Forest Birds at Risk of the Carolinian Forest in Southwestern Ontario

2018 Summary Report


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LIST OF ABBREVIATIONS

ACFL – Acadian Flycatcher

BMP – Best Management Practices

BSC – Bird Studies Canada

CA – Conservation Authority

CCCA – Catfish Creek Conservation Area

CERW – Cerulean Warbler

EAB – Emerald Ash Borer

ECCC – Environment and Climate Change Canada

ERCA – Essex Region Conservation Authority

FBAR – Forest Birds at Risk

HCA – Hamilton Conservation Authority

HNC – Hamilton Naturalist Club

LOWA – Louisiana Waterthrush

LPBLT – Long Point Basin Land Trust

LPRCA – Long Point Region Conservation Authority

LTCA – Lower Thames Conservation Authority

MNRF – Ontario Ministry of Natural Resources and Forestry

NCC – Nature Conservancy of Canada

NGO – Non-government Organization

PROW – Prothonotary Warbler

SAR – Species at Risk

TTLT – Thomas Talbot Land Trust

PREAMBLE

This report summarizes results of the 8th year of the Southern Ontario Forest Birds at Risk monitoring and stewardship program.

ACKNOWLEDGEMENTS

Thank you to the many landowners who make this project possible, and especially to those taking action to support SAR and SAR habitat on their properties.

Thank you to the 2018 BSC field staff, Jacob Lachapelle and Larissa Simulik who collected and entered the data for this report and prepared materials for landowners. Special thanks to volunteers Don Wills and Dean Ware who monitor Prothonotary Warbler breeding success at several sites throughout southwestern Ontario. Thank you to BSC staff and volunteers Jody Allair, Myles Falconer, Bronwyn Harkness, Verena Rupprecht, and Ana Morales for aiding in occupancy surveys and to the many other BSC staff who provided input and commentary.

Finally, this endeavour would not be possible without the continued financial support of:

Ontario

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U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

PROJECT GOALS AND OBJECTIVES

Our goal is to improve the conservation status of four high priority forest birds at risk in southwestern Ontario's forests: Acadian Flycatcher (ACFL; Endangered), Louisiana Waterthrush (LOWA; Threatened), Cerulean Warbler (CERW; Endangered), and Prothonotary Warbler (PROW; Endangered). Project results are intended to direct conservation and stewardship efforts over the short and long-term.

Primary project objectives are to:

- Determine and monitor site occupancy of the four target SAR in the Norfolk Sand Plain and elsewhere throughout southwestern Ontario (e.g., federally-identified Critical Habitat);
- Identify and mitigate threats to the target SAR in the Norfolk Sand Plain and elsewhere throughout southwestern Ontario;
- Increase key audiences' awareness and understanding of the target SAR and conservation needs, and to engage land owners and managers in stewardship for SAR.

In 2018, we also had the following secondary objectives to:

- Increase our understanding of CERW habitat preferences in southwestern Ontario.

METHODS

Site Occupancy Surveys

Target SAR were searched for in forest tracts with known and potential breeding habitat for one or more of the four target SAR. Sites surveyed included: "known" sites (occupied by target species within the last five years), "historic" sites (occupied by target species over five years ago, but not since), and new sites (sites with potential habitat that have not been previously surveyed, or have never had target SAR detected). Sites were surveyed at least once during the breeding season and most were surveyed multiple times throughout the season to account for differences in timing of breeding amongst target species (e.g., LOWA breeding season: May to June, ACFL breeding season: June to August). BSC staff surveyed each site with area searches, recording target species locations and breeding evidence and assessing habitat quality. Nests were searched for when time permitted, however it was not a priority. See Appendix A: Species Occupancy Data Sheet for a copy of the occupancy data form used in the field. Further details of survey methodology, including levels of breeding evidence, can be obtained by contacting speciesatrisk@birdscanada.org.

Cerulean Warbler Habitat Measurements

In 2017, the FBAR program began collecting information about CERW habitat in their Carolinian Forest range and the Frontenac Forests Important Bird and Biodiversity Area (FF IBA). Preliminary analysis of the 2017 data (see FBAR 2017 summary report) suggested there may be differences between male song post habitat preferences between the Carolinian and Frontenac populations. Developing a clear understanding of local and/or regional habitat preferences/needs is important from a forest management perspective in that CERW populations in southwestern Ontario may need to be managed distinctly from the CERW population in the Frontenac region and a Best Management Practice (BMP) for CERW may not be universal across the species' Ontario range. Thus, in 2018, we focused on gathering more detailed habitat information, including increasing and improving the quantifiable variables measured, to better determine habitat preferences as well as our ability to detect potential differences between the two regions. To help ensure that the information gathered could be related to potential BMP forest prescriptions, we used standard forestry measurement techniques and worked with the OMNRF to identify key variables to be measured. We measured habitat at CERW occupied and unoccupied sites in their Carolinian Forest range and the FF IBA (Appendix B: Habitat Data Sheet). For the purpose of this report, only the southwestern Ontario results will be reported.

Forest composition was measured using a 2M basal prism sweep. A basal prism sweep measures the basal area of the forest in a 0.04 ha (400 m^2) plot from some random point within the forest. However, our priority with the prism sweep was to determine the forest composition of the local area around male CERW song posts by noting tree species and size. Individual trees that had been counted "in" during a prism sweep were identified to species and basal size of a tree was categorized into 1 of 4 size classifications: saplings (0-9 cm); polewood (10-24 cm); small to medium sawlog (25-50 cm); large to x-large sawlog (>50 cm). Forest vertical structure at occupied and unoccupied CERW locations was determined by separating the vertical structure into four canopy heights (<6 m, 6-12 m, 12-18 m, and >18 m high) and proportion of foliage density was estimated within those 4 vertical areas. Average canopy cover at occupied and unoccupied locations was determined using a densiometer. Canopy cover was measured at the 4 cardinal directions and the overall average of canopy cover density was reported. Tree height was measured using a Suunto clinometer from the tree in which the male CERW was first located as singing; or in the case of a control location where no CERW was present, the height of the tallest tree within the basal prism sweep was measured. Finally, CERW habitat suitability was scored on a scale from 1 to 5.

When male CERW were detected during occupancy survey, their location was determined and habitat measurements were taken directly under from where the male was singing. Habitat measurements for unoccupied sites would be taken after an occupancy survey had been

completed and no CERW were observed or detected. Measurements were taken at a random point ≥100 m from the forest edge. The distance chosen is based on previous information suggesting CERW are interior forest species.

Analysing Cerulean Warbler Habitat

CERW absence and presence was identified as the binomial dependent variable, vertical structure was categorized as the nested random effect factor and all other habitat covariates were fixed effects. The decision to assign vertical structure as a nested random effect allowed us to obtain the hierarchical structure among foliage densities from which male CERW prefer to sing. Species of trees were retained but we also summed tree genera (e.g. red, sugar, silver maple were summed into *Acer* spp.) and that are considered important to CERW ecology based on literature and included as habitat covariates.

Covariates were scaled around the mean and we used a first and second order polynomial approach to select covariates that explain shape variation that best fit CERW presence to the forest stand characteristics. To reduce the number of variables, we considered covariates at a significance value of $p \leq 0.10$. We then conducted a correlation analysis to assess collinearity on the remaining covariates. Significant correlated covariates ≥ 0.60 were exchanged to assess which covariate best fit the CERW response but only one correlated covariate at a time was used for model building.

General linear regression (GLM) and generalized linear mixed effects regression (GLMM) from the "lme4" package in Program R were used to build CERW habitat models. Mixed effects models provide a more robust analytical approach than the generalized linear model (GLM) approach and allowed us to assess variables with an associated hierarchical structure (i.e. vertical structure). GLMs and GLMMs were tested using the Hosmer-Lemeshow goodness-of-fit test. We further tested model performance by determining the area under the curve (AUC) and considered models to perform well when AUC was ≥0.85. Models that best described CERW presence were evaluated using Akaike's Information Criteria (AIC) and we considered models with a $\Delta AIC_c \leq 4$ to be supported by the data. All analysis was completed in Program R. We set the significance level at 0.10 to account for small sample size and variation within the data.

Landowner Engagement and Stewardship

Private land ownership in the region falls into one of two categories: individual landowners and conservation organizations. Individual landowners manage or conserve their property for various purposes, ranging from conservation to personal recreation and/or animal harvesting to active forest harvest, whereas conservation organizations typically work to maintain or restore forests for conservation purposes.

All individual private landowners were contacted preceding the field season either in person or by phone to gain permission to access their land. We also contacted the respective landowner 24-48 hours prior to conducting each survey as a courtesy and as a reminder of the survey. Permission to conduct surveys on public properties (including land managed by Conservation Authorities, provincial and federal parks, and municipal property) was obtained through the appropriate permit process.

After each visit, all landowners were provided with survey results for their property. Private landowners also received thank-you letters along with the list of birds detected on their property. All landowner engagements (e.g. discussions and threat mitigation efforts) were tracked to help maintain strong communicative relationships between BSC and landowners between years, and to enable evaluation of the effectiveness of our outreach and engagement efforts.

Forest Health Risk surveys[1]

While conducting occupancy surveys, we assessed all sites for risks to target SAR and/or their habitat. Forest Health Risks were classified into three main categories: Human-related, Invasive Species, or Natural, and location coordinates taken. When immediate risk(s) to target SAR or their habitat were observed during surveys, the appropriate landowner was informed and mitigation options were discussed. Refer to Appendix C: Forest Health Risk Data Sheet for the forest health risk datasheet.

[1] In previous reports, we have referred to forest health risks as "threats". However, the term "threat" is value-laden and suggests an intention to cause damage or harm. The term "forest health risk" is more objective, in that it does not suggest or imply fault, and is thus more appropriate when working with landowners and stewards.

RESULTS AND DISCUSSION

In 2018, we surveyed a total of 97 sites in southwestern Ontario with known, historic, or potential SAR habitat. The total area of the 97 woodlots and forests surveyed was 6849.7 ha (Table 1). Sites ranged in size from 5.0 to 697.0 ha with an average area of 70.6 ±9.5 ha. All sites were visited once and some sites were visited multiple times (Appendix D). A total of 154 site visits were made either for species occupancy surveys, breeding confirmation, or to monitor SAR nests. Total search area covered after multiple surveys per site was 11,254 ha and total person-effort to cover this area was 361.2 hours (Table 1). Site visits ranged from 16 minutes (nest check) to 4.75 hours (occupancy survey) with an average time spent at a site of 3.7 ± 0.4 hours (Appendix D: Survey Effort Table).

All 97 sites were either privately or publicly owned and every landowner and manager exhibited either complete land conservation, some degree of forest management (i.e. forest harvesting), or recreation at varying levels (i.e. hiking to ATV use). Private landowners consisted of 40 individual landowners (41.2%) and 4 conservation organizations (e.g. NCC, 2 local land trusts, and a naturalist club) (12.4%). Nine public landowners consisted of 5 CAs (38.1%) as well as 4 municipal, provincial, and federal governments in southwestern Ontario (8.2%; Table 3).

Table 1. Survey effort separated by various landowners. Individual private landowners account for the majority of sites surveyed.

Landowner	No. Sites	Total Area (ha)	No. of visits	Person-effort (hours)	Area Covered per site
CCCA	4	375.3	4	9.3	375.3
ECCC	2	61.0	6	6.0	272.0
ERCA	2	94.0	4	4.0	183.0
HCA	1	420.0	1	7.9	420.0
HNC	1	33.7	1	4.5	33.7
LPBLT	3	290.4	4	5.1	387.9
LPRCA	24	1437.3	36	82.3	2462.8
LTCA	4	664.2	4	7.7	664.2
Middlesex Cty	1	59.0	1	1.4	59.0
MNRF	5	530.6	6	12.4	559.3
NCC	5	458.6	15	38.4	2191.2
Norfolk Cty	1	111.0	3	5.7	333.0
Ontario Parks	1	697.0	1	4.2	697.0
private	40	1473.5	64	154.2	2391.0
TTLT	3	144.0	4	18.2	224.7
TOTAL	**97**	**6849.7**	**154**	**361.2**	**11254.0**

*for landowner names see list of acronyms at the beginning of the summary

CONSERVATION PRIORITY

An overall conservation ranking was determined for each site by summing the proportions of years occupied. For example, a site surveyed in two different years that was occupied by ACFL in both years and LOWA in one was ranked 1.5 (1.0 for ACFL and 0.5 for LOWA). The highest possible ranking of 4.0 indicates that all target SAR were present in all years surveyed and is a site of high conservation priority. Only sites surveyed in multiple years were included in the ranking exercise.

A total of 97 sites were included in the conservation scoring in 2018, with 13 new sites relative to 2017. Individual landowners comprised 34.0% (33) of the sites; conservation organizations, 15.5% (15); and public landowners, 50.5% (49). Of the 97 sites ranked, 32 had a score of 1.0 or greater (Table 2), indicating that these sites have either consistently supported one or more target SAR in every year they have been surveyed. Additionally, of the 33 of the privately owned woodlots, 16 of those sites have a ranking ≥1.0. Conservation organizations made up 15 of the 97 sites ranked, with 3 sites ranking ≥1.0. Public sites, comprising 49 of the sites, ranked for conservation priority, with 12 sites showing a ranking of ≥1.0. These high ranking sites include both public and privately owned sites, including sites that are actively logged and/or where the conservation status of the property is relatively unknown.

Table 2. Conservation ranking for sites surveyed in southwestern Ontario from 2011 to 2018. Bolded sites are sites newly ranked in 2018.

Site ID	Ownership	Years Surveyed	Proportion of years detected				Rank
			ACFL	CERW	LOWA	PROW	
HN1b	NCC	8	0.50	0.88	1.00	1.00	3.38
HN1c	NCC	8	1.00	0.50	1.00	0.38	2.88
HN27c	LPRCA	8	1.00	0.13	1.00	0.00	2.13
EL45a	private	3	1.00	0.00	1.00	0.00	2.00
EL45z	private	7	1.00	0.00	0.86	0.00	1.86
LA2z	ABCA	4	1.00	0.25	0.50	0.00	1.75
EL14b	**private**	2	0.50	0.00	1.00	0.00	1.50
HN27d	LPRCA	8	1.00	0.13	0.38	0.00	1.50
EL27z	private	7	1.00	0.00	0.43	0.00	1.43
KE2z	Parks Ontario	5	0.60	0.00	0.00	0.80	1.40
MI3b	LTCA	5	1.00	0.40	0.00	0.00	1.40
HN12g	MNRF	8	0.50	0.75	0.13	0.00	1.38
HN30z	private	6	0.33	0.00	1.00	0.00	1.33
HN69z	private	3	0.67	0.67	0.00	0.00	1.33
MI3h	LTCA	3	0.67	0.67	0.00	0.00	1.33
EL46d	private	4	0.75	0.00	0.50	0.00	1.25
HN81z	LPBLT	8	1.00	0.00	0.00	0.13	1.13

EL14z	private	5	0.30	0.00	0.80	0.00	1.10
BR02z	private	3	0.00	0.00	0.00	1.00	1.00
EL14c	**private**	2	0.00	0.00	1.00	0.00	1.00
EL46c	private	7	0.29	0.00	0.71	0.00	1.00
EL54b	private	3	0.00	0.00	1.00	0.00	1.00
EL57z	private	3	0.00	1.00	0.00	0.00	1.00
EL60z	**private**	2	1.00	0.00	0.00	0.00	1.00
ES2z	Parks Canada	4	0.25	0.00	0.00	0.75	1.00
ES5z	Parks Canada	3	0.00	0.00	0.00	1.00	1.00
HN111b	**LPRCA**	2	0.00	1.00	0.00	0.00	1.00
HN112c	private	3	0.00	0.00	1.00	0.00	1.00
HN16b	MNRF	8	0.13	0.00	0.88	0.00	1.00
HN21e	**private**	2	0.50	0.50	0.00	0.00	1.00
HN27a	LPRCA	8	0.00	0.00	1.00	0.00	1.00
HN4d	LPRCA	8	0.75	0.13	0.13	0.00	1.00
HN27g	NFN	8	0.88	0.00	0.00	0.00	0.88
HN52a	Norfolk Cty	8	0.50	0.00	0.38	0.00	0.88
HN5a	LPRCA	8	0.25	0.00	0.63	0.00	0.88
HN21b	LPRCA	7	0.00	0.86	0.00	0.00	0.86
HN31a	LPRCA	4	0.50	0.00	0.25	0.00	0.75
EL20z	TTLT	7	0.70	0.00	0.00	0.00	0.70
ES20z	ERCA	3	0.00	0.00	0.00	0.67	0.67
HN160z	private	3	0.00	0.67	0.00	0.00	0.67
HN21a	LPRCA	8	0.00	0.63	0.00	0.00	0.63
MI6z	Middlesex Cty	5	0.60	0.00	0.00	0.00	0.60
EL15z	CCCA	4	0.25	0.00	0.25	0.00	0.50
EL51z	LPRCA	6	0.00	0.17	0.33	0.00	0.50
HN102b	**private**	2	0.50	0.00	0.00	0.00	0.50
HN14z	HNC	8	0.38	0.00	0.13	0.00	0.50
HN160a	**private**	2	0.00	0.50	0.00	0.00	0.50
HN26c	**LPRCA**	2	0.00	0.50	0.00	0.00	0.50
HN27l	LPRCA	2	0.00	0.50	0.00	0.00	0.50
HN5z	NCC	4	0.25	0.00	0.25	0.00	0.50
HW1z	**HCA**	2	0.50	0.00	0.00	0.00	0.50
MI3k	LTCA	4	0.50	0.00	0.00	0.00	0.50
HN112b	private	6	0.00	0.00	0.40	0.00	0.40
EL29z	private	6	0.00	0.17	0.17	0.00	0.33
EL3z	private	3	0.33	0.00	0.00	0.00	0.33
ES10z	ERCA	3	0.00	0.00	0.00	0.33	0.33
HN101b	NCC	3	0.33	0.00	0.00	0.00	0.33
HN12e	MNRF	3	0.33	0.00	0.00	0.00	0.33
HN12f	MNRF	3	0.33	0.00	0.00	0.00	0.33
HN161z	private	3	0.33	0.00	0.00	0.00	0.33
HN16e	MNRF	3	0.33	0.00	0.00	0.00	0.33
HN21c	LPRCA	6	0.00	0.33	0.00	0.00	0.33

HN37a	LPRCA	6	0.00	0.33	0.00	0.00	0.33
HN3c	LPRCA	6	0.00	0.00	0.33	0.00	0.33
HN96a	NCC	3	0.33	0.00	0.00	0.00	0.33
HN99z	private	3	0.00	0.33	0.00	0.00	0.33
HN12d	MNRF	7	0.29	0.00	0.00	0.00	0.29
HN19b	LPRCA	7	0.00	0.14	0.14	0.00	0.29
HN16m	LPEA	4	0.25	0.00	0.00	0.00	0.25
HN5b	NCC	4	0.00	0.00	0.25	0.00	0.25
EL43b	CCCA	5	0.20	0.00	0.00	0.00	0.20
HN17b	LPCRA	5	0.00	0.20	0.00	0.00	0.20
HN5c	NCC	5	0.00	0.00	0.20	0.00	0.20
EL49z	private	7	0.14	0.00	0.00	0.00	0.14
BR80z	LPRCA	2	0.00	0.00	0.00	0.00	0.00
BR81z	LPRCA	2	0.00	0.00	0.00	0.00	0.00
EL28z	private	5	0.00	0.00	0.00	0.00	0.00
EL44z	private	2	0.00	0.00	0.00	0.00	0.00
EL50a	private	3	0.00	0.00	0.00	0.00	0.00
EL52z	private	2	0.00	0.00	0.00	0.00	0.00
EL53b	private	2	0.00	0.00	0.00	0.00	0.00
HN113a	NCC	2	0.00	0.00	0.00	0.00	0.00
HN114z	LPBLT	5	0.00	0.00	0.00	0.00	0.00
HN17a	LPCRA	4	0.00	0.00	0.00	0.00	0.00
HN18a	**LPRCA**	2	0.00	0.00	0.00	0.00	0.00
HN27j	LPRCA	2	0.00	0.00	0.00	0.00	0.00
HN31z	LPRCA	3	0.00	0.00	0.00	0.00	0.00
HN37c	LPRCA	6	0.00	0.00	0.00	0.00	0.00
HN37d	**LPRCA**	2	0.00	0.00	0.00	0.00	0.00
HN37z	**LPRCA**	2	0.00	0.00	0.00	0.00	0.00
HN41z	private	2	0.00	0.00	0.00	0.00	0.00
HN4a	LPRCA	5	0.00	0.00	0.00	0.00	0.00
HN59z	private	2	0.00	0.00	0.00	0.00	0.00
HN7z	NCC	3	0.00	0.00	0.00	0.00	0.00
HN8a	LPRCA	2	0.00	0.00	0.00	0.00	0.00
HN90z	LPRCA	2	0.00	0.00	0.00	0.00	0.00
MI3g	**private**	2	0.00	0.00	0.00	0.00	0.00

OCCUPANCY SURVEYS

Of the 97 sites surveyed, 123 individual SAR were detected at 40 sites in total (Table 3 and Table *4*). Of the 40 sites in which SAR were detected in southwestern Ontario, ACFL were detected at 23 sites, LOWA were detected at 14 sites, CERW were detected at 7 sites, and PROW at 5 locations. SAR occupied 16 private landowner sites (40.0%), 5 conservation organization sites (12.5%), 13 publicly-managed sites (32.5%), and 5 government-owned sites (12.5%).

Table 3. SAR detected in southwestern Ontario separated by landowner. According to data from the sites surveyed, private individual landowners are very important contributors to maintaining SAR. One third of all target SAR and two thirds of LOWA were detected on private individual land.

Landowner	Ownership	ACFL	LOWA	CERW	PROW	Total
CCCA	public	1		1		2
ECCC	gov't				7	7
HCA	public	1				1
LPBLT	private	2				2
LPRCA	public	11	5	7		23
LTCA	public	6				6
Middlesex Cty	gov't	4				4
MNRF	gov't		2			2
NCC	private	3	3	1	16	23
Norfolk Cty	gov't	2				2
Ontario Parks	gov't				7	7
Individual	private	17	21	2	2	42
TTLT	private	2				2
	Total	49	31	11	32	123

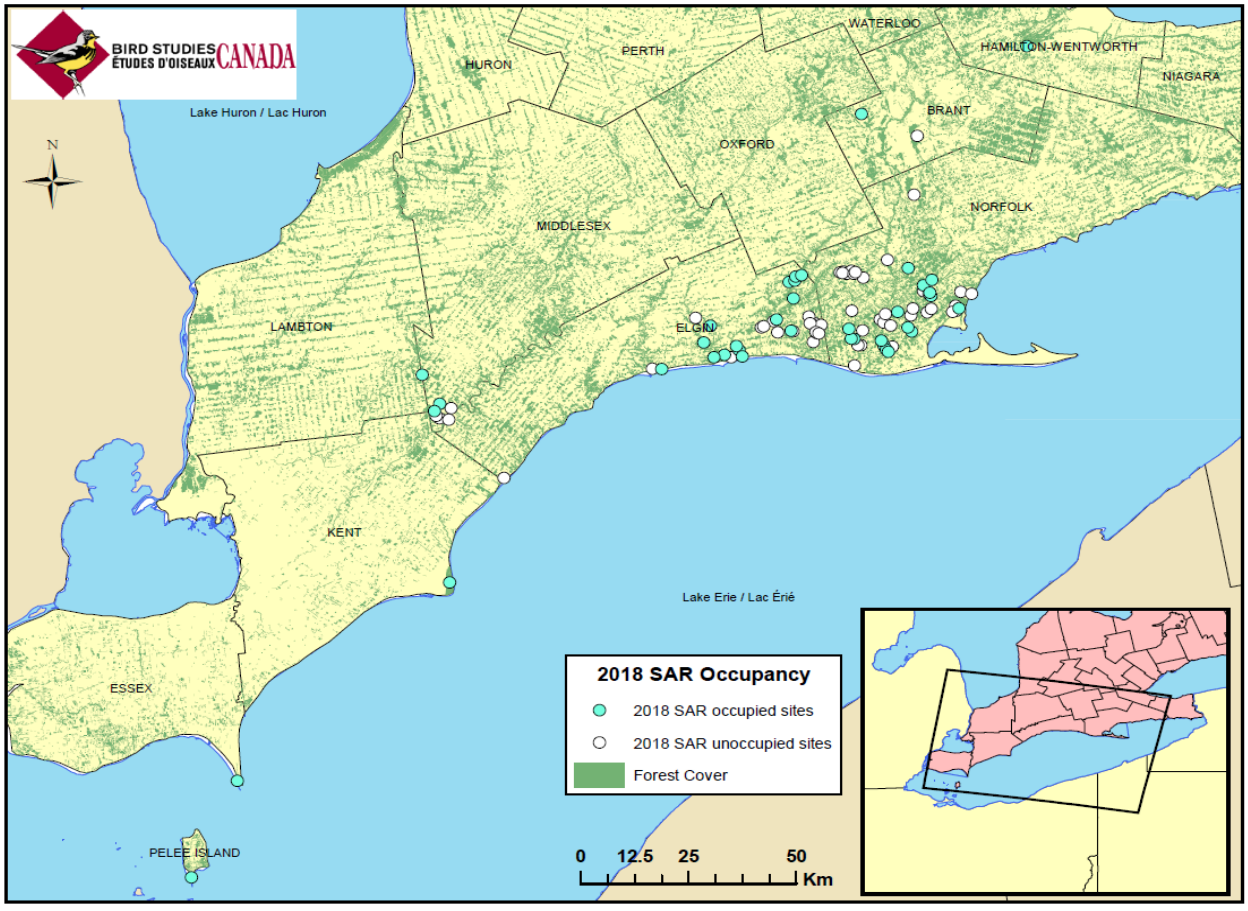

Figure 1. SAR occupancy in southwestern Ontario for 2018. A total of 97 sites were surveyed and 40 sites were identified with priority SAR.

Table 4. Target SAR occupancy by site surveyed in 2018. We were able to identify 40 SAR occupied sites from the 97 sites surveyed in total.

		ACFL			CERW			LOWA			PROW			
Site ID	Ownership	S	P	N	S	P	N	S	P	N	S	P	N	Y
BR02z	private											1	1	6
EL14b	private							2	2	1				
EL14c	private							1						
EL14z	private	1						1	1					
EL15z	CCCA	1												
EL16a	CCCA				1									
EL20z	TTLT	2												
EL27z	private	1												
EL29z	private							1						
EL45a	private	3	2	2				1						
EL45z	private	1	1	1					1	1				
EL46c	private								1					
EL51z	LPRCA				2									
EL54b	private								1	1				
EL57z	private				1									
EL60c	private	1												
EL60z	private	1												
ES2z	ECCC										2	2	2	?
ES5z	ECCC										1			
HN111b	LPRCA				2									
HN160z	private				1									
HN16b	MNRF								1	1				
HN1b	NCC	1						1				8	8	31
HN1c	NCC	1			1				1	1				
HN21b	LPRCA				3									
HN21e	private		1	1										
HN27a	LPRCA								1					
HN27c	LPRCA	4						1	1					
HN27d	LPRCA	2												
HN30z	private	1						1	1	1				
HN4a-2	LPRCA	2												
HN4d	LPRCA	3												
HN52a	Norfolk Cty		1	1										
HN81z	LPBLT		1	1										
HN96a	NCC	1												
HW1z	HCA	1												
KE2z	Ontario Parks										3	2	2	?
MI3b	LTCA	4												
MI3h	LTCA	2												
MI6z	Middlesex Cty	4												
	TOTALS	**37**	**12**	**6**	**11**	**0**	**0**	**9**	**22**	**6**	**6**	**26**	**13**	**37**

† ACFL Critical Habitat

* S = singing males observed only; P = pairs observed; N = nests located; Y = young fledged

Acadian Flycatcher (ACFL)

ACFL were located at 23 sites throughout southwestern Ontario in 2018. We located 37 territorial males, 12 pairs, and 6 nests (Table 3). Of the 6 nests located, 1 was considered successful and the other 5 had an unknown outcome. ACFL were located on 15 sites previously designated as Critical Habitat. Several additional sites occupied by ACFL meet the criteria for Critical Habitat designation and this has been highlighted to ECCC staff.

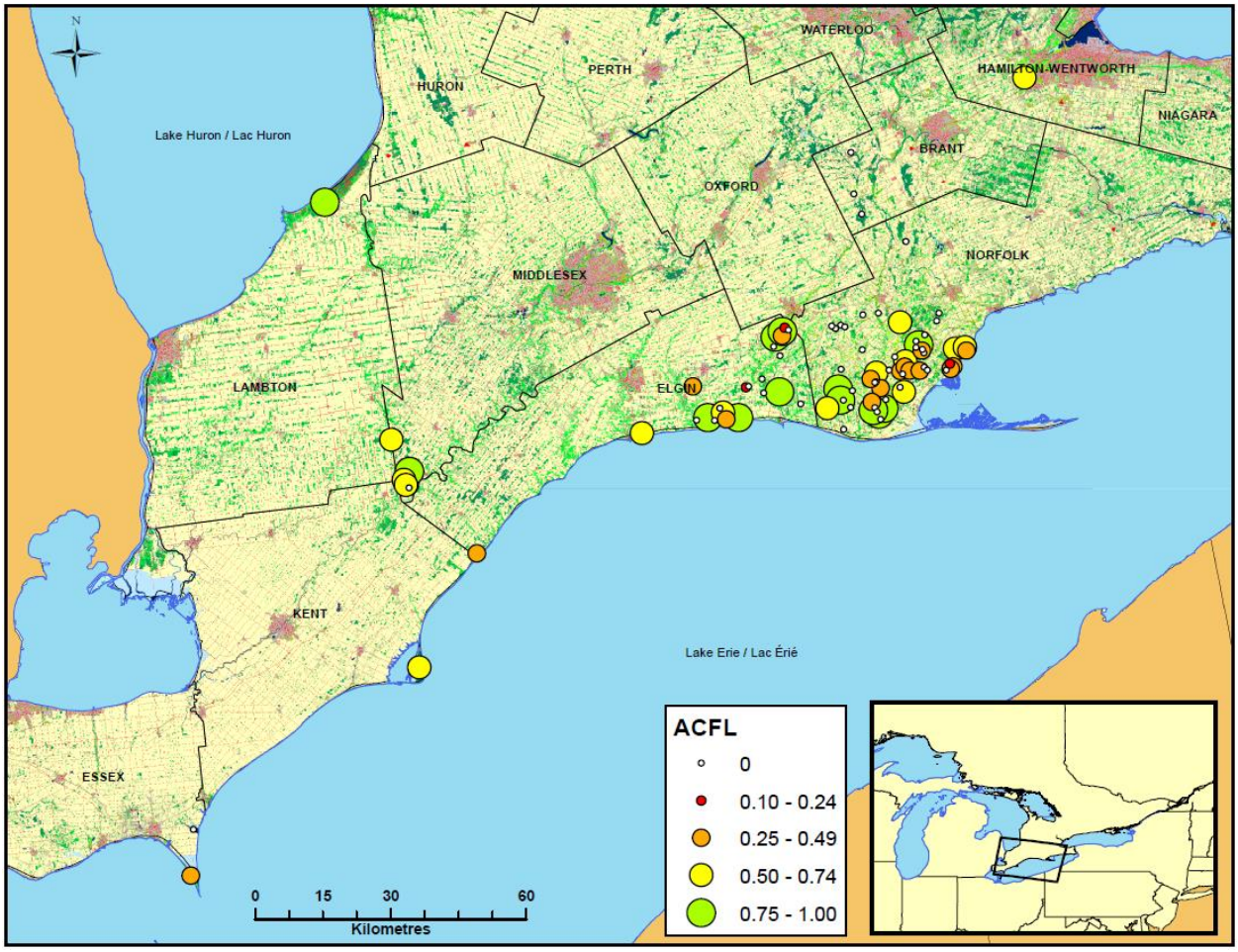

Figure 2. ACFL site occupancy in southwestern Ontario from 2011 to 2018; larger circles (yellow and green dots) represent sites that have been consistently occupied.

Louisiana Waterthrush (LOWA)

We located LOWA at 14 sites in southwestern Ontario in 2018. We were able to observe 9 territorial males and 22 pairs, and locate 6 nests (Table 3). Two nests were monitored; 1 was considered successful and the other had an unknown outcome.

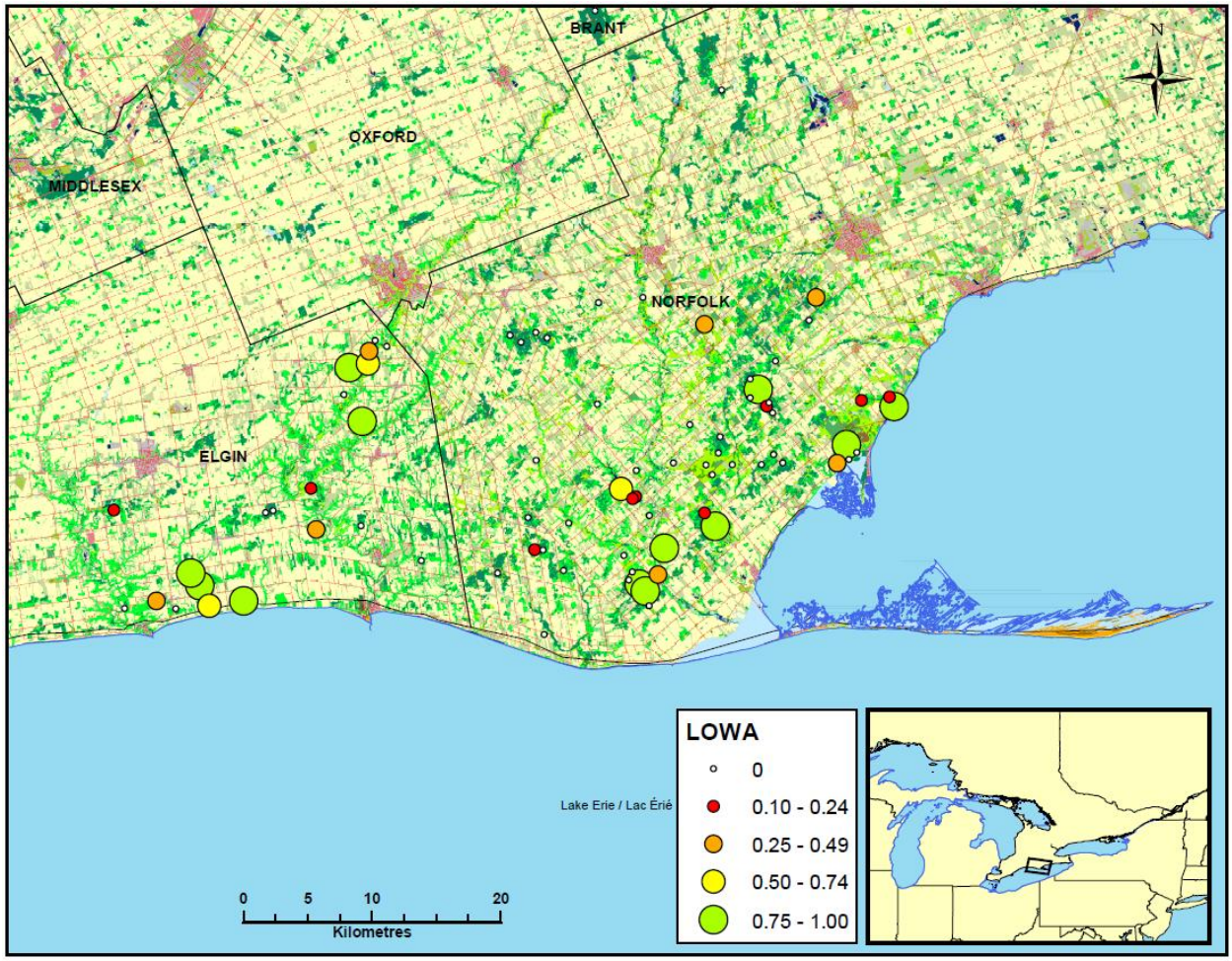

Figure 3. LOWA site occupancy in southwestern Ontario from 2011 to 2018; larger circles (yellow and green dots) represent sites that have been consistently occupied.

The importance of maintaining watershed habitat for LOWA can be seen in Figure 3 where private and public landowners have maintained forest cover which have delineated streams and rivers within the watershed. The majority of LOWA have been located in stream ravines and hardwood bottomland sloughs in the west Norfolk and east Elgin area. Locating potential areas of occupancy and identifying important habitat factors for LOWA could help us better understand their ecology and population.

Cerulean Warbler (CERW)

During the 2018 breeding season, 11 singing males were located at 7 sites (Table 3). In 2017, 12 properties with large patches of deciduous, low-lying forest were identified as high potential CERW habitat and targeted for occupancy surveys in 2018 (Appendix D: Survey Effort Table). Unfortunately, none of the new sites yielded new locations of CERW however, we were able to accumulate additional habitat information to help determine CERW habitat preferences. 2018 marks an all-time low for CERW, with fewer singing males detected than in all but one other year (only 11 males were detected in 2016) and the lowest percentage of sites occupied since the program's outset.

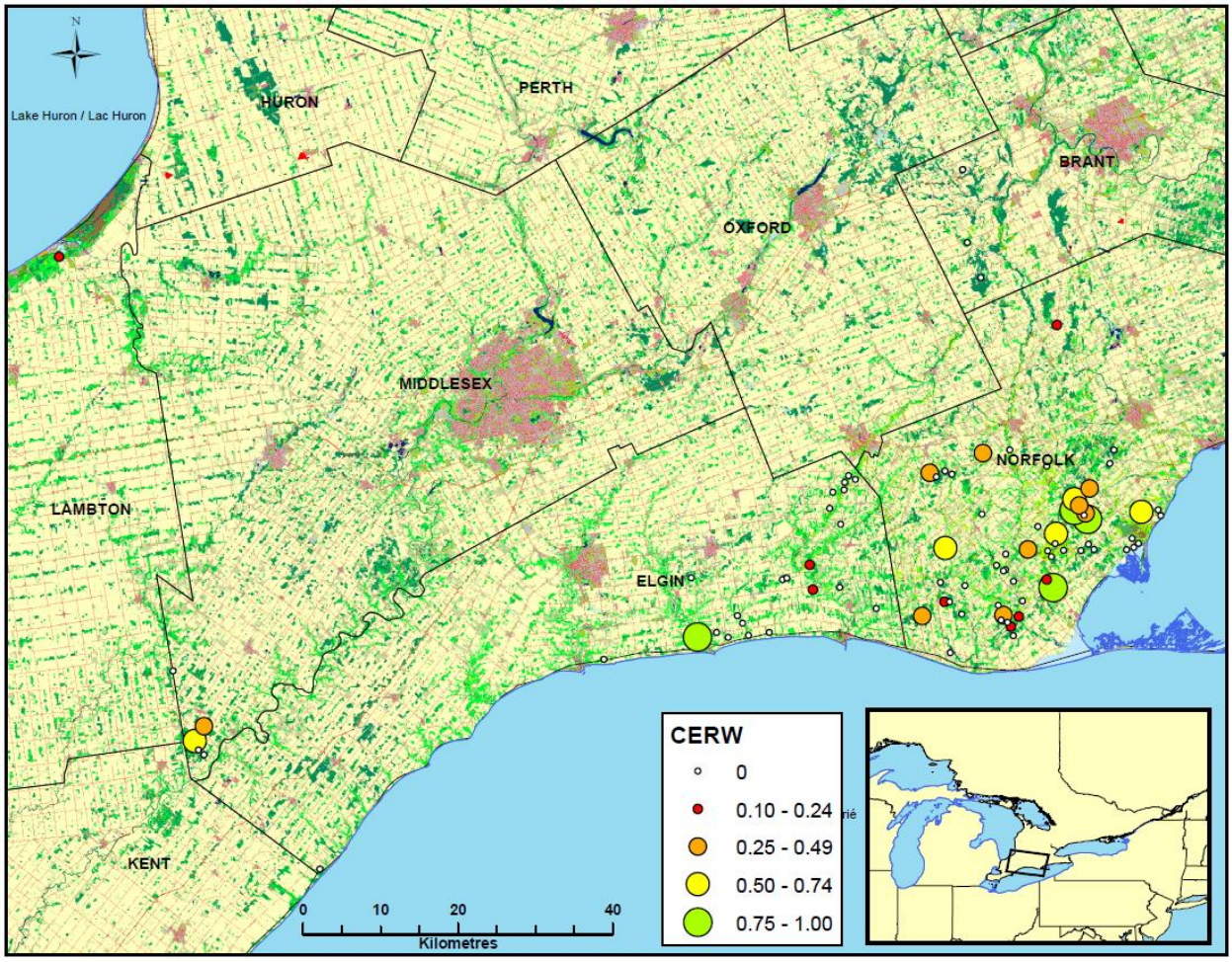

Figure 4. CERW occupancy in southwestern Ontario.

CERW habitat

We measured habitat features for CERW in southwestern Ontario at 22 CERW occupied locations and 78 unoccupied locations from 87 sites. Due to low sample sizes from 2018 (n = 11), we included 11 CERW occupied sites measured in 2017. Although 22 CERW were detected in 2017 (see 2017 FBAR report), 11 individuals occupied the same site in 2018 as they did in 2017. We excluded those individuals from 2017 to avoid pseudo-replication. We recognize the limitation within the current analysis and anticipate increased confidence in future analyses once more data is collected. In the current top model (Table 5), red maple (*Acer rubrum*) was found to be the only tree species positively associated with CERW presence (Table 6). Red maple is considered a generalist species, occurring in moist as well as drier areas but often associated with late successional, wet species such as black ash (*Quercus nigra*), American elm (*Ulmus americana*), and yellow birch (*Betula alleghaniensis*). It very readily hybridizes with silver maple (*Acer saccharinum*). Notably, the moist forest floor

Table 5. AIC table showing the top models selected from CERW habitat analysis. Based on the current data, Model 3 best described CERW habitat preferences.

Models	df	logLik	AIC_c	ΔAIC_c	weight
Model 3	9	-36.07	92.14	0.00	0.32
Model 5	9	-36.61	93.22	1.09	0.18
Model 6	9	-37.33	94.66	2.53	0.09
Model 4	7	-39.88	94.99	2.85	0.08
Model 2	11	-35.08	95.17	3.03	0.07
Model 1	11	-35.11	95.23	3.09	0.07
Null Model	1	-52.69	107.42	15.29	0.00

Table 6. CERW habitat model coefficients. Model 3 was found to be the top model from the analysis. Red maple or maple species, Beech, and Total dead trees were consistently found within all models. Red maple and maple species was the only habitat covariate showing a positive association with CERW presence. Bolded coefficients are significant to CERW.

	Model 3		Model 5		Model 6		Model 4		Model 2		Model 1	
Predictors	Estimate (SE)	P	Estimate (SE)	P	Estimate (SE)	P	Estimate (SE)	P	Estimate (SE)	P	Estimate (SE)	P
Intercept	**-2.90 (0.98)**	**0.003**	**-2.64 (0.86)**	**0.002**	**-2.43 (0.74)**	**<0.001**	**-2.52 (0.80)**	**0.001**	**-2.81 (0.90)**	**0.001**	**-2.41 (0.58)**	**<0.001**
Beech	-1.94 (1.31)	0.14	-1.97 (1.24)	0.11	-1.78 (1.11)	0.11	-1.65 (1.06)	0.12	-1.64 (1.21)	0.17	-1.34 (0.88)	0.13
Ironwood											0.05 (0.28)	0.86
Acer spp.[2]			**0.54 (0.29)**	**0.06**	**0.67 (0.29)**	**0.02**					0.20 (0.31)	0.52
Quercus spp.[2]					-0.82 (0.58)	0.16					-0.75 (0.61)	0.22
Total Trees[2]									0.28 (0.37)	0.44	**0.66 (0.35)**	**0.05**
TDT[2]	**-2.37 (1.13)**	**0.04**	**-1.87 (0.96)**	**0.05**	**-1.59 (0.81)**	**0.05**	**-2.12 (0.95)**	**0.02**	**-2.26 (1.14)**	**0.05**	**-1.60 (0.90)**	**0.07**
Soft Maple[2]												
Red Maple[2]	**0.86 (0.39)**	**0.03**					**0.83 (0.38)**	**0.03**	**0.78 (0.40)**	**0.05**		
White Oak[2]	-0.89 (0.67)	0.18	-0.91 (0.65)	0.16					-0.99 (0.64)	0.12		
Random Effects												
σ^2	3.13		2.34		1.81		2.09		2.14			
τ	$3.14_{VS\ 12\text{-}18m}$		$2.36_{VS\ 12\text{-}18m}$		$1.82_{VS\ 12\text{-}18m}$		$2.09_{VS\ 12\text{-}18m}$		$2.14_{VS\ 12\text{-}18m}$			
Marginal R^2/ Conditional R^2	0.685/0.839		0.656/0.800		0.626/0.759		0.647/0.784		0.705/0.821		0.296/0.455	

where CERW had been located is representative of the survey areas and typical of the southwestern Ontario Carolinian interior forest region.

The only significant negatively associated habitat characteristic for CERW was total dead trees (TDT; Table 6). CERW may also have a negative association with beech (*Fagus grandifolia*) and white oak (*Quercus alba*). CERW are typically associated with oak species and although the results were not significant, variation of the white oak data seen in the top model indicated a quadratic variation suggesting there may be some advantage for CERW when white oak is present (Figure 5B). White oak grows well in a variety of soil moisture regimes and is often associated with beech in hardwood moist bottomlands. The structure of beech trees may be a limiting factor for CERW as the branches are stout, ascending, and leaves are interlocking, creating a dense crown. Previous studies on canopy preferences for CERW state conclusively that males prefer open canopies, as increased leaf density negatively affects the ability for males to broadcast vocalizations.

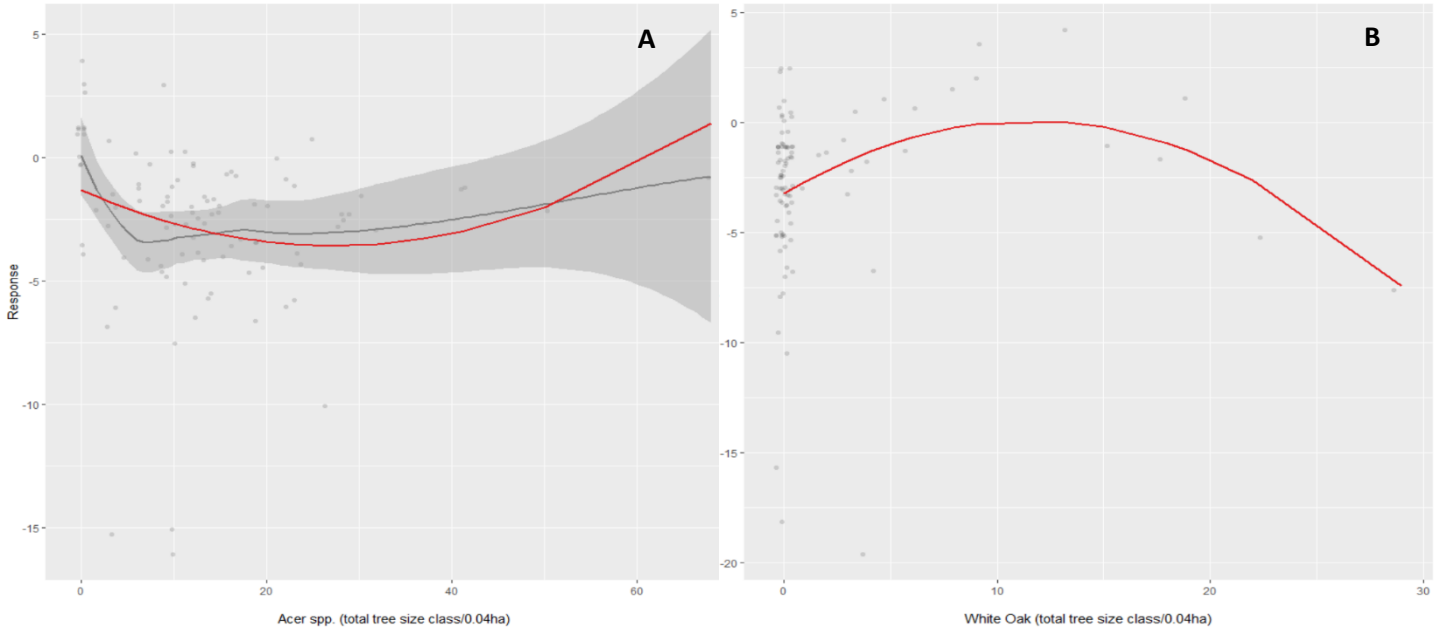

Figure 5. Predicted outcome of tree species on CERW habitat models for southwestern Ontario.

A moderate amount of variance for hierarchical models is important to delineate the structure within the nested effect. Vertical structure (VS) at all levels was assessed using the top model. We were able to determine that VS at 6 – 12m and >18m had no variance association (τ = 0.007 and 0.02, respectively) and thus provided no information about foliage densities preferred by

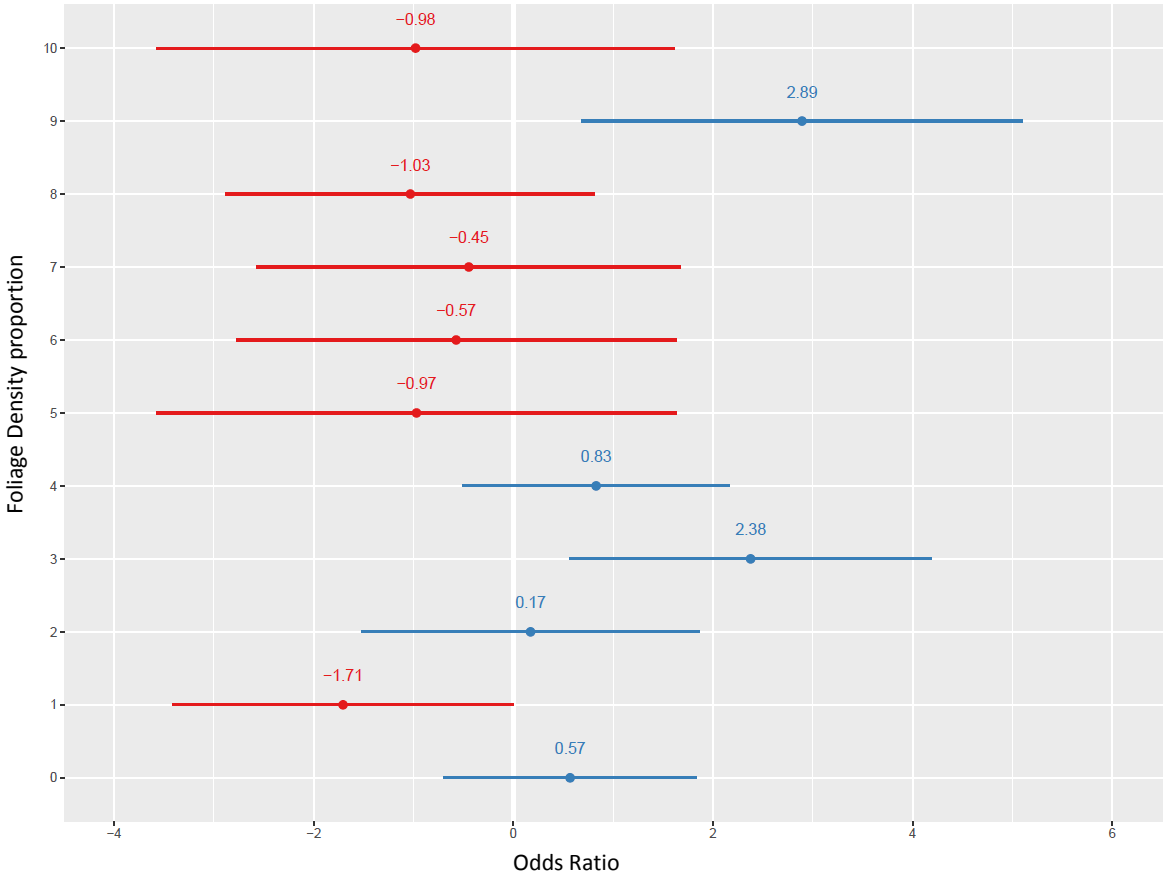

Figure 6. Odds ratios for the nested random effect VS 12 – 18m. Foliage density estimates were recorded as a proportion of the occupied volume within the vertical structure level. Odds ratio above 0 suggest CERW associate positively to the corresponding foliage density. Foliage density at 30% and 90% were significant positive associations.

CERW. Similarly, VS < 6m showed slight variance (τ = 0.85) but provided very little contribution to preferred foliage density. On the other hand, VS 12 – 18m showed suitable variation within the top model (τ = 3.14) and provided some information on foliage density for CERW (Figure 6).

Significant positive association for CERW at a VS 12 – 18m suggest CERW are 2.38 times more likely to occur at 30% and 2.89 more likely to occur at 90% foliage densities. Conversely, foliage densities show a negative association between 50% and 80% (Figure 6). Contrasting information at the various foliage densities at VS 12 – 18m does not provide us with a confident conclusion about CERW foliage density preferences at the different vertical forest structures.

Given the small sample size (n = 22), we believe there is still insufficient information to provide conclusive results and consequently, we have little confidence in the models at this time. For example, CERW occupancy preference for the super canopy (> 18m) is well documented, however, our data have not provided sufficient information on this vertical structure layer to provide a suitable recommendation. Despite this, these habitat models are providing a baseline for CERW habitat and as more data are collected, we hope a clearer picture may emerge.

Prothonotary Warbler (PROW)

PROW were detected at 5 sites in 2018; 4 of which are identified as Critical Habitat. Thirteen active nests were located in nest boxes at 4 locations. Fish Point (Pelee Island – not surveyed) had an observation of a PROW but no nest was initiated. Six territorial males were observed among Pelee Island – Fish Point (1), Point Pelee National Park (2) and Rondeau Provincial Park (3), and 13 nesting pairs were observed at 4 sites that have consistent breeding pairs in Norfolk and Brant Counties (Table 3). Of the nests monitored, 37 young were confirmed to have fledged, making 2018 one the most productive years since 2011. Unfortunately, nests at Rondeau Provincial Park and Point Pelee National Park were not monitored and nest outcome was unknown so a complete account of PROW productivity in 2018 is unknown.

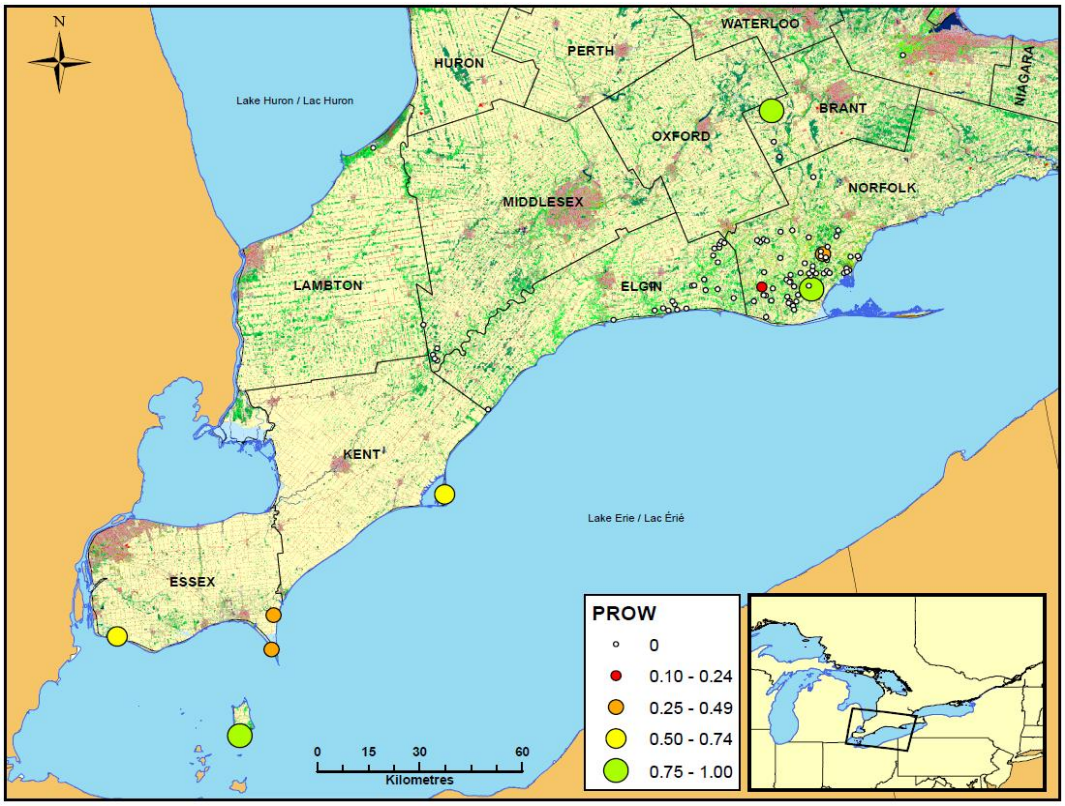

Figure 7. PROW occupancy in southwestern Ontario.

PRODUCTIVITY

Productivity levels for all SAR measured (ACFL, LOWA, and PROW) show a downward trend since 2011 (Figure 8). LOWA show the steepest decline in productivity (30.1% decline since 2011). ACFL and PROW show a 12.5% and 10% decline in productivity since 2011, respectively (Figure 8). ACFL have had very low productivity overall, averaging 0.84 fledgling/nest while PROW have consistently had high productivity levels (between 3.27 and 4.43 fledglings/nest per year).

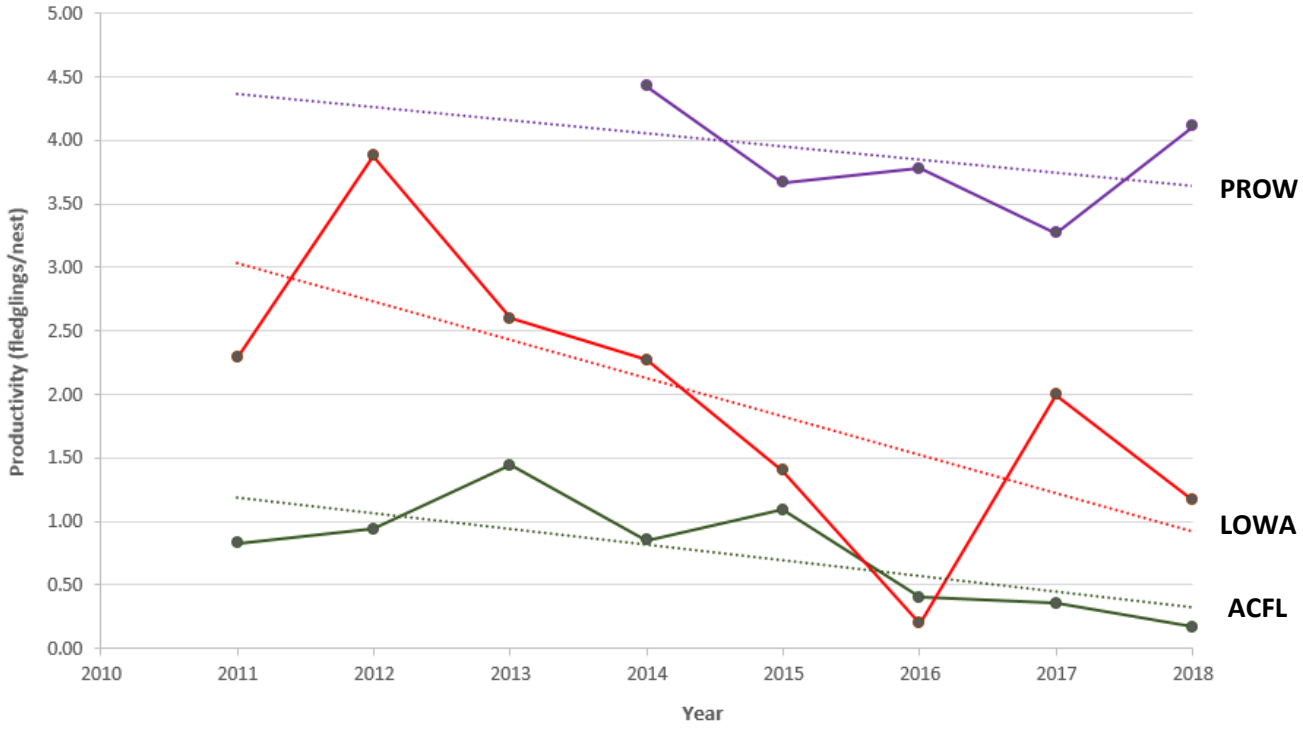

Figure 8. Productivity trends for target SAR between 2011 and 2018. ACFL (green) are showing a 12% decline in productivity while LOWA (red) are showing a decline of 30%. Despite PROW (purple) show a slight decline (~10%) in number of fledglings per nest, productivity is higher than all other SAR (increased nest monitoring) and the consistent increase in number of nests per year may be increasing PROW recruitment into the area. Nest data between 2011 and 2013 were insufficient to provide a confident productivity estimate. No data to include CERW productivity trends.

Although PROW productivity trends are showing a decline of 10.4%, the number of nests has been increasing steadily, suggesting that suitable habitats in southwestern Ontario are being occupied by young birds or birds emigrating from southern locations. In 2011, 2012, and 2013, there were 1, 5, and 4 recorded nests monitored, respectively, with all young projected as fledged (Table 7). With increased effort for nest monitoring and nest box maintenance in 2018, there were 13 total nests and over 37 fledged young reported (Table 7). This suggests that habitat loss may be the limiting factor for this species' population in the Carolinian region. With the exception of the first few years (data not shown - insufficient), 2018 marks the most productive year for

PROW. The increased nest box maintenance and monitoring by local bird conservationists has maintained an average PROW productivity of 4.1 young fledged/per nest (Table 7). No productivity data were gathered for CERW given the high level of effort required to locate and monitor nests (typically located within the canopy, at heights > 12m).

Due to various constraints, determining productivity in SW ON was not a high priority in 2018 (or 2017) so little effort was placed on searching for and monitoring nests of ACFL, LOWA, and CERW; PROW were the exception and productivity was monitored as in years past. Despite the reduced effort, we were able to maintain productivity trends and, in the case of PROW, determine an increase in productivity from previous years. In 2019, the scope of the project will once again include an increased effort to search for and monitor target SAR nests.

Table 7. Productivity (young fledged/nest) for target SAR from 2011 to 2018 in southwestern Ontario.

Species	Year	# Sites	% Sites Occupied	Pairs	Males	Females	Nests	Host Young Fledged	Host Young Fledged / Nest	Nest Parasitism Rate	Cowbird Young Fledged
Acadian Flycatcher	2011	12	32%	11	18	12	18	15	0.83	0	0
	2012	17	28%	13	20	13	16	15	0.94	0.06	0
	2013	12	22%	10	17	10	16	23	1.44	0	0
	2014	18	31%	26	37	26	33	28+	0.85	0	0
	2015	17	27%	19	31	19	23	25+	1.09	0	0
	2016	13	22%	9	11	11	10	4	0.40	0	0
	2017	22	25%	29	30	29	34	12+	0.35	0	0
	2018	23	24%	6	37	6	6	1+	0.17	-	-
Cerulean Warbler	2011	6	16%	1	16	1	0	-	-	-	-
	2012	5	8%	2	13	2	0	-	-	-	-
	2013	5	9%	1	15	1	1	2+	2.00	0	0
	2014	8	14%	1	20	1	0	-	-	-	-
	2015	6	10%	2	15	2	0	-	-	-	-
	2016	10	17%	0	11	0	0	-	-	-	-
	2017	14	17%	0	22	0	0	-	-	-	-
	2018	7	7%	0	11	0	0	-	-	-	-
Louisiana Waterthrush	2011	11	30%	7	13	7	7	16	2.29	0.14	1
	2012	17	28%	17	24	17	8	31	3.88	0	0
	2013	13	24%	11	17	12	10	26+	2.60	0.3	3+
	2014	11	19%	13	15	12	11	25	2.27	0.42	2
	2015	15	23%	9	22	10	10	14	1.40	0.3	4
	2016	12	21%	8	7	8	5	1	0.20	0	0
	2017	14	17%	9	17	9	4	8+	2.00	0	0
	2018	14	14%	11	9	11	6	7	1.17	0	0
Prothonotary Warbler	2011	1	3%	1	2	1	1	5	5.00	0	0
	2012	1	2%	4	3	4	5	25	5.00	0	0
	2013	1	2%	4	4	4	4	20	5.00	0	0
	2014	3	5%	6	6	6	7	31	4.43	0	0
	2015	2	3%	8	6	8	9	33	3.67	0	0
	2016	9	16%	10	5	10	9	34	3.78	0	0
	2017	7	8%	11	3	11	11	36	3.27	0	0
	2018	5	5%	13	6	13	13	37+	4.11*	0	0

* nests were not monitored at 2 sites and were not incuded in the final productivity calculation

FOREST HEALTH RISKS

Another priority of the FBAR program is determining the risks to target SAR and their habitat, as well as to overall forest health, by site or property. While addressing immediate risks to target SAR is our highest priority, it is also important to address risks to overall forest health, particularly those that are likely to be of high concern to landowners and potential SAR stewards. In doing so, it is possible to encourage practices that may maintain or restore suitable SAR habitat and that will help foster a healthy natural woodlot which, in turn, may benefit target SAR, other SAR, and/or the ecological integrity and resilience of southwestern Ontario's forests.

Table 8. Total forest health risks occurrence by landownership.

Landowner Type	n	Human	Invasive species	Natural	TOTAL
CCCA	4	1	8	2	11
ECCC*	2				0
ERCA*	2				0
HCA	1		5		5
HNC	1		5		5
LPBLT	3	1	8	4	13
LPRCA	24	28	36	40	104
LTCA	4	1		7	8
Middlesex Cty	1	1		3	4
MNRF	5	8			8
NCC	5	2	14	3	19
Norfolk Cty	1	3	1		4
Ontario Parks	1	1	1		2
private	40	55	82	26	163
TTLT	3		4		4
TOTAL	97	101	164	85	350

* forest risks were not assessed at these locations

Forest health risks are classified into one of three categories. Human-related risks include a wide range of threats with varying levels of potential impact to SAR, all of which are directly related to anthropogenic activities. This category includes activities such as garbage dumping, inappropriate trail placement or road placement, all-terrain vehicle use, and forest harvesting. Invasive species also pose a risk to SAR and their habitat by reducing the amount of available suitable habitat. Finally, "natural" risks include risks such as avian and mammalian nest predators, low moisture levels (dried out sloughs) or streambank erosion which may be indirectly related to human activity.

In 2018, we identified 350 occurrences of risks throughout the 93 sites that were surveyed (Table 8). Four sites were monitored for PROW only and were not assessed for forest health risks. Invasive species accounted for 46.9% of all occurrences, followed by human-related forest health risks at 28.9%, and natural risks with 24.3% (Table 8). For an extensive list of each forest health risk per site, see Appendix E: Forest Health Risk Occurrence by Type and Landownership.

Waste pollution was the most common human-related forest risk observed during our surveys accounting for 26.7% of all human-related forest health risk occurrences (Table 9). In general, waste and garbage dumping present a minor issue for target SAR. That said, a local incident of stream pollution in LOWA habitat could have breeding season and longer term impacts for one or more pairs. With respect to the landowner, it is suggested by local woodlot associations and government and industry professionals that all waste should be cleared before managing their

Table 9. Human-related forest health risks. Waste was most prevalent however the number reported is probably underestimated and does not represent an accurate picture as to the extent of waste in some areas.

Human-related Forest Risk	Occurrence
Pollution - waste	27
Motorized Vehicle Trails	23
Recent Harvest	13
Hunting Structure	12
Active or Potential Harvest	8
Hiking Trails	8
Recreational Use	4
Structure	4
Housing Development	1
Road	1
Total	101

woodlot to create a safe and effective harvest area. This also makes for an aesthetic woodlot. However, risks associated with pollution are generally related to illegal waste dumping and thus are more difficult to address proactively. Motorized vehicle trails followed pollution, occurring at 22.7% (23) of the site surveyed (Table 9). SAR were present at 9 of those sites. Depending on the species, trails could offer benefits and provide suitable overstory habitat for SAR. CERW often prefer open canopies and vehicle trails may provide an opportunity for recreational activities and SAR to coexist, whereas vehicle trails through streams and swamps could do long-term damage to LOWA and ACFL habitat. In one instance in 2018, an ACFL nest was located about 3 m above an ATV trail and was later determined to be unsuccessful. Active, recent, and potential (i.e. marked trees) harvest was the next most abundant human-related action. Surveys at 21 of the sites detected the woodlot was going or had gone through the process of forest management (Table 9). Target SAR were detected at 8 locations with active, recent, or potential forest harvest (Appendix E: Forest Health Risk Occurrence by Type and Landownership). ACFL and LOWA were detected where harvesting practices were planned. Additional considerations during management planning should be made as to the impact harvesting could have for LOWA as they are a ground-nesters and nest in stream banks or in uprooted trees within sloughs. Similar to maintaining cavity trees for wildlife, uprooted trees in sloughs could be retained for LOWA habitat consideration.

The most prominent invasive species on the landscape was Garlic Mustard (detected at 66 sites, Table 10) which may have deleterious effects to SAR habitat as it typically blankets the forest floor and outcompetes native vegetation SAR and other wildlife would use for foraging and nesting opportunities. Emerald Ash Borer (EAB) and Beech Bark disease present more direct and immediate forest health risks, not only to SAR but to a landowner's woodlot. EAB was found at 38.7% (36) of the sites surveyed (Table 10). The invasive insect is responsible for the decline of ash trees throughout Ontario and with regards to SAR, the insect poses an immediate threat by reducing foraging and nesting habitat, especially for CERW and ACFL. Beech Bark disease is becoming more prominent in the Carolinian region and also poses a direct risk to SAR and other wildlife by reducing foraging and nesting opportunities.

Table 10. Invasive species forest health risks found during 2018 surveys. Garlic mustard was the most prevalent invasive species and EAB and Beech Bark Disease pose the biggest potential risk to SAR.

Invasive Species	Occurrence
Garlic mustard	66
Multiflora Rose	40
Emerald Ash Borer	36
Beech bark disease	13
European Buckthorn	6
Invasive species - multiple	2
Phragmites	1
Total	164

It is notable that, to date, there have been no records of either Hemlock Woolly Adelgid or Oak Wilt in our study area. The presence of the pest and pathogen would pose a substantial risk to the forests upon which target SAR depend at multiple spatial scales. For example, woolly adelgid, which directly attacks eastern hemlock, could reduce or eliminate ACFL and LOWA nesting habitat and overhead cover throughout the area. Similarly, oak wilt could negatively impact CERW which have been shown to prefer oak species. Red oak species in particular are most susceptible to the fungus that causes oak wilt. Further the decline of oak trees could change the structure and composition of southwestern Ontario's forests, including opening up the canopy (all target SAR require a relatively closed canopy).

Dried up sloughs accounted for the biggest natural forest health risk and also the biggest risk to target SAR (Table 11). Dried sloughs accounted for 69.4% of all naturally occurring health risks but also accounted for 17.0% of all 3 risks categories combined (Table 11). All FBAR target SAR prefer some type of treed wetland habitat for nesting. ACFL will nest in branches of trees that overhang the edge of sloughs. LOWA nest within the soil and roots of an uprooted tree in sloughs. CERW have a preference for soft maples which grow in treed wetlands, and PROW are a secondary cavity nester in treed wetlands with water at least 1m deep. The cause of dried sloughs within the study area is uncertain and the evidence we are suggesting is anecdotal, but the reduction in slough habitat is likely related to climate change and increased pressures on the area's water supplies. A consistent lack of rain and snow combined with high average summer temperatures and tile drainage near agricultural areas could all contribute to drying sloughs. Streambank erosion occurred at 16.5% of the locations surveyed and poses a threat to ACFL and LOWA as both species also nest in stream ravines. Streambank erosion could result in felling preferred trees for ACFL and carving out preferred streambank nesting locations for LOWA. Erosion could be a result of many things.

Table 11. Types of natural forest health risk identified on sites surveyed in 2018. Dried sloughs are most prevalent as a naturally-occurring risk and pose a substantial threat to all target SAR and their habitat.

Natural Forest Risk	Occurrence
Dry slough	59
Streambank erosion	14
COGR - nest predator	9
Dead trees	2
BHCO - nest parasite	1
Total	85

First, streambank erosion is an important natural process and creates meandering streams that maintain the integrity of the waterway by way of water flow, especially after a storm event. However, human development upstream may result in stream straightening, streambank hardening, and increased sedimentation, resulting in amplified bank disturbance and water pollution downstream, and could negatively affect LOWA and ACFL habitat.

To date, and to our knowledge, there have been no known efforts to systematically quantify moisture levels and hydrology at these sites or the surrounding area, particularly as they relate to forest sloughs, which are ephemeral habitat. Our own risk assessment efforts only began recording dry sloughs in 2018 and only determine whether dried sloughs are present (with no mechanism of determining how or if this differs in comparison to previous years). Thus, the degree to which sloughs are "drying up" and our understanding of the timing of these processes is very limited. That said, several staff members who have surveyed in these sites for multiple years believe that they are witnessing a change with fewer and/or smaller sloughs and wet areas in the forests than in years past. Similarly, in some places, the vegetation present indicated that these areas had been wetter at some point in recent history. These observations indicate that changing moisture regimes and the "drying up" of sloughs are likely important measures to quantify and track. Additional efforts will be made prior to 2019 to determine a more systematic approach to tracking this threat such that it is quantifiable and comparable between years.

LANDOWNER STEWARDSHIP AND MANAGEMENT

A high proportion of SAR-occupied sites are privately owned and/or managed for activities other than conservation, thus it is critical that the FBAR program work with private woodlot owners as well as local government agencies and Conservation Authorities, as these groups have great potential to positively (or negatively) impact target SAR, their habitat, and the ecological integrity of the Carolinian forest region.

It is the priority of the FBAR program to work with all private landowners and establish a working relationship that protects target SAR without adjusting private landowner woodlot economic or conservation opportunities, but perhaps assists or leads the landowner towards sustainable woodlot management that benefits all parties.

Private Land Ownership

In 2018, 41% of the sites surveyed, totalling 1475 ha, were owned by individual landowners (Figure 9, Table 1). Of these, 16 sites were occupied by one or more target SAR. Twelve new landowners whose properties totaled 274.5 ha had not been previously surveyed. No target SAR were located on these newly surveyed properties. These properties were chosen as potential habitat for multiple SAR but primarily for CERW. Surveys will be considered for the

2019 field season, but if target SAR are still not detected, these sites will only be considered in the future (e.g., 5 years from 2019). All individual private landowners received a written "thank-you" letter informing them of all species (SAR and non-SAR) identified on their property. Target SAR were highlighted in a table and non-target species of concern were highlighted within the list of species provided to the landowner.

In 2018, 12% of the sites surveyed were owned by private conservation businesses and covered a little over 925 ha (Figure 9, Table 1). Raw SAR occupancy data were provided to each of these groups for their properties in support of their monitoring and conservation management efforts. This report has also been provided to each of those groups as well as to all project partners and public landowners.

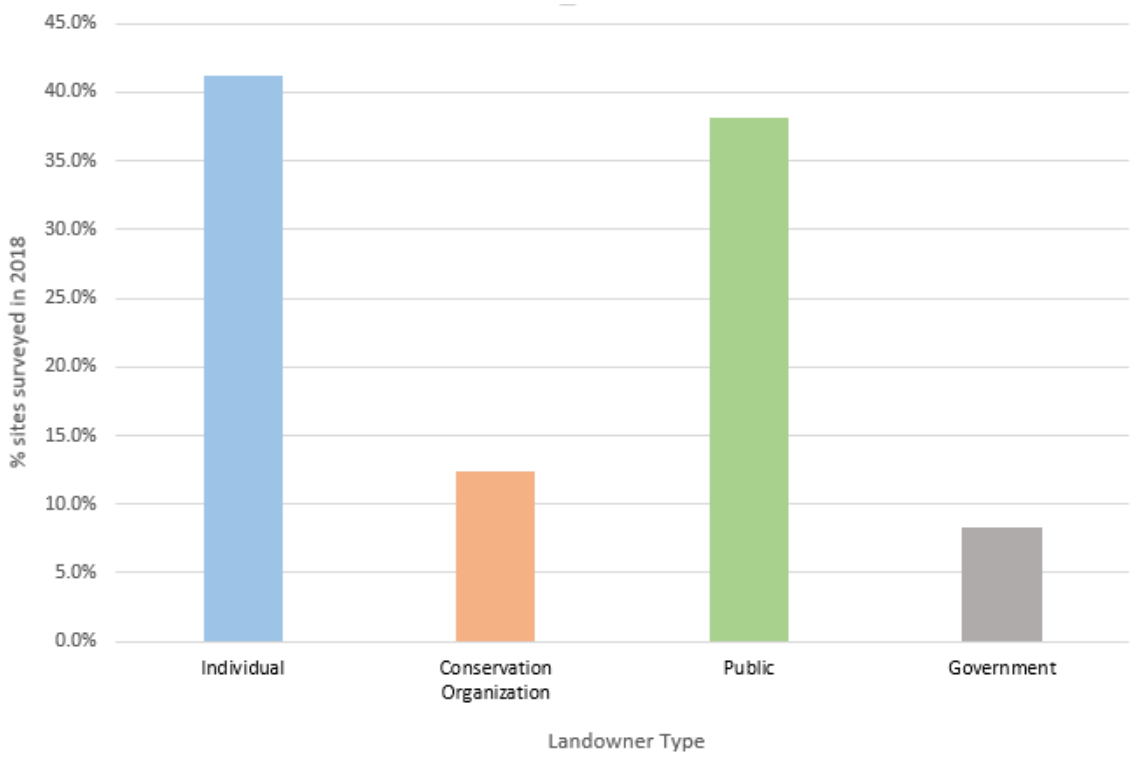

Figure 9. Percentage of 2018 surveyed sites by land ownership. Individual landowners accounted for > 40% of our surveyed area followed by public landowners, primarily consisting of various CAs throughout southwestern Ontario.

Of the 40 target SAR-occupied sites, 41% were owned by individual landowners. A total of 42 individual SAR (ACFL – 17, CERW – 2, LOWA – 21, PROW – 2) were located in individual landowner woodlots (Table 12). SAR were detected at 13% of all sites owned by conservation organizations (which is not surprising since these properties were acquired, at least in part,

because of the presence of these target SAR and their habitats). A total of 27 individual target SAR (ACFL – 7, CERW – 1, LOWA – 3, PROW – 16) were located in these locations (Table 12).

With more than half of the sites surveyed occupied by SAR privately owned, there is great importance in maintaining and building private landowner relationships to encourage and support management practices that will benefit their forests as well as target SAR.

Table 12. SAR occurrence in 2018 divided by landownership. SAR detected on individual private land accounted for one-third of all SAR detection.

Landowner	Ownership	ACFL	LOWA	CERW	PROW	Total
CCCA	public	1		1		2
ECCC	gov't				7	7
HCA	public	1				1
LPBLT	private	2				2
LPRCA	public	11	5	7		23
LTCA	public	6				6
Middlesex Cty	gov't	4				4
MNRF	gov't		2			2
NCC	private	3	3	1	16	23
Norfolk Cty	gov't	2				2
Ontario Parks	gov't				7	7
Individual	private	17	21	2	2	42
TTLT	private	2				2
	Total	49	31	11	32	123

Public Land Ownership

In 2018, 46% (38% conservation authorities, 8% government landowner) of all sites surveyed, totaling 4450 ha, are public land (Figure 9, Table 1). Most of these properties had been surveyed in previous years with the exception of a few CA properties. Similar to land trusts and naturalist groups, all public landowners received raw survey data regarding target and non-target SAR occupancy. Also similar to the ENGOs, public landowners are able to use this information to meet their monitoring mandates as well as inform their forest management practices. A total of 32 individual SAR were found on publicly owned property (ACFL – 19, CERW – 8, LOWA – 5) and 12 SAR were detected on government land (ACFL – 6, LOWA – 2, PROW – 4) (Table 12).

Similar to privately-owned woodlots, public sites in the area are subject to various management regimes, including recreation and harvesting. Other sites are managed strictly for conservation purposes, such as Natural Heritage Sites, and are maintained to protect SAR and SAR habitat. As with other woodlot owners, BSC works with public landowners to encourage as well as support

efforts to manage for SAR and SAR habitat, including providing additional monitoring and expertise as needed to help incorporate SAR needs into management objectives and plans. For example, in 2018, BSC staff joined LPRCA tree markers to provide advice on an upcoming site that was to be harvested in the winter of 2018. The location was historically occupied by CERW and LOWA and our presence was to encourage re-occupation of one or both species. This type of on-the-ground support is important for information sharing as well as relationship building between organizations.

FBAR's Future

Based on 2018 results and initiatives, we have identified the following objectives for 2019 (in addition to the program's overarching goals and objectives):

- Continue to engage landowners, focusing on identifying what motivates them as woodlot owners and stewards;
- Develop a quantitative approach to tracking the outcomes of stewardship engagement (e.g., number of hectares stewarded) and changes over time (e.g., number of hectares where conservation status has improved);
- Introduce protocols to standardize the tracking of occupancy and abundance over time;
- Re-establish productivity surveys to track recovery and to evaluate management and conservation efforts;
- Build on 2018 efforts to standardize approach to identifying, quantifying, and tracking risks;
- Continue to collect habitat information for Cerulean Warbler to inform BMPs;
- Further engage partners to identify additional ways to increase target SAR habitat conservation;
- Extend survey efforts to new areas with high potential to support target SAR (and identify ways the upcoming Ontario Atlas can assist with these efforts).

The FBAR program has successfully identified and monitored SAR and built relationships with private and public landowners in southwestern Ontario for eight consecutive years.

To get a better picture of SAR populations and habitat availability, it is important to expand our survey area throughout the Carolinian region of southwestern Ontario. The FBAR program will continue to engage landowners through various communication means to establish a cooperative relationship and in the future, strengthen that cooperative relationship with new program developments based on increasing the forest health of landowner's woodlots.

We will maintain our survey focus on forest health risks that may become detrimental to SAR and landowners, such as Hemlock Woolly Adelgid and Oak Wilt. To tackle and mitigate forest health risks on private and public land, we will continue to collaborate with landowners and

other ENGOs on efforts to identify, monitor, alleviate, or remove forest health risks throughout the survey area.

Private landowner stewardship will be important for attaining the goals of the FBAR program, as 90% of the land throughout the Carolinian region is owned by private landowners. We hope to build and develop closer relationships with existing landowners to provide more engagement opportunities and to implement BMPs for target SAR within their woodlots. Habitat fragmentation is a leading cause for SAR decline and as stewardship among landowners grows, so will habitat connectivity, reducing extensive fragmentation within the Carolinian region.

For more information regarding the Forest Birds at Risk program, visit our website (www.birdscanada.org/research/speciesatrisk) or direct any questions through email to Ian Fife at speciesatrisk@birdscanada.org.

APPENDIX

Appendix A: Species Occupancy Data Sheet

SOUTHERN ON SPECIES AT RISK PROGRAM - OCCUPANCY DATA FORM

Observer 1	
Observer 2	
Site Name	
Site ID	

Date (dd-mm-yy)	
Visit No.	
Start Time (24 hr)	
End Time (24 hr)	

Occupancy							
			UTM Coordinates				
Species	No.	BE	Easting	Northing	previously observed (w/in yr) (Y or N)	NR (Y or N)	Hab No. CERW only

No. = number of species observed
BE = Breeding Evidence
NR = Nest Record (if an Ontario Nest Record Scheme was completed)
Hab. No. = Habitat number measurement (see habitat data sheet)

Appendix B: Habitat Data Sheet

SOUTHERN ONTARIO SPECIES AT RISK PROGRAM - HABITAT DATA FORM

Observer 1	
Observer 2	
Site ID	
Date (dd-mm-yy)	

	Easting	Northing
UTM Coordinates		
Waypoint Name		

Basal Prism Sweep	
Tree Species	Tree Class

Tree Classification	
Class	Size (cm)
1	1-9
2	10 - 24
3	25 - 50
4	>50

Vertical Structure (0-10)	
Height (m)	%cover
<6	
6-12	
12-18	
>18	

Canopy Cover			
Cardinal Point	open or closed?	# of dots	% cover
North			
East			
South			
West			
Average canopy cover			

open dots - # of dots * 1.04 - 100

closed dots - # of dots * 1.04

Tree height			Tree height* (m)	CERW present (Y or N)
Species	canopy (+)	base (-)		

*h = (canopy - base)(d x 0.01)

Habitat Suitability (1-5)

Slope	
%	Aspect

Additional notes:

Appendix C: Forest Health Risk Data Sheet

SOUTHERN ONTARIO SPECIES AT RISK PROGRAM - FOREST HEALTH RISK DATA FORM

Observer 1		Site ID	
Observer 2		Date (mm/dd/yy)	

Health Risk	Risk Type (IS, H, N)	UTM Coordinates Easting	Northing	Additional Comments

LANDOWNER CONTACT INFORMATION	Name:	Contact info:
Informed? (Y or N)	If yes, what was discussed:	
Will there be an attempt to mitigate threat?		

List of possible threats to forest health:

Invasive Species:
- Emerald Ash Borer
- Beech Bark Disease
- Oak Wilt
- Hemlock Woolly Adelgid
- European Buckthorn
- Dog-strangling Vine
- Kudzu
- Garlic Mustard
- Multiflora Rose

Natural Risk:
- Stream Bank Erosion
- PROW nest degradation
- PROW competition

Human-related:
- Forestry Activity (other)
- Tree Marking
- Active Harvesting
- Recreational Use (other)
- ATV trails
- Hunting structures
- Pollution (other)
- Garbage dumping
- Stream discolouration
- Drying of slough

Appendix D: Survey Effort Table

Site	Landowner	Site Size (ha)	No. of visits	Person-effort (hours)	Area Covered per site
BR02z	private	19.50	7	14.00	136.50
BR24z	**private**	**6.64**	**1**	**3.73**	**6.64**
EL14b	private	56.40	2	7.47	112.80
EL14c	private	25.20	2	4.72	50.40
EL14z	private	59.80	3	14.82	179.40
EL15z	CCCA	195.00	1	3.60	195.00
EL16a	CCCA	93.60	1	2.00	93.60
EL18a	CCCA	53.70	1	1.00	53.70
EL20z	TTLT	80.70	2	16.23	161.40
EL22z	private	13.50	1	3.00	13.50
EL27z	private	61.60	2	5.67	123.20
EL28z	private	54.70	1	5.33	54.70
EL29d	private	161.00	1	2.00	161.00
EL29z	private	39.00	2	10.70	78.00
EL3z	private	118.20	1	1.43	118.20
EL43b	CCCA	33.00	1	2.70	33.00
EL45a	private	79.30	4	13.48	317.20
EL45z	private	61.00	3	11.15	183.00
EL46c	private	14.80	2	8.73	29.60
EL49z	private	59.80	1	2.27	59.80
EL50a	private	9.10	1	2.20	9.10
EL51z	LPRCA	22.70	1	2.00	22.70
EL54b	private	9.94	2	7.20	19.88
EL57z	private	17.90	1	0.68	17.90
EL60c	private	19.20	1	0.75	19.20
EL60z	private	17.00	2	2.55	34.00
EL70m	**private**	14.40	1	1.08	14.40
EL70n	**private**	7.60	1	0.83	7.60

EL70o	**private**	12.30	1	0.82	12.30
EL70p	**private**	8.15	1	0.90	8.15
EL70q	**private**	29.20	1	0.95	29.20
EL70r	**private**	6.84	1	2.47	6.84
EL71m	**private**	16.80	1	0.55	16.80
EL71n-1	**private**	9.54	1	0.88	9.54
EL71n-2	**private**	37.60	1	0.77	37.60
ES10z	ERCA	89.00	3	3.00	150.00
ES20z	ERCA	5.00	1	1.00	33.00
ES2z	ECCC	50.00	3	3.00	267.00
ES5z	ECCC	11.00	3	3.00	5.00
HN101b	NCC	24.80	1	2.43	24.80
HN102b	private	20.50	1	1.45	20.50
HN111b	LPRCA	6.45	1	1.70	6.45
HN112b	private	10.40	1	0.75	10.40
HN114z	LPBLT	96.50	1	0.67	96.50
HN12d	MNRF	160.00	1	2.97	160.00
HN12g	MNRF	243.00	1	2.38	243.00
HN14z	HNC	33.70	1	4.53	33.70
HN160a	private	13.80	1	1.50	13.80
HN160z	private	20.20	1	1.50	20.20
HN161z	private	107.00	1	2.47	107.00
HN16b	MNRF	28.70	2	6.07	57.40
HN16e	MNRF	8.67	1	0.27	8.67
HN16m	MNRF	90.20	1	0.67	90.20
HN17a	LPRCA	103.00	1	2.05	103.00
HN17b	LPRCA	9.77	2	2.45	19.54
HN18a	LPRCA	42.00	1	0.57	42.00
HN19b	LPRCA	247.00	2	4.73	494.00
HN1b	NCC	241.00	7	19.13	1687.00
HN1c	NCC	93.70	3	9.02	281.10
HN21a	LPRCA	100.00	1	2.08	100.00

HN21b	LPRCA	42.30	1	2.92	42.30
HN21c	LPRCA	20.50	1	1.17	20.50
HN21e	private	32.80	3	3.43	98.40
HN26c	LPRCA	86.80	1	1.73	86.80
HN27a	LPRCA	81.70	3	9.48	245.10
HN27c	LPRCA	82.80	3	7.45	248.40
HN27d	LPRCA	78.50	3	7.23	235.50
HN27g	private	77.60	1	2.37	77.60
HN30z	private	19.80	2	5.17	39.60
HN31a	LPBLT	96.40	1	1.07	96.40
HN37a	LPRCA	36.90	1	2.58	36.90
HN37c	LPRCA	39.30	1	1.90	39.30
HN37d	LPRCA	91.90	2	3.98	183.80
HN37e	LPRCA	20.00	1	2.00	20.00
HN37m	**private**	34.30	1	1.28	34.30
HN37n	**private**	11.60	2	1.85	23.20
HN37o	**private**	79.50	1	1.25	79.50
HN37z	LPRCA	14.10	1	2.78	14.10
HN3c	LPRCA	83.11	2	3.82	166.23
HN4a-1	LPRCA	61.70	1	1.75	61.70
HN4a-2	LPRCA	21.20	1	2.38	21.20
HN4b	LPRCA	37.90	1	0.77	37.90
HN4d	LPRCA	81.10	2	6.08	162.20
HN52a	Norfolk Cty	111.00	3	5.72	333.00
HN5a	LPRCA	26.60	2	8.70	53.20
HN5c	NCC	94.00	2	3.28	188.00
HN81z	LPBLT	97.50	2	3.40	195.00
HN96a	NCC	5.14	2	4.52	10.28
HW1z	HCA	420.00	1	7.93	420.00
KE2z	Ontario Parks	697.00	1	4.17	697.00
MI2a	TTLT	20.20	1	0.65	20.20
MI3b	LTCA	187.00	1	1.65	187.00

MI3g	LTCA	108.00	1	1.10	108.00
MI3h	LTCA	289.00	1	3.83	289.00
MI3k	LTCA	80.20	1	1.07	80.20
MI4a	TTLT	43.10	1	1.30	43.10
MI6z	Middlesex Cty	59.00	1	1.38	59.00
TOTALS		6,850	154	361	11,254

* bolded sites are newly surveyed sites

Appendix E: Forest Health Risk Occurrence by Type and Landownership

Site ID	Landowner	SAR present	Forest Health Risk	Human	Invasive species	Natural	Total
BR24z	private	No	Beech bark disease		1		1
			Emerald Ash Borer		2		2
EL14b	private	Yes	Emerald Ash Borer		1		1
			Garbage	5			5
			Garlic mustard		2		2
			Hunting structure	2			2
			Recent harvest	1			1
			Streambank erosion			2	2
			Tree marking	1			1
EL14c	private	Yes	Garbage	2			2
			Garlic mustard		2		2
			Streambank erosion			2	2
EL14z	private	Yes	Emerald Ash Borer		1		1
			Multiflora Rose		2		2
			Streambank erosion			6	6
EL15z	CCCA	Yes	Beech bark disease		1		1
			Garlic mustard		1		1
			Hiking trails	1			1
EL16a	CCCA	Yes	Garlic mustard		1		1
EL18a	CCCA	No	Emerald Ash Borer		1		1
			Garlic mustard		1		1
EL20z	TTLT	Yes	Beech bark disease		1		1
			Emerald Ash Borer		1		1
			Garlic mustard		1		1
EL22z	private	No	Emerald Ash Borer		1		1
			European Buckthorn		1		1
			Garlic mustard		1		1
			Housing development	1			1

			Phragmites		1		1
EL27z	private	Yes	Beech bark disease		1		1
			Emerald Ash Borer		1		1
			Garbage	2			2
			Garlic mustard		2		2
			Multiflora Rose		2		2
EL28z	private	No	Dry slough			2	2
			Emerald Ash Borer		1		1
			Garlic mustard		1		1
			Hiking trails	1			1
EL29d	private	No	Garlic mustard		2		2
			Multiflora Rose		1		1
			Tree marking	2			2
			Vehicle trails	2			2
EL29z	private	Yes	Beech bark disease		3		3
			Emerald Ash Borer		3		3
			European Buckthorn		2		2
			Garbage	1			1
			Garlic mustard		3		3
			Multiflora Rose		1		1
			Streambank erosion			1	1
EL3z	private	No	Emerald Ash Borer		1		1
			Multiflora Rose		1		1
EL43b	CCCA	No	Dry slough			2	2
			Emerald Ash Borer		1		1
			Multiflora Rose		2		2
EL45a	private	Yes	ATV trails	2			2
			Emerald Ash Borer		1		1
			Garlic mustard		5		5
			Recent harvest	1			1
			Recreational use	1			1
			Streambank erosion			3	3

EL45z	private	Yes	ATV trails	2			2
			Emerald Ash Borer		1		1
			Garlic mustard		2		2
			Multiflora Rose		1		1
			Recreational use	1			1
			Structure	1			1
EL46c	private	Yes	Beech bark disease		1		1
			Emerald Ash Borer		1		1
			Garbage	2			2
			Garlic mustard		2		2
			Multiflora Rose		2		2
EL49z	private	No	Emerald Ash Borer		1		1
			Hiking trails	1			1
			Hunting structure	1			1
			Multiflora Rose		1		1
EL50a	private	No	Garlic mustard		1		1
EL51z	LPRCA	Yes	Garlic mustard		1		1
EL54b	private	Yes	ATV trails	1			1
			Beech bark disease		1		1
			European Buckthorn		1		1
			Garlic mustard		1		1
			Tree marking	1			1
EL57z	private	Yes	Dead trees			1	1
			Dry slough			1	1
			Multiflora Rose		1		1
EL60c	private	Yes	Recent harvest	1			1
EL60z	private	Yes	Garbage	1			1
			Multiflora Rose		1		1
EL70m	private	No	Dry slough			1	1
			Garbage	3			3
			Structure	2			2
EL70n	private	No	Garbage	1			1

EL70o	private	No	Dry slough			1	1
			Multiflora Rose		1		1
EL70p	private	No	Dry slough			1	1
			Garbage	2			2
EL70q	private	No	Hunting structure	1			1
EL71m	private	No	Emerald Ash Borer		1		1
EL71n-2	private	No	Emerald Ash Borer		1		1
			Garbage	1			1
HN101b	NCC	No	Beech bark disease		1		1
			Dry slough			1	1
			Garbage	1			1
			Garlic mustard		1		1
HN102b	private	No	Garlic mustard		1		1
			Multiflora Rose		1		1
HN111b	LPRCA	Yes	Dry slough			1	1
HN112b	private	No	Emerald Ash Borer		1		1
			Garlic mustard		1		1
HN114z	LPBLT	No	Garlic mustard		1		1
HN12d	MNRF	No	ATV trails	3			3
HN12g	MNRF	No	ATV trails	1			1
			Hiking trails	1			1
			Recent harvest	1			1
HN14z	HNC	No	Emerald Ash Borer		1		1
			Garlic mustard		1		1
			Multiflora Rose		3		3
HN160a	private	No	Dry slough			1	1
			Recent harvest	1			1
HN160z	private	Yes	Dry slough			1	1
HN161z	private	No	Garlic mustard		1		1
			Recent harvest	1			1
HN16m	MNRF	No	Hiking trails	1			1

			Recreational use	1			1
HN17a	LPRCA	No	Beech bark disease		1		1
			Dry slough			2	2
HN17b	LPRCA	No	Dry slough			3	3
			Garlic mustard		1		1
			Multiflora Rose		1		1
HN19b	LPRCA	No	Garlic mustard		1		1
			Hiking trails	1			1
			Hunting structure	1			1
			Recent harvest	1			1
HN1b	NCC	Yes	Dry slough			1	1
			Multiflora Rose		1		1
HN1c	NCC	Yes	Dry slough			1	1
			Multiflora Rose		2		2
HN21a	LPRCA	No	Dead trees			1	1
			Dry slough			2	2
			Invasive species - multiple		1		1
			Tree marking	1			1
HN21b	LPRCA	Yes	ATV trails	1			1
			Garbage	1			1
			Recent harvest	1			1
HN21c	LPRCA	No	Emerald Ash Borer		1		1
			Multiflora Rose		1		1
HN21e	private	Yes	Dry slough			2	2
			Emerald Ash Borer		1		1
			Multiflora Rose		1		1
			Tree marking	1			1
HN26c	LPRCA	No	Dry slough			2	2
			Emerald Ash Borer		1		1
			Garlic mustard		1		1
HN27a	LPRCA	Yes	ATV trails	1			1
			Dry slough			4	4

			Emerald Ash Borer		1		1
			Garlic mustard		1		1
			Road	1			1
HN27c	LPRCA	Yes	ATV trails	1			1
			Beech bark disease		1		1
			Dry slough			2	2
			Emerald Ash Borer		1		1
			Garlic mustard		3		3
HN27d	LPRCA	Yes	Dry slough			4	4
			Garlic mustard		3		3
			Hunting structure	3			3
			Vehicle trails	1			1
HN27g	private	No	Garlic mustard		1		1
			Multiflora Rose		1		1
HN30z	private	Yes	Garbage	2			2
			Garlic mustard		2		2
HN31a	LPBLT	No	Emerald Ash Borer		3		3
			Garlic mustard		2		2
			Multiflora Rose		1		1
HN37a	LPRCA	No	Invasive species - multiple		1		1
HN37c	LPRCA	No	Dry slough			3	3
			Multiflora Rose		1		1
HN37d	LPRCA	No	Active harvest	1			1
			ATV trails	1			1
			Emerald Ash Borer		1		1
			Garlic mustard		1		1
			Multiflora Rose		2		2
			Recent harvest	3			3
HN37e	LPRCA	No	Garlic mustard		1		1
HN37m	private	No	Garlic mustard		1		1
			Multiflora Rose		1		1
HN37n	private	No	Hiking trails	1			1

			Hunting structure	1			1
			Recent harvest	1			1
HN37o	private	No	ATV trails	1			1
			Emerald Ash Borer		1		1
			Multiflora Rose		1		1
HN37z	LPRCA	No	Garlic mustard		1		1
			Hiking trails	1			1
			Hunting structure	1			1
			Multiflora Rose		1		1
HN3c	LPRCA	No	ATV trails	1			1
			Garbage	1			1
			Hunting structure	1			1
			Multiflora Rose		1		1
HN4a-1	LPRCA	No	Dry slough			1	1
HN4b	LPRCA	No	Dry slough			1	1
			Multiflora Rose		1		1
HN4d	LPRCA	Yes	ATV trails	2			2
			Dry slough			5	5
			Emerald Ash Borer		1		1
			Garlic mustard		2		2
HN52a	Norfolk Cty	Yes	ATV trails	2			2
			Garbage	1			1
			Garlic mustard		1		1
HN5a	LPRCA	No	Active harvest	1			1
			ATV trails	1			1
			Emerald Ash Borer		1		1
			Garlic mustard		1		1
HN5c	NCC	No	Emerald Ash Borer		1		1
			Garlic mustard		1		1
			Structure	1			1
HN81z	LPBLT	Yes	Beech bark disease		1		1
			Dry slough			4	4

			Recent harvest	1			1
HN96a	NCC	Yes	Garlic mustard		5		5
			Multiflora Rose		2		2
HW1z	HCA	Yes	Emerald Ash Borer		1		1
			European Buckthorn		2		2
			Garlic mustard		1		1
			Multiflora Rose		1		1
KE2z	Ontario Parks	Yes	Garlic mustard		1		1
			Recreational use	1			1
MI3b	LTCA	Yes	Dry slough			1	1
			Garbage	1			1
MI3g	LTCA	No	Dry slough			2	2
MI3h	LTCA	Yes	Dry slough			4	4
MI4a	TTLT	No	Multiflora Rose		1		1
MI6z	Middlesex Cty	Yes	Dry slough			3	3
			Hunting structure	1			1
			TOTAL	**101**	**164**	**85**	**350**