesters.

The presence of Red-eyed Vireo and Eastern Wood-pewee (*Contopus virens*) indicates a more mature, closed canopy forest; however, all stations had a mixture of species representing both forest-related and more generalist or edge environments. This diversity indicates that the forests have not completely matured and/or are in patches too small to attract forest interior species. If forest interior habitat is created in the long-term, Ovenbird (*Seiurus aurocapillus*) or Scarlet Tanager (*Piranga olivacea*) may be documented in forest bird surveys. Veery was detected at station 26A.2 for the first time in 2018. This species prefers wet sites, can occur in disturbed or regenerating forests and is area-sensitive meaning that it prefers to nest in larger forest tracts (Rosenberg et al. 2003). It is important to note that the mere presence of a species does not indicate that the habitat is of high quality because the species could still be subject to high nest predation rates due to matrix influences (e.g. predators associated with urban housing developments).

Notable species of regional conservation concern found at forest bird stations include Least Flycatcher (*Empidonax minimus*) and Yellow-billed Cuckoo (*Coccyzus americanus*) at station 1, Mourning Warbler (*Geothlypis philadelphia*) at station 2 (all ranked L3). American Redstart (*Setophaga ruticilla*) was found at stations 2 and 3 (ranked L4) and is a forest-edge nester. Brown-headed Cowbirds (*Molothrus ater*), a nest parasite of numerous bird species, were found at both stations 1 and 2 but was not detected at station 3. This species can significantly decrease the number of young produced from each nest it parasitizes and is thought to contribute to declines in forest bird populations (Brittingham and Temple 1983).

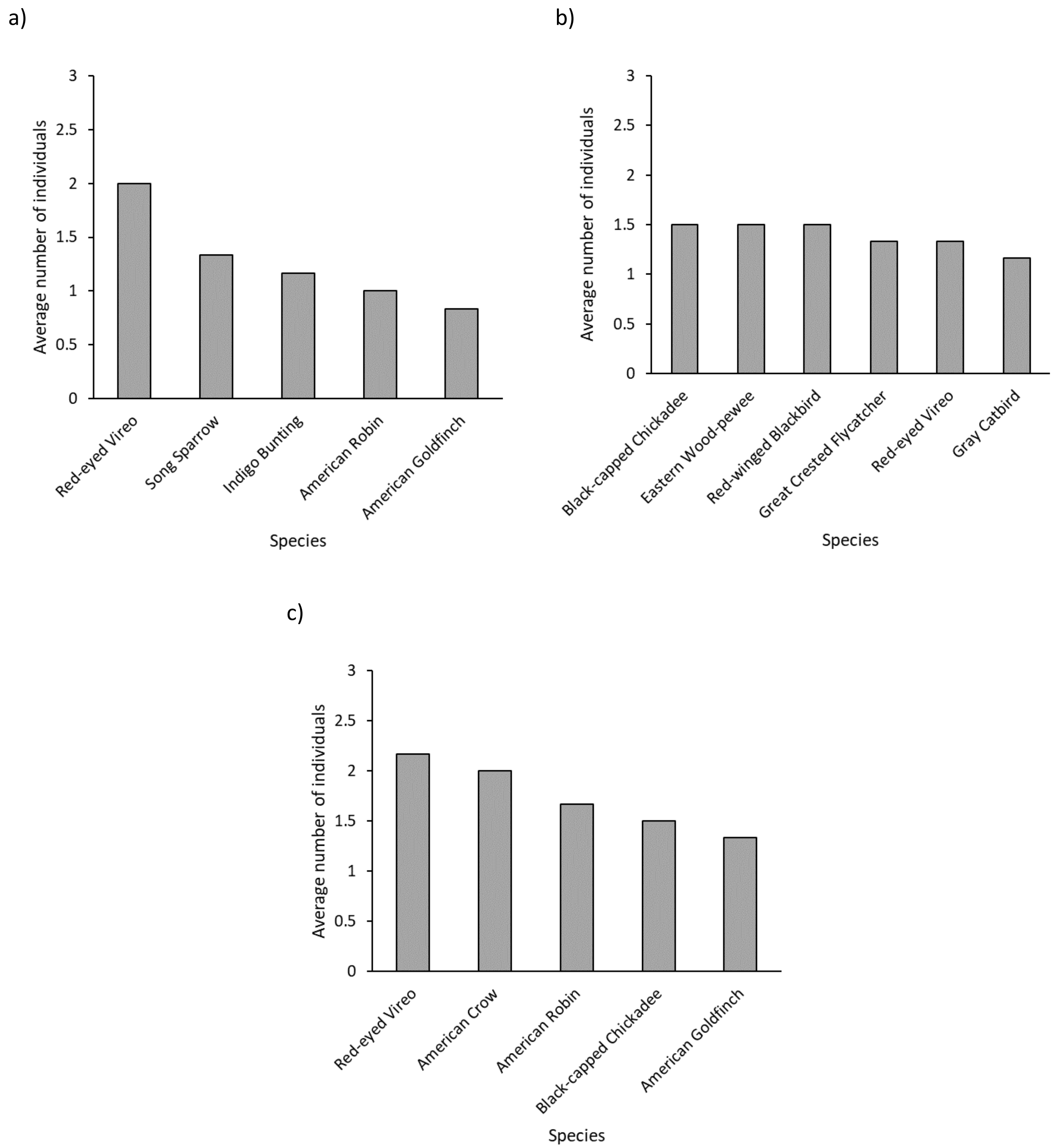


Figure 9. Community composition of the five most abundant species (averaged 2008-2018) recorded at forest bird monitoring stations a) FB 26A.1, b) FB 26A.2 and c) FB 26A.3.

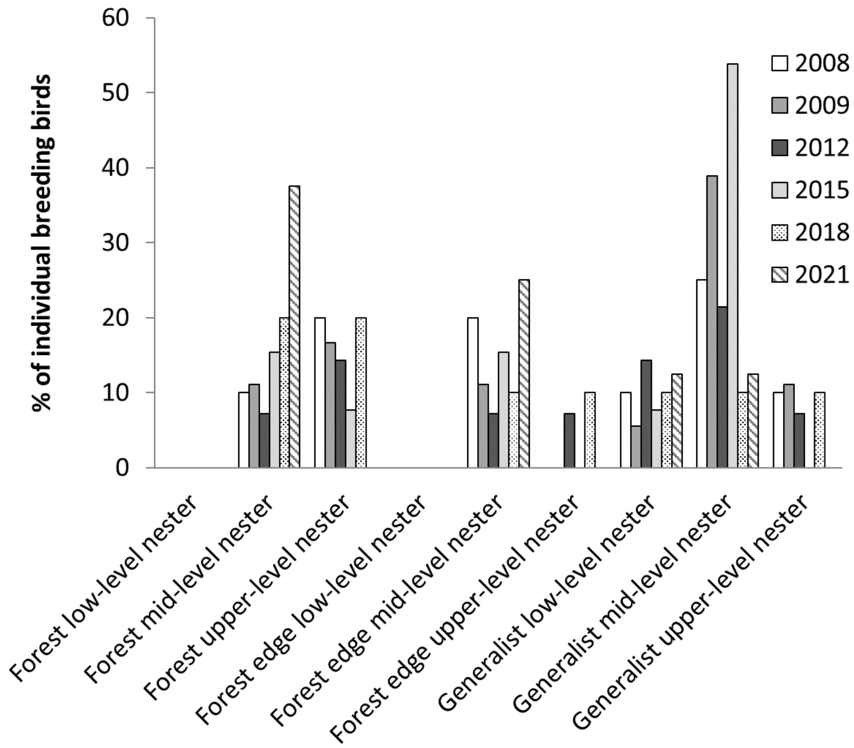


Figure 10. Proportion of individual breeding birds by habitat and nesting location at forest bird monitoring station FB 26A.1.

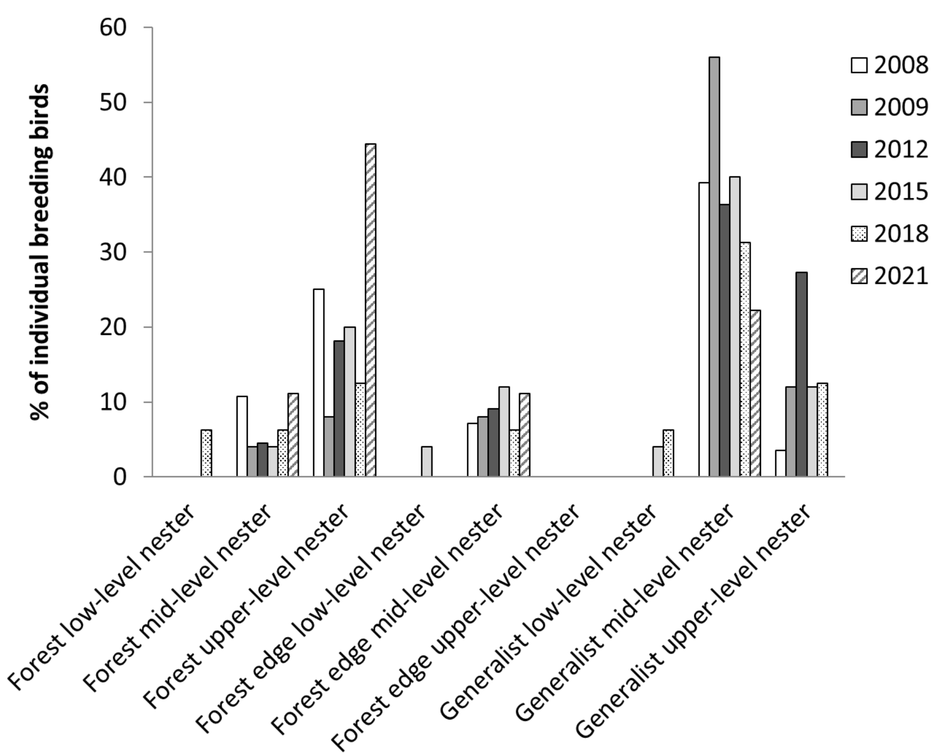


Figure 11. Proportion of individual breeding birds by habitat and nesting location at forest bird monitoring station FB 26A.2.

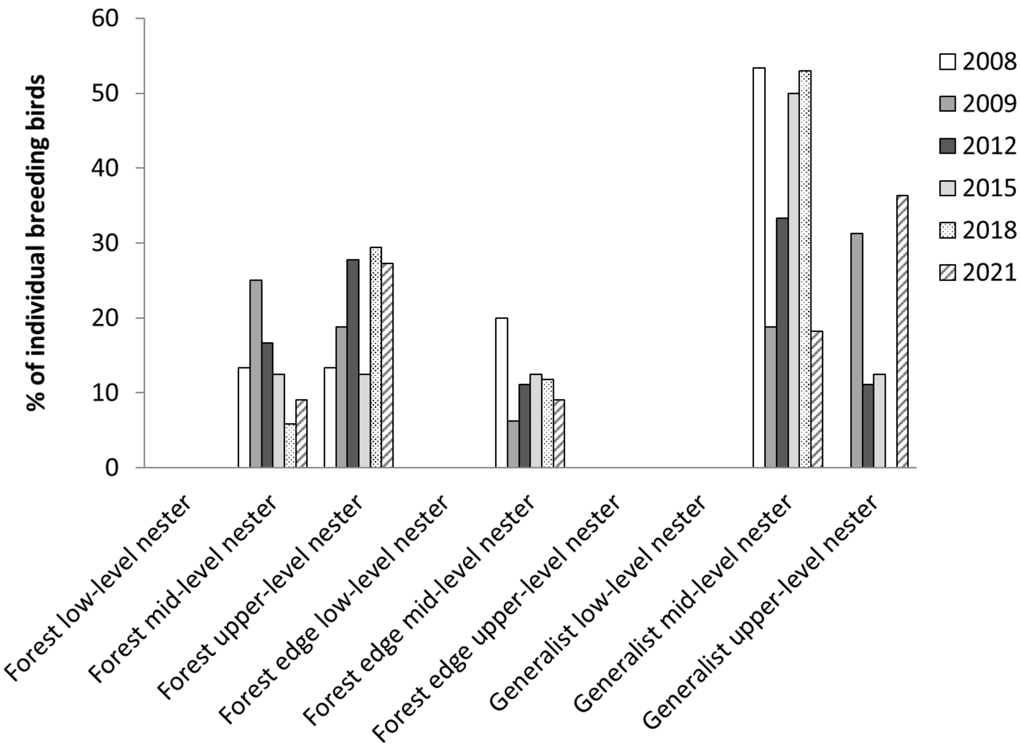


Figure 12. Proportion of individual breeding birds by habitat and nesting location at forest bird monitoring station FB 26A.3.

Changes in the number of L1-L4 bird species, abundance of forest-dependent birds, species richness of forest-dependent birds, and the percent forest-dependent birds (individuals) were examined (Figure 13). Bird species were defined as forest-dependent based on their nesting requirements in forest or swamp habitat (Appendix Table A.1). There did not appear to be a change in the number of L1-L4 bird species or forest-dependent bird species richness; however, there may be declines in the abundance of forest-dependent birds but the percentage appears to be increasing. This suggests that the total number of birds is decreasing but the proportion consisting of forest-dependent species may be increasing at stations 26A.1 and 26A.2.

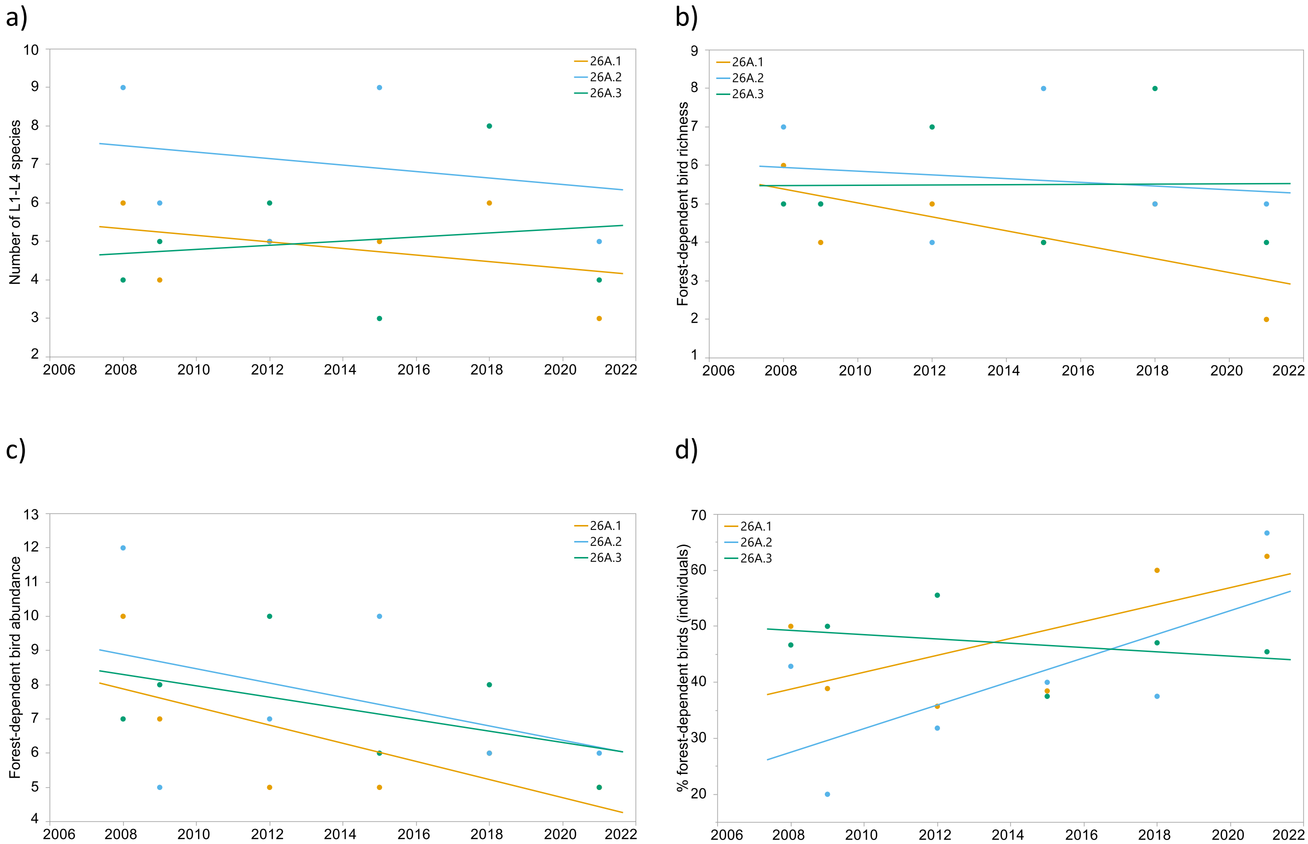


Figure 13. Changes in forest bird high-level indicators between 2009 and 2021: a) number of L1-L4 bird species, b) forest-dependent bird richness, c) forest-dependent bird abundance, and d) % forest-dependent birds (individuals).

Wetland Monitoring

Wetland vegetation

Floristic Quality Index, Percent Native Species, Number of L1-L3 Species

Floristic quality index (FQI) varied among wetland vegetation transects (Figure 14). Higher floristic quality index values indicate an area with many native species and/or many species that have a low tolerance to disturbance and a high fidelity to specific natural habitats (Bourdaghs et al. 2004). Tolerance to disturbance and site fidelity are combined to create a CC value for each species which is used to calculate FQI. For example, a species that is common to floodplain forests and riverbanks but is also found in urban areas would be assigned a low value for its CC (Chadde 1998). If many species in one area share this characteristic, the value of FQI will be low.

Transect 7B had the highest FQI value meaning that this transect contained species with high CC values and a large number of native species. The FQI at 7B decreased from 33 in 2018 to 19 in 2021 and this was due to both a large decrease in the number of native species and mean CC score. This could be explained by water level changes where levels were deeper in 2021 compared to prior years. The decrease in mean CC score at 7B also appears to be occurring at the other transects except for 7E. The percentage of native species and number of L1-L3 species appears to be relatively similar between 2009 and 2021 across stations.

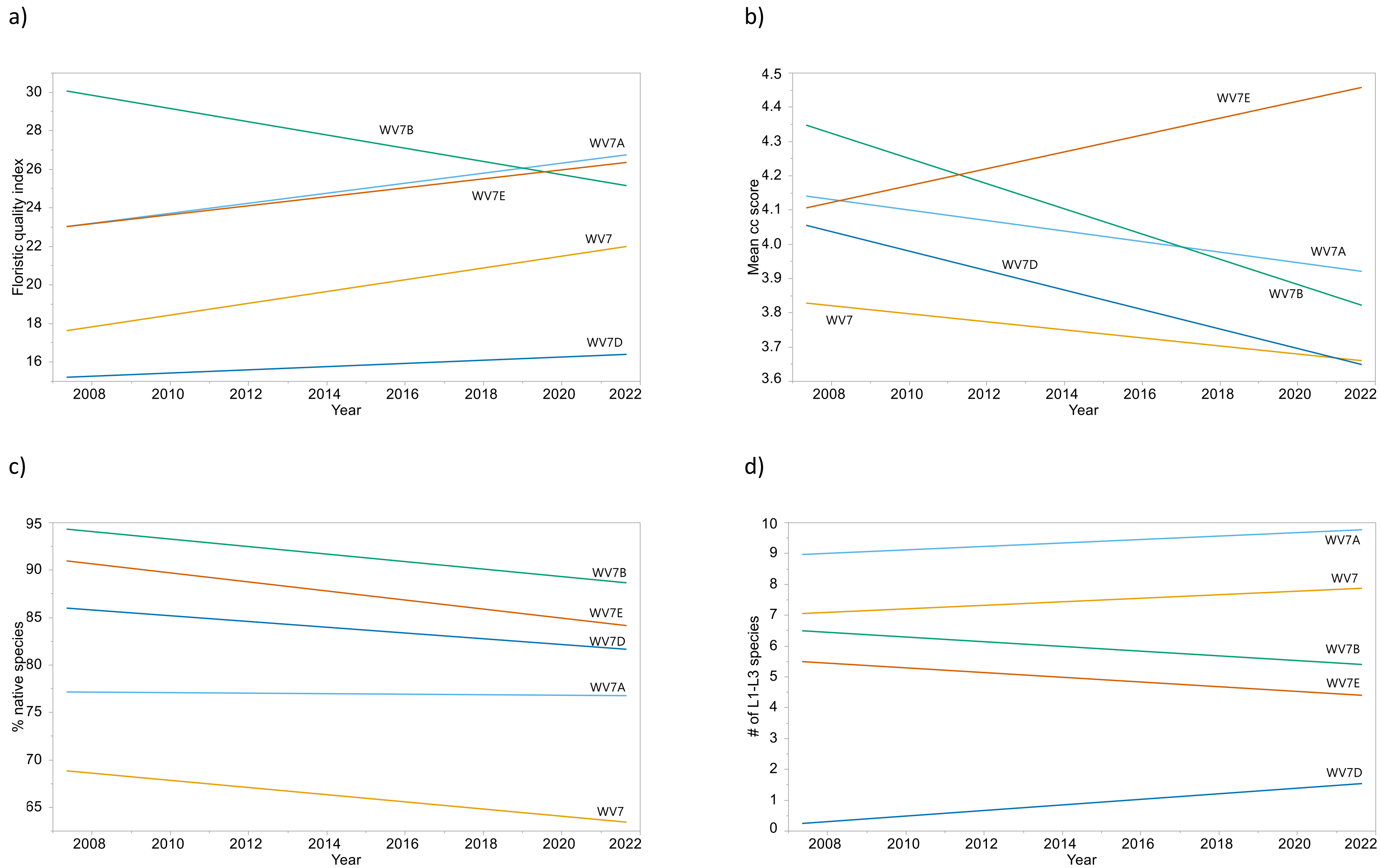


Figure 14. Changes in wetland flora species metrics between 2009 and 2021.

Wetland Water Levels

Changes in wetland hydrology were apparent between 2009 and 2021 at transect 7, 7A, 7B, and 7D (Table 6). Transect 7 had no water in 2021 while in other years the wetland had considerable water depths. Transect 7A also had no water in 2021 while 7B had deeper water in 2021 than in prior years. Water levels increased in transect 7D between 2008 and 2018 and decreased between 2018 and 2021.

Table 6. Water depths at the 0, 10, 20, 30, 40 and 50 m points along wetland vegetation transects between 2008 and 2021.

Transect	Visit Year	Water Depth 0 m	Water Depth 10 m	Water Depth 20 m	Water Depth 30 m	Water Depth 40 m	Water Depth 50 m
WV 7	2008	19	48	55	46	55	93
	2009	28	65	86	75	73	110
	2010	29	-	-	71	-	110
	2011	11	58	73	70	81	107
	2013	27	73	87	78	91	116
	2014	17	71	84	84	85	104
	2015	21	59	74	61	59	110
	2016	0	26	43	43	47	77
	2017	29	73	72	76	89	123
	2018	27	67	74	74	83	118
	2021	0	0	0	0	0	0
WV 7A	2008	0	48	46	33	0	0
	2009	4	96	100	89	22	34
	2015	0	53	63	52	0	0
	2018	0	51	69	50	0	12
	2021	0	0	0	0	0	0
WV 7B	2008	0	0	11	0	5	1
	2009	0	0	5	0	0	0
	2015	0	0	19	0	0	0
	2018	0	4	29	0	14	0
	2021	0	32	55	0	39	16
WV 7D	2008	0	8	13	5	12	0
	2009	0	14	21	12	15	1
	2015	0	83	88	64	76	75
	2018	11	104	106	94	99	84
	2021	0	42	51	36	51	41
WV 7E	2008	0	0	0	0	0	0
	2009	0	20	20	20	20	20
	2015	0	0	0	0	0	0
	2018	0	0	0	0	0	0
	2021	0	0	0	0	0	0

Wetland Woody Regeneration Species Composition

Relative percent cover of wetland woody regeneration was dominated by slender willow (*Salix petiolaris*) on transects 7 and 7A, red osier dogwood on transects 7B and 7E, and common buckthorn (*Rhamnus cathartica*) on transect 7D (Figure 15). Common buckthorn continues to increase in percent cover on transect 7D and had the highest percent cover and abundance in 2021. Higher water levels in transect 7B in 2021 likely led to a decrease in the number of woody species from 14 in 2018 to 8 in 2021 along with decreases in percent cover for persisting species such as red osier dogwood and black ash (*Fraxinus nigra*).

Transects 7, 7B, and 7E had the same species dominating based on relative abundance as relative cover (slender willow dominated transect 7 and red osier dogwood dominated transects 7B and 7E) (Figure 16). There was an increase in both the number of woody species and abundance in transect 7 between 2009 and 2021. The number of woody species increased from 2 in 2009 to 10 in 2021. Again, this is likely due to the large drop in water levels in 2021 resulting in dry conditions more suitable for these species. Peach-leaved willow (*Salix amygdaloides*) had the highest relative abundance in transect 7A. Silver maple remains the dominant species by relative abundance in transect 7D.

Winterberry and shining willow were the only two species in the top five based on relative cover and abundance that are species of regional concern (ranked L3). Winterberry was ranked in the top five species based on relative percent cover and relative abundance on transects 7A, 7B, and 7E, while shining willow was ranked in the top five on transects 7A and 7E based on relative percent cover.

Several exotic species with invasive characteristics were found ranked in the top five based on relative abundance including common buckthorn on transects 7, 7D, and 7E, shrub honeysuckle on transect 7, and bittersweet nightshade (*Solanum dulcamara*) on transects 7A, 7B, 7D, and 7E. Common buckthorn decreased in both cover and abundance between 2018 and 2021 in transects 7 and 7B and increased cover in 7D.

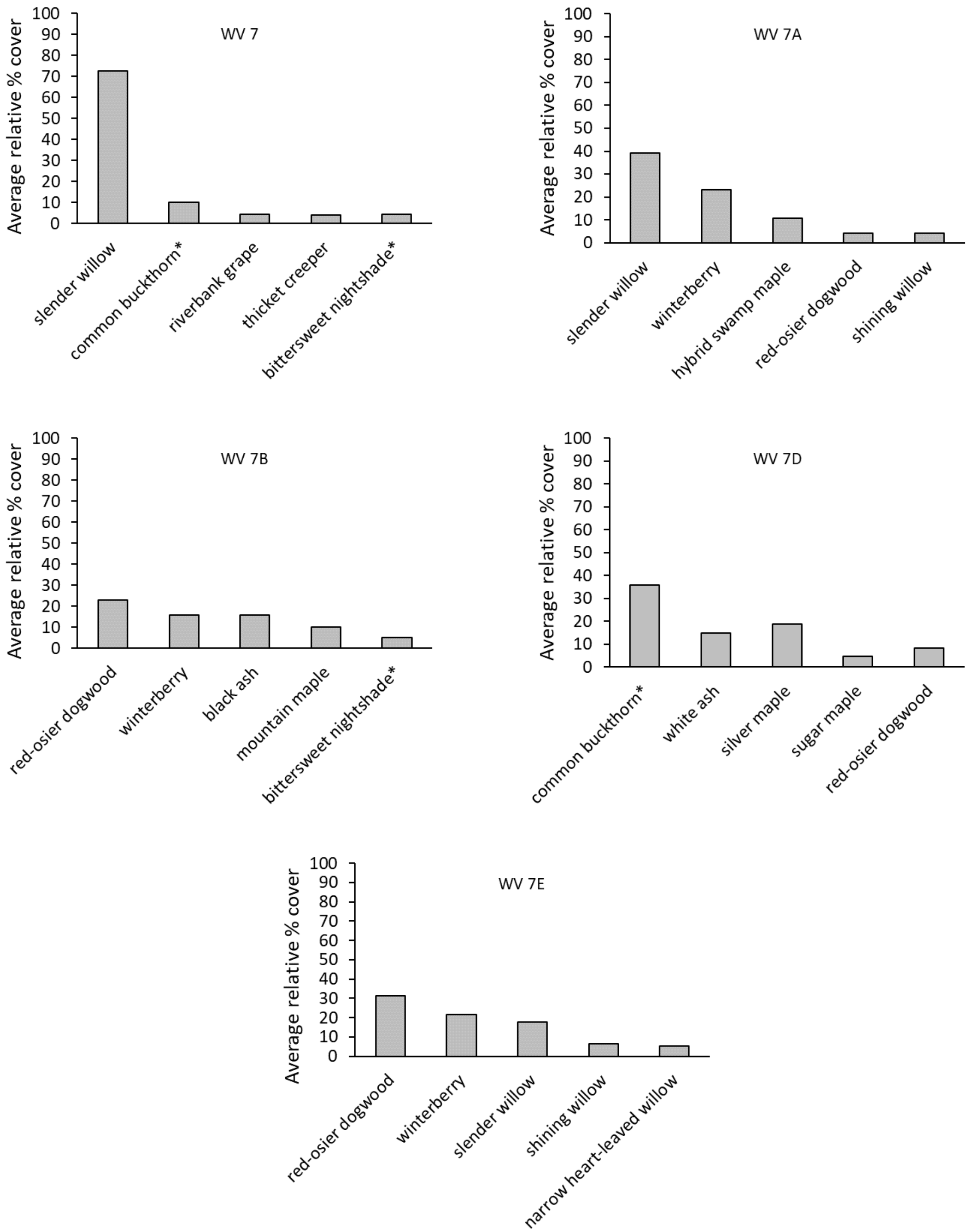


Figure 15. Average relative percent cover of the five most common wetland woody species at wetland vegetation transects WV-7, 7A, 7B, 7D and 7E. Exotic species are indicated with an asterisk (*).

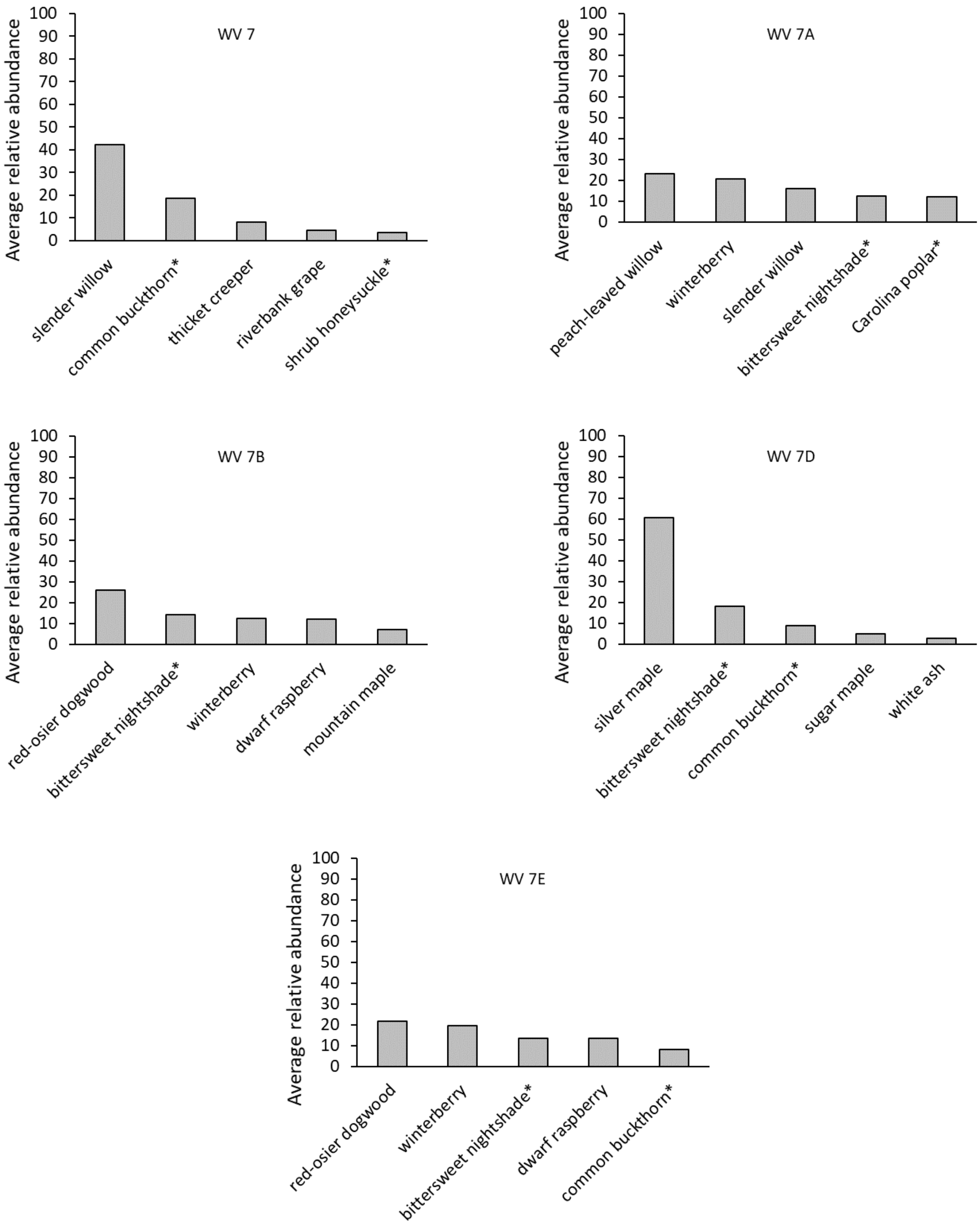


Figure 16. Average relative abundance of the five most common wetland woody species at wetland vegetation transects WV 7, 7A, 7B, 7D, and 7E. Exotic species are indicated with an asterisk (*).

Wetland Herbaceous Vegetation Species Composition

Transects varied greatly in herbaceous vegetation species composition for the top five ranked species based on relative percent cover (Figure 17). The majority of species in the top five based on relative cover on transects 7 and 7A were species of regional concern (ranked L3) including flat-stemmed pondweed (*Potamogeton zosteriformis*), floating pondweed (*Potamogeton natans*), bushy naiad (*Najas flexilis*), northern manna grass (*Glyceria borealis*), columbia water-meal (*Potamogeton zosteriformis*), and star duckweed (*Lemna trisulca*). Even though these were the dominant species on average over all years, there was a large drop in cover in 2021 in transect 7 and 7A, likely due to the dry conditions in 2021 since these are submergent species.

The herbaceous vegetation on transect 7B changed between 2018 and 2021 likely due to increases in water levels. Submergent and floating aquatic species increased in cover including star duckweed and columbia water-meal; however, more terrestrial species decreased in cover including sensitive fern (*Onoclea sensibilis*) and lake-bank sedge (*Carex lacustris*). Transect 7D was dominated by coontail (*Ceratophyllum* spp.) and dotted water-meal (*Wolffia borealis*). Fringed sedge (*Carex crinita*) was the only L3 ranked species with a relative cover in the top five of transect 7E.

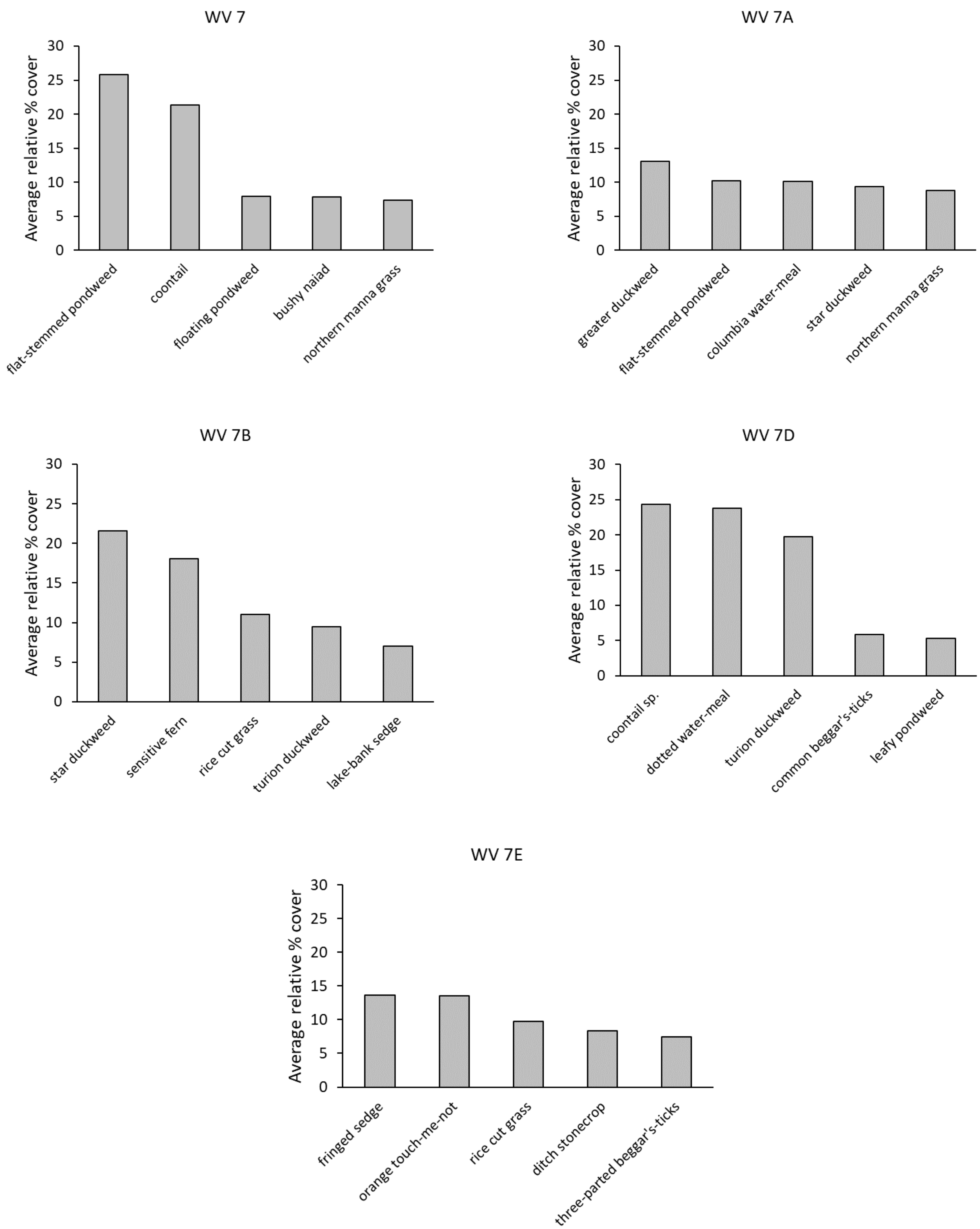


Figure 17. Average relative percent cover of the top five ranked ground vegetation (herbaceous) species on transects 7, 7A, 7B, 7D and 7E. Exotic species are indicated with an asterisk (*).

Wetland birds

Wetland bird communities differed based on station location (Figure 18). Mallard (*Anas platyrhynchos*) dominated station 1, Canada Goose (*Branta canadensis*) dominated station 2, and Red-winged Blackbird (*Agelaius phoeniceus*) dominated station 3. Nesting guild (generalist vs. wetland) did not vary greatly based on station location and were mostly dominated by generalist species. There appears to have been an increase in the percent composition of generalists and a decrease in the percent composition of wetland-dependent individuals at station 3 (Figure 19).

Species of regional conservation concern (ranked L3) highly dependent on wetland habitat include Virginia Rail (*Rallus limicola*) at stations 1, 2 and 3, Hooded Merganser (*Lophodytes cucullatus*) at station 1, and Sora (*Porzana carolina*) and Pied-billed Grebe (*Podilymbus podiceps*) at stations 1 and 2. Northern Waterthrush (*Parkesia noveboracensis*), a swamp-nesting species, was observed for the first time in 2021 at station 1.

We examined changes over time for the abundance of wetland-dependent birds (excluding Canada Goose and Mallard), species richness of wetland-dependent birds, the number L1-L3 bird species, and the number of L1-L4 bird species (Figure 20). Bird species were defined as wetland-dependent based on their nesting requirements (Appendix Table A.1). There did not appear to be any consistent changes in these indicators across stations; however, station 1 may show an increasing trend for all indicators while station 3 appears to be decreasing in the abundance of wetland-dependent birds.

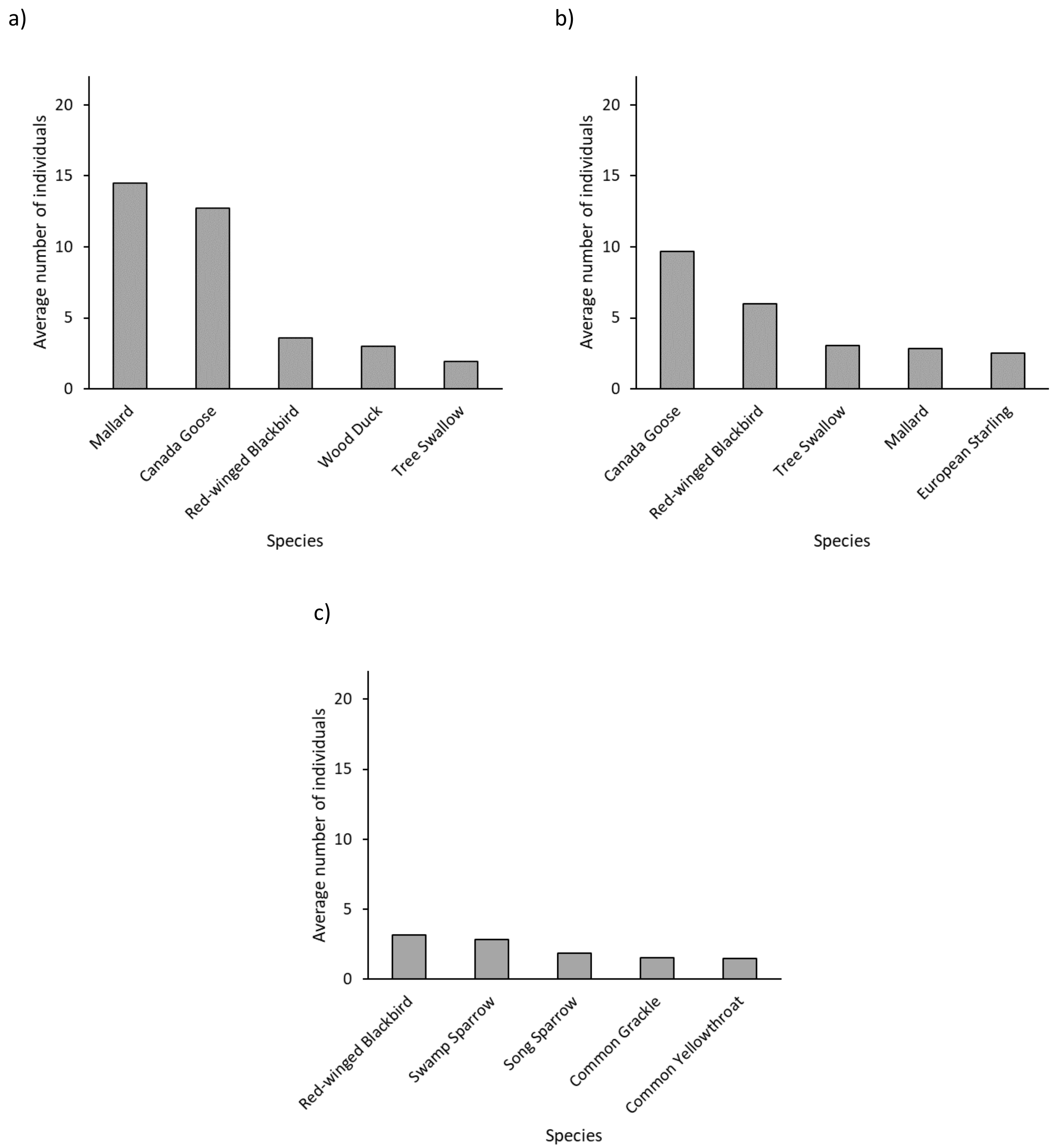
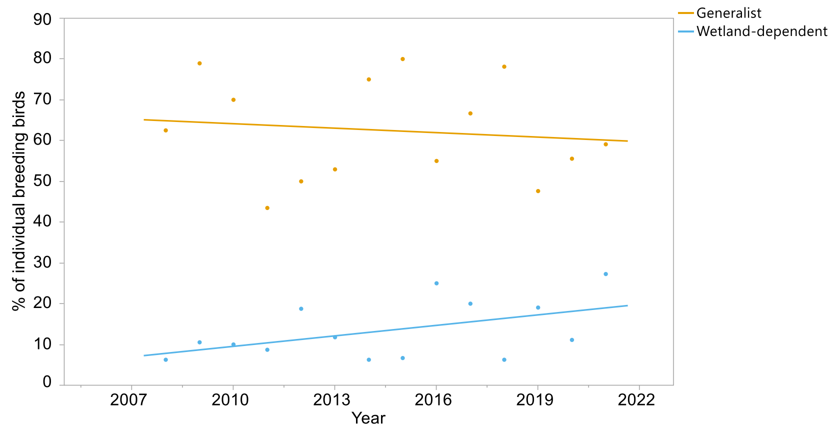
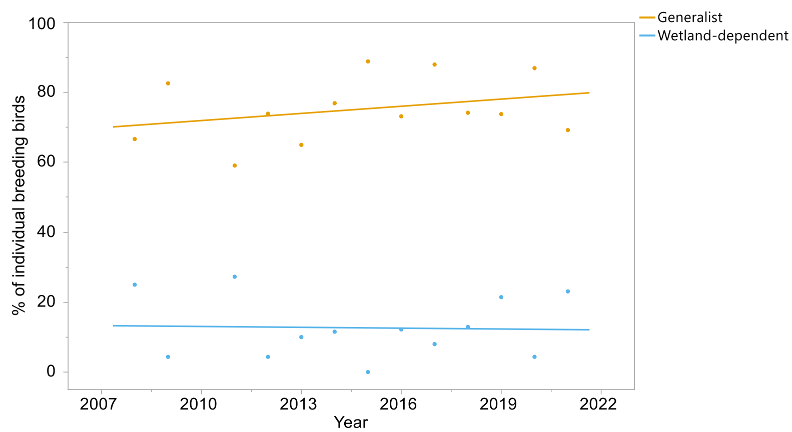


Figure 18. Community composition of the five most abundant species (averaged 2008-2021) recorded at wetland bird monitoring stations a) WB 7.1, b) WB 7A.2 and c) WB 7A.3.

a)



b)



c)

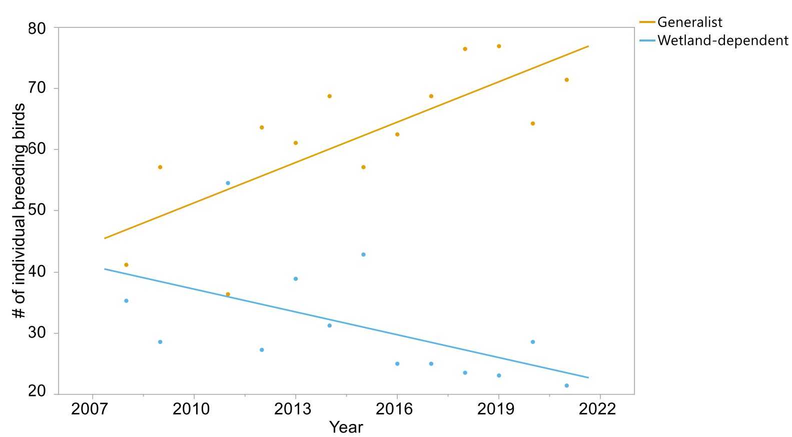


Figure 19. Proportion of individual breeding birds by habitat (only wetland and generalist) at wetland bird monitoring stations a) WB 7.1, b) W 7A.2 and c) WB 7A.3. Canada Goose and Mallard were excluded.

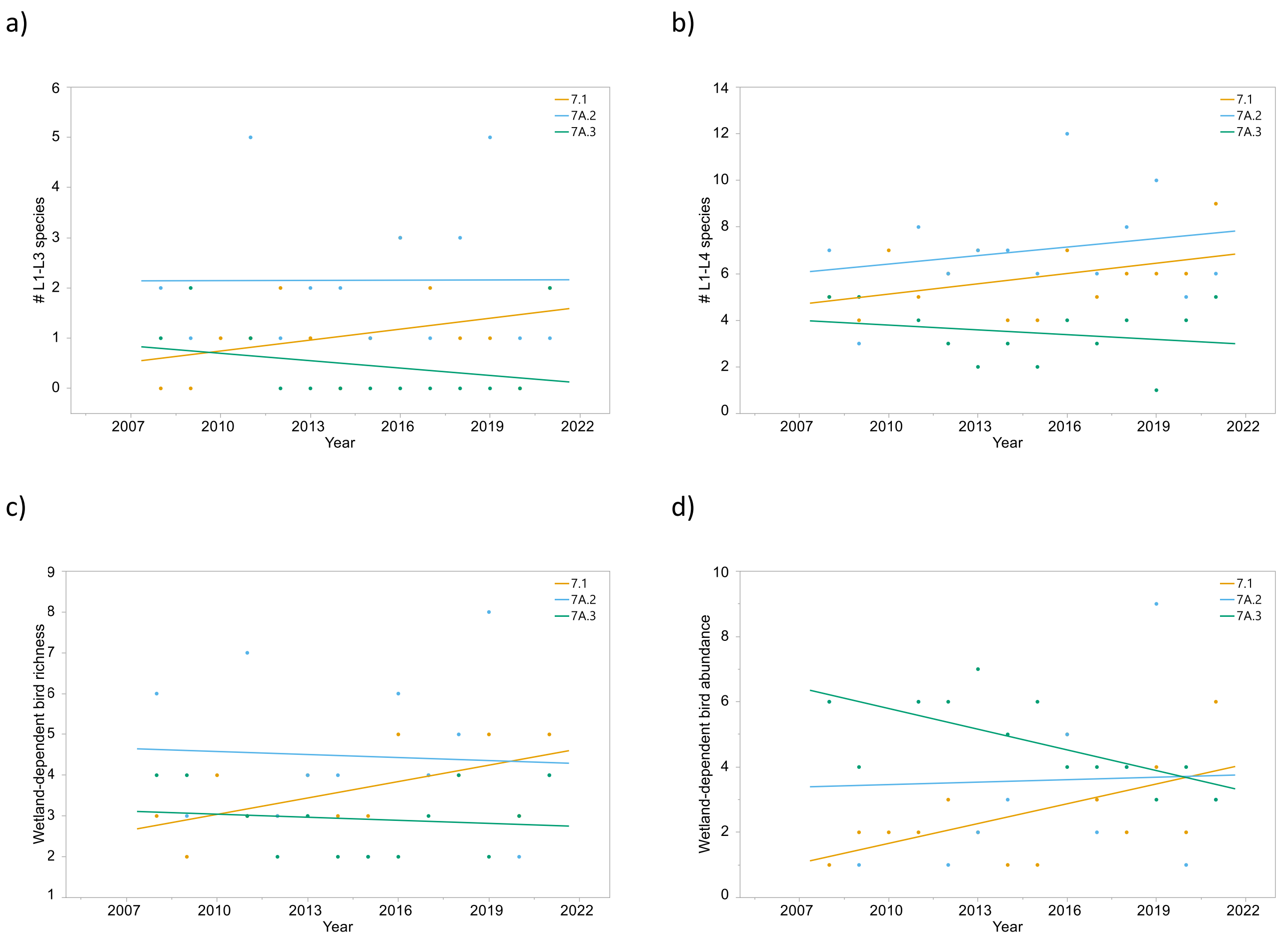


Figure 20. Changes over time in wetland bird high-level indicators a) number of L1-L3 bird species, b) number of L1-L4 species, c) wetland-dependent bird richness, and d) wetland-dependent bird abundance.

Frogs

Frog Species Composition

Six frog species were detected at wetland frog stations between 2009 and 2021 including Green Frog (*Lithobates clamitans*), Spring Peeper, Wood Frog, Tetraploid Grey Treefrog (*Hyla versicolor*), Northern Leopard Frog (*Lithobates pipiens*), and American Toad (*Anaxyrus americanus*). Green Frog, Spring Peeper, Tetraploid Grey Treefrog, and Wood Frog were found in every year; however, American Toad and Northern Leopard Frog were detected less frequently.

Percent of Stations Occupied

The number of frog species detected appeared to be similar between 2009 and 2021 at stations 7A.2 and 7A.3; however, the number of species may have decreased at station 7.1 (Figure 21). Since surveys measure frog abundance based on a calling code (refer to methods section) it is often difficult to measure temporal changes in absolute abundance. Instead, the proportion of stations occupied was used to measure changes in occurrence temporally (Figure 22). Spring Peeper occupied all stations in all years suggesting the population is healthy at this site. The proportion of stations occupied by Green Frog appears to have decreased since 2009. Between 2009 and 2013 all stations were occupied, followed by only 2 stations occupied for 5 years, then only one station occupied in 2021. Wood Frog also appeared to decrease in the proportion of stations occupied; however, all stations were occupied in 2021.

A further examination of the data was conducted to determine if these species were disappearing from a specific station or stations. Both American Toad and Northern Leopard Frog occurred sporadically between 2009 and 2021. Spring Peeper, Tetraploid Grey Treefrog, and Green Frog calling codes and presence at specific stations appear to be stable over time.

Wood Frog was present at all stations in 2009 with full choruses; however, since 2009 both the number of stations occupied and the calling code has decreased (Table 7). Again, these lower calling codes and non-detections at up to two stations (7.1 and 7A.2) is cause for concern and warrants further investigation.

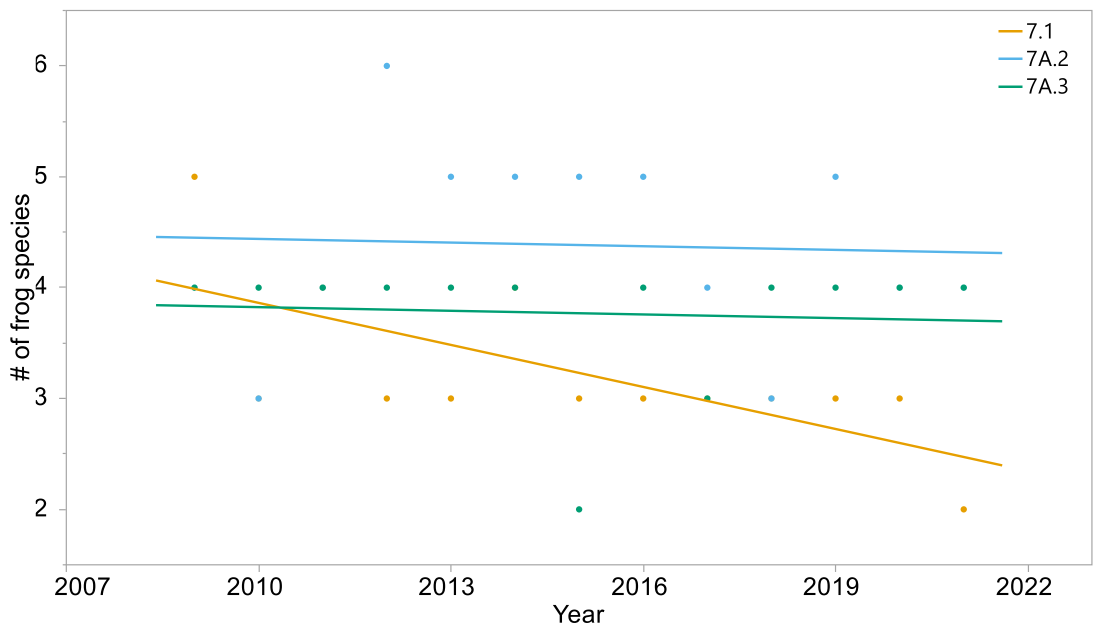


Figure 21. Temporal trends in frog species richness at stations WF 7.1, WF 7A.2 and WF 7A.3 between 2009 and 2021.

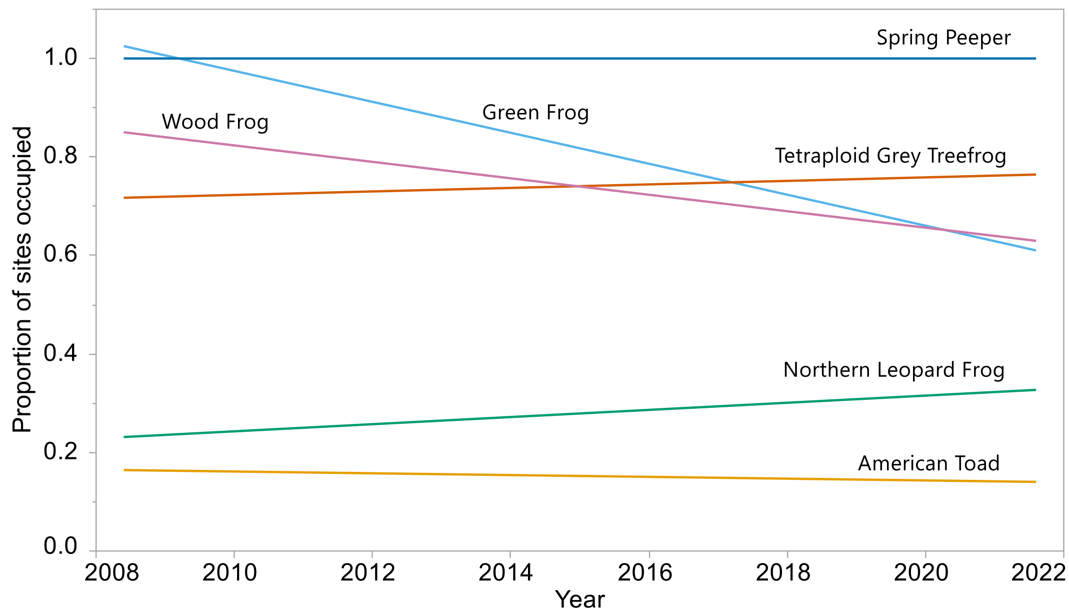


Figure 22. Temporal trends in the percent of sites occupied by specific frog species from 2009 to 2021.

Table 7. Changes over time in calling code and occurrence for Wood Frog at stations 7.1, 7A.2, and 7A.3 between 2009 and 2021.

Station #	**Calling code**												
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
7.1	3	1	1	0	0	0	0	0	1	0	0	0	1
7A.2	3	3	3	3	1	3	2	1	1	1	2	0	1
7A.3	3	3	3	3	1	1	3	3	3	1	2	2	2

Meadow monitoring

Meadow birds

Meadow bird communities differed based on station location (Figure 23). Red-winged Blackbird (*Agelaius phoeniceus*) dominated station 1 while Savannah Sparrow (*Passerculus sandwichensis*) dominated station 2 and Song Sparrow (*Melospiza melodia*) dominated stations 3 and 4. Nesting guild (generalist vs. meadow) varied greatly based on station location (Figures 24 and 25). Stations 1 and 2 had a greater proportion of meadow-nesting species than stations 3 and 4 which had a larger proportion of generalist species. The proportion of individuals that are meadow-dependent appears to have decreased between 2008 and 2021 at both stations 1 and 2.

Bobolink is a notable species of regional conservation concern (ranked L2) and was found at meadow bird stations 1 and 2; however, the number of individuals appears to have decreased over time. No Bobolink have been detected at station 2 since 2018 when one individual was observed. This species is area-sensitive meaning it relies on large grassland patches for breeding and generally avoids edges near woody vegetation (Johnson and Igl 2001). In addition to being a species of regional conservation concern by TRCA this species is listed as threatened by the Species at Risk Act in Ontario.

Other species of regional conservation concern (ranked L3) detected at meadow stations include Least Flycatcher (*Empidonax minimus*) at station 1, Eastern Meadowlark (*Sturnella magna*) at station 2, Chestnut-sided Warbler (*Setophaga pensylanica*) at stations 3 and 4, and Alder Flycatcher (*Empidonax alnorum*), Mourning Warbler (*Geothlypis philadelphia*), Blue-winged Warbler (*Vermivora pinus*), and Eastern Towhee (*Piplio erythrophthalmus*) at station 4.

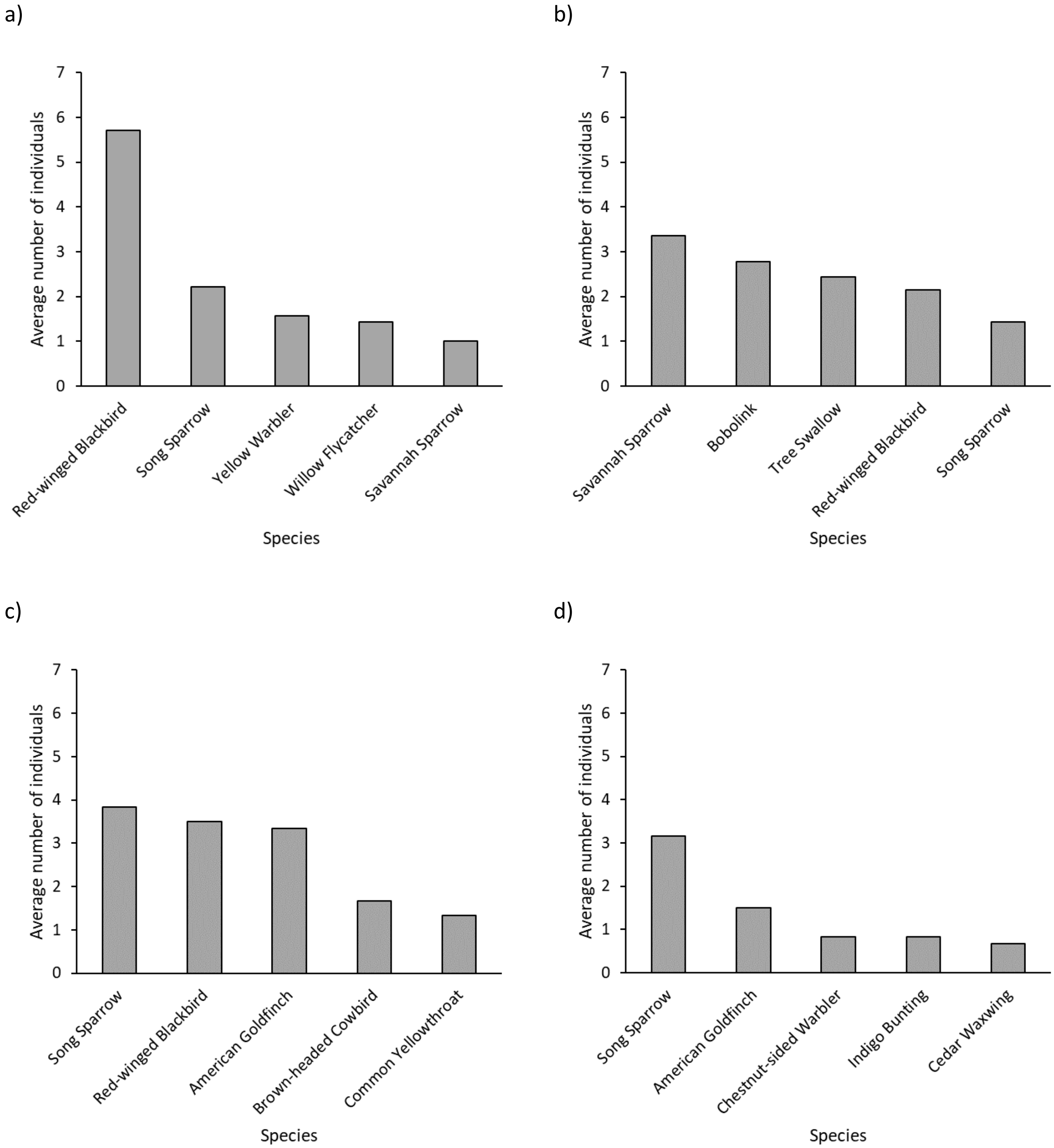


Figure 23. Community composition of the five most abundant species (averaged 2008-2021) recorded at meadow bird monitoring stations a) MB 8.1, b) MB 8.2, c) MB 8A.3 and d) MB 8A.4.

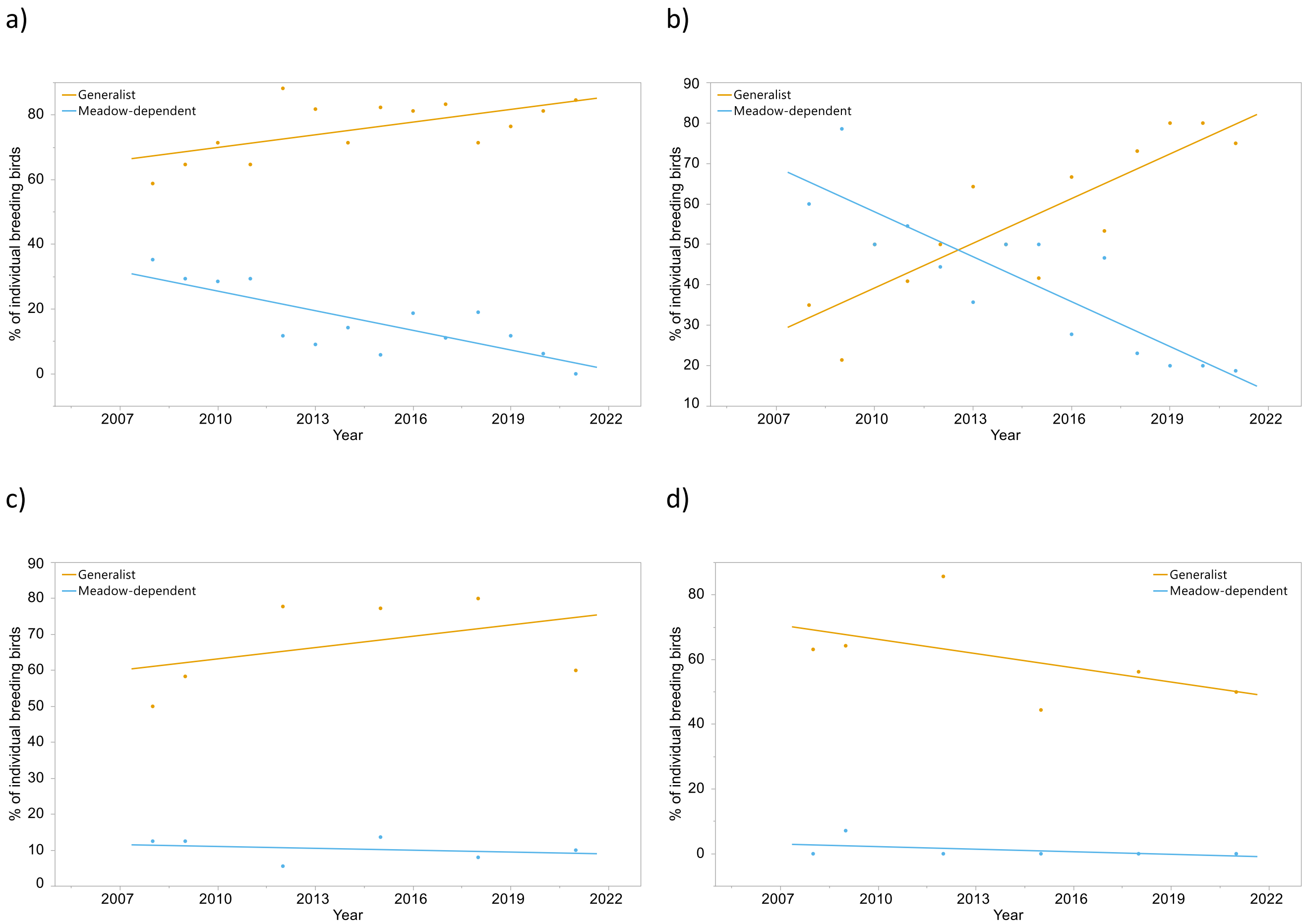


Figure 24. Proportion of individual breeding birds by habitat at meadow bird monitoring stations a) MB 8.1, b) MB 8.2, c) MB 8A.3, and d) MB 8A.4.

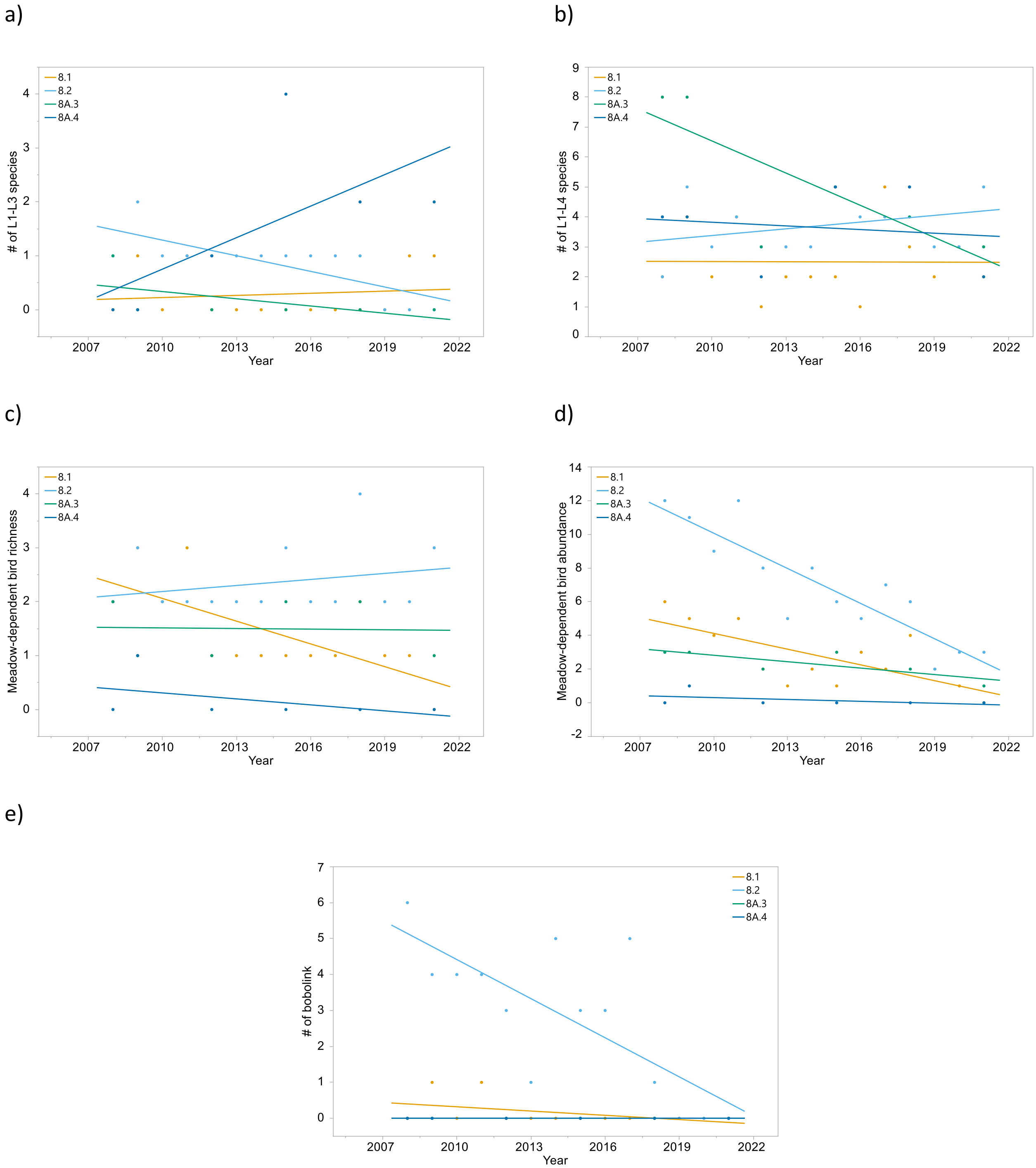


Figure 25. Temporal trends in meadow bird high-level indicators a) number of L1-L3 bird species, b) number of L1-L4 species, c) meadow-dependent bird richness, d) meadow-dependent bird abundance and e) number of Bobolinks.

SUMMARY

Flora and fauna communities at the ORCCR have changed between 2008 and 2021 and some of these changes may be related to natural succession, reforestation and/or restoration activities, adjacent residential development, and increased public use of the site.

The forest vegetation plot is experiencing natural succession towards a more mature forest community as observed by high mortality rates of pin cherry (a mid-successional species). The forest has also lost mature ash trees as a result of Emerald Ash Borer which has affected trees across the jurisdiction. Forest bird communities have not changed over time and consist of a mixture of species representing both forest/generalist/edge environments. Veery was detected for the first time in 2018 at station 2 and is an area-sensitive species known to occur in disturbed or regenerating forests.

Changes in wetland hydrology appeared to have occurred between 2008 and 2021. Two wetlands in the west end had no water in 2021 while in other years had considerable water depths. Two wetlands in the north had considerably greater water depths in recent years than in the past. These changes in hydrology affected wetland vegetation and are expected to also affect fauna communities in subsequent years.

Water levels can fluctuate both naturally or due to interference from development or other activity. Natural fluctuations are most common in coastal wetlands where changes in lake levels affect water levels and lead to expansion or contraction of vegetation communities. Natural fluctuations in water levels for inland wetlands could be due to weather patterns such as drier years or wetter years, or changes in groundwater. The large fluctuations in water levels at ORCCR likely reflect changes in water balance due to a local factor such as water taking or development impacts, but this cannot be confirmed and could be a result of a combination of factors (both natural and anthropogenic).

Wetland vegetation was most heavily affected by changes in water levels. There was a decrease in the amount of woody vegetation on transects where water levels increased, while transects that lost water subsequently lost floating and submergent species. Common buckthorn continues to spread in one transect; however, has decreased in cover and abundance on two other transects. Wetland bird communities have been similar over time consisting of several generalist and wetland-dependent species.

Six frog species were found between 2008 and 2021 and the number of species has not changed over time at any of the stations. Frequency of occurrence of Spring Peeper was the highest occurring at all stations, while Wood Frog at station 1 in the west end have only been detected in low numbers in recent years and could be an early warning sign of an issue for the local population.

Several species of regional concern were detected at meadow bird stations including most notably Bobolink although numbers of this species, along with several other meadow bird metrics (such as meadow-dependent bird species richness, proportion of birds using meadow habitat), have been declining at stations in the west end. These declines may be occurring due to the recent nearby residential development or re-forestation efforts.

In addition to biodiversity monitoring, several forms of recreation-related impacts have been noted such as informal trails, mountain biking off trails, litter, and intentionally broken branches, and these impacts appear to have increased since the start of the covid-19 pandemic.

Overall, terrestrial monitoring has highlighted that ORCCR has been subject to changes in biodiversity reflecting both regional patterns (e.g. Emerald Ash Borer) and more localized changes (e.g. water levels). Changes in biodiversity in response to localized changes should be carefully considered within the context of the overall natural heritage vision and objectives and used to guide future management of ORCCR.

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APPENDIX

Table A.1. Nesting habitat preferences for bird species found in the TRCA region. Preferences were used to determine the dependence of a species on a particular habitat (forest, wetland, or meadow). Swamp nesters were included as forest-dependent.

Common name	Scientific name	Forest	Edge	Wetland	Meadow	General
Acadian flycatcher	*Empidonax virescens*	■				
barred owl	*Strix varia*	■				
black and white warbler	*Mniotilta varia*	■				
Blackburnian warbler	*Setophaga fusca*	■				
black-throated blue warbler	*Setophaga caerulescens*	■				
black-throated green warbler	*Setophaga virens*	■				
blue-grey gnatcatcher	*Polioptila caerulea*	■				
blue-headed vireo	*Vireo solitarius*	■				
broad-winged hawk	*Buteo platypterus*	■				
brown creeper	*Certhia americana*	■				
canada warbler	*Cardellina canadensis*	■				
cerulean warbler	*Setophaga cerulea*	■				
Cooper's hawk	*Accipiter cooperii*	■				
eastern screech-owl	*Megascops asio*	■				
eastern wood-pewee	*Contopus virens*	■				
golden-crowned kinglet	*Regulus satrapa*	■				
great-crested flycatcher	*Myiarchus crinitus*	■				
hairy woodpecker	*Picoides villosus*	■				
hermit thrush	*Catharus guttatus*	■				
hooded warbler	*Setophaga citrina*	■				
long-eared owl	*Asio otus*	■				
magnolia warbler	*Setophaga magnolia*	■				
merlin	*Falco columbarius*	■				
northern saw-whet owl	*Aegolius acadicus*	■				
nothern goshawk	*Accipiter gentilis*	■				
olive-sided flycatcher	*Contopus cooperi*	■				
ovenbird	*Seiurus aurocapillus*	■				
pileated woodpecker	*Dryocopus pileatus*	■				
pine siskin	*Carduelis pinus*	■				
pine warbler	*Setophaga pinus*	■				
red-breasted nuthatch	*Sitta canadensis*	■				
red-eyed vireo	*Vireo olivaceus*	■				
red-shouldered hawk	*Buteo lineatus*	■				
ruffed grouse	*Bonasa umbellus*	■				
scarlet tanager	*Piranga olivacea*	■				
sharp-shinned hawk	*Accipiter striatus*	■				
veery	*Catharus fuscescens*	■				
whip-poor-will	*Caprimulgus vociferus*	■				
white-breasted nuthatch	*Sitta carolinensis*	■				
white-winged crossbill	*Loxia leucoptera*	■				
winter wren	*Troglodytes hiemalis*	■				
wood duck	*Aix sponsa*	■		■		
wood thrush	*Hylocichla mustelina*	■				
worm-eating warbler	*Helmitheros vermivorus*	■				
yellow-bellied sapsucker	*Sphyrapicus varius*	■				
yellow-throated vireo	*Vireo flavifrons*	■				
		[redacted]				

Common name	Scientific name	Forest	Edge	Wetland	Meadow	General
American redstart	*Setophaga ruticilla*					
American woodcock	*Scolopax minor*					
black-billed cuckoo	*Coccyzus erythropthalmus*					
blue-winged warbler	*Vermivora pinus*					
brown thrasher	*Toxostoma rufum*					
chestnut-sided warbler	*Setophaga pensylvanica*					
downy woodpecker	*Picoides pubescens*					
eastern bluebird	*Sialia sialis*					
eastern towhee	*Piplio erythrophthalmus*					
golden-winged warbler	*Vermivora chrysoptera*					
indigo bunting	*Passerina cyanea*					
least flycatcher	*Empidonax minimus*					
mourning warbler	*Geothlypis philadelphia*					
Nashville warbler	*Oreothlypis ruficapilla*					
purple finch	*Carpodacus purpureus*					
red-bellied woodpecker	*Melanerpes carolinus*					
red-headed woodpecker	*Melanerpes erythrocephalus*					
ring-necked pheasant	*Phasianus colchicus*					
rose-breasted grosbeak	*Pheucticus ludovicianus*					
ruby-throated hummingbird	*Archilochus colubris*					
white-throated sparrow	*Zonotrichia albicollis*					
wild turkey	*Meleagris gallopavo*					
yellow-billed cuckoo	*Coccyzus americanus*					
yellow-breasted chat	*Icteria virens*					
yellow-rumped warbler	*Setophaga coronata*					
alder flycatcher	*Empidonax alnorum*					
American bittern	*Botaurus lentiginosus*					
American black duck	*Anas rubripes*					
American coot	*Fulica americana*					
black tern	*Chlidonias niger*					
black-crowned night-heron	*Nycticorax nycticorax*					
blue-winged teal	*Anas discors*					
Canada goose	*Branta canadensis*					
canvasback	*Aythya valisineria*					
Caspian tern	*Sterna caspia*					
common gallinule	*Gallinula galeata*					
common tern	*Sterna hirundo*					
common yellowthroat	*Geothlypis trichas*					
double-crested cormorant	*Phalacrocorax auritus*					
gadwall	*Anas strepera*					
great black-backed gull	*Larus marinus*					
great blue heron	*Ardea herodias*					
great egret	*Casmerodius albus*					
green heron	*Butorides virescens*					
green-winged teal	*Anas crecca*					
herring gull	*Larus argentatus*					
hooded merganser	*Lophodytes cucullatus*					

Common name	Scientific name	Forest	Edge	Wetland	Meadow	General
least bittern	*Ixobrychus exilis*					
mallard	*Anas platyrhynchos*					
marsh wren	*Cistothorus palustris*					
mute swan	*Cygnus olor*					
osprey	*Pandion haliaetus*					
pied-billed grebe	*Podilymbus podiceps*					
ring-billed gull	*Larus delawarensis*					
sora	*Porzana carolina*					
swamp sparrow	*Melospiza georgiana*					
trumpeter swan	*Cygnus buccinator*					
Virginia Rail	*Rallus limicola*					
Wilson's snipe	*Gallinago delicata*					
bobolink	*Dolichonyx oryzivorus*					
clay-coloured sparrow	*Spizella pallida*					
eastern kingbird	*Tyrannus tyrannus*					
eastern meadowlark	*Sturnella magna*					
field sparrow	*Spizella pusilla*					
grasshopper sparrow	*Ammodramus savannarum*					
Henslow's sparrow	*Ammodramus henslowii*					
horned lark	*Eremophila alpestris*					
loggerhead shrike	*Lanius ludovicianus*					
northern harrier	*Circus cyaneus*					
savannah sparrow	*Passerculus sandwichensis*					
sedge wren	*Cistothorus platensis*					
short-eared owl	*Asio flammeus*					
spotted sandpiper	*Actitis macularia*					
upland sandpiper	*Bartramia longicauda*					
vesper sparrow	*Pooecetes gramineus*					
western meadowlark	*Sturnella neglecta*					
willow flycatcher	*Empidonax traillii*					
American Crow	*Corvus brachyrhynchos*					
American goldfinch	*Carduelis tristis*					
American kestrel	*Falco sparverius*					
American robin	*Turdus migratorius*					
Baltimore oriole	*Icterus galbula*					
barn swallow	*Hirundo rustica*					
black-capped chickadee	*Parus atricapillus*					
blue jay	*Cyanocitta cristata*					
Carolina wren	*Thryothorus ludovicianus*					
cedar waxwing	*Bombycilla cedrorum*					
chimney swift	*Chaetura pelagica*					
chipping sparrow	*Spizella passerina*					
cliff swallow	*Petrochelidon pyrrhonota*					
common grackle	*Quiscalus quiscula*					
common nighthawk	*Chordeiles minor*					
eastern phoebe	*Sayornis phoebe*					

Common name	Scientific name	Forest	Edge	Wetland	Meadow	General
European starling	*Sturnus vulgaris*					■
great-horned owl	*Bubo virginianus*					■
grey catbird	*Dumetella carolinensis*					■
house finch	*Carpodacus mexicanus*					■
house sparrow	*Passer domesticus*					■
house wren	*Troglodytes aedon*					■
killdeer	*Charadrius vociferus*					■
mourning dove	*Zenaida macroura*					■
northern cardinal	*Cardinalis cardinalis*					■
northern flicker	*Colaptes auratus*					■
northern mockingbird	*Mimus polyglottos*					■
orchard oriole	*Icterus spurius*					■
peregrine falcon	*Falco peregrinus*					■
red-tailed hawk	*Buteo jamaicensis*					■
red-winged blackbird	*Agelaius phoeniceus*					■
rock dove	*Columba livia*					■
song sparrow	*Melospiza melodia*					■
tree swallow	*Tachycineta bicolor*					■
warbling vireo	*Vireo gilvus*		■			■
yellow warbler	*Setophaga petechia*					■
northern waterthrush	*Parkesia noveboracensis*	■		■		
prothonotary warbler	*Protonotaria citrea*	■		■		
bank swallow	*Riparia riparia*					■
belted kingfisher	*Ceryle alcyon*			■		
brown-headed cowbird	*Molothrus ater*					■
northern rough-winged swallow	*Stelgidoptery x serripennis*					■
purple martin	*Progne subis*					■
turkey vulture	*Cathartes aura*					■

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