COSEWIC
Assessment and Status Report

on the

Pumpkin Ash
Fraxinus profunda

in Canada

ENDANGERED
2022

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Pumpkin Ash — Photograph by William van Hemessen.

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COSEWIC
Assessment Summary

Assessment Summary – May 2022

Common name
Pumpkin Ash

Scientific name
Fraxinus profunda

Status
Endangered

Reason for designation
This rare tree occurs in forested wetlands in the Carolinian Zone of southern Ontario, where it is estimated the number of mature individuals has recently declined by over 90% due to impacts of invasive Emerald Ash Borer. Only two mature individuals are known and fewer than ten are expected to remain in Canada, and these potentially face additional threats from logging and land conversion. Over 400 known seedlings and saplings are also at continued risk from Emerald Ash Borer.

Occurrence
Ontario

Status history
Designated Endangered in May 2022.

COSEWIC
Executive Summary

Pumpkin Ash
Fraxinus profunda

Wildlife Species Description and Significance

Pumpkin Ash (*Fraxinus profunda*) is a medium-sized, broad-leaved hardwood tree in the Olive Family (Oleaceae). It was first discovered in Canada in 1992. The opposite, pinnately-compound leaves are 20 to 45 cm long with leaflets which are densely pubescent on the bottom surface or, occasionally, only on the veins. Pumpkin Ash has the largest winged fruit (samaras) of any ash. Like most ash species in Canada, Pumpkin Ash is threatened by Emerald Ash Borer, an invasive non-native insect.

Morphological Description

Pumpkin Ash is a member of the Meliodes section of ashes, which includes White Ash and Green Ash. Pumpkin Ash is difficult to distinguish from other species especially if fruit is absent, but diagnostic vegetative key features can be used. The fruit of Pumpkin Ash has a broader wing and a longer calyx than other Meliodes ashes.

Distribution

Pumpkin Ash is native to eastern North America from Florida to extreme southern Canada. In Canada, Pumpkin Ash is only found in southwestern Ontario where it was previously reported from 39 subpopulations in Elgin, Essex, Lambton, Norfolk, and Middlesex counties, the Municipality of Chatham-Kent and the Regional Municipality of Niagara. Less than 1% of the global range of Pumpkin Ash occurs in Canada.

Habitat

Throughout its range, Pumpkin Ash occurs in swamps, wet floodplain forests and, occasionally, in brackish coastal swamps. In Canada, Pumpkin Ash occurs in intermediate-mature deciduous swamps often dominated by Silver Maple, and in floodplain forests. Much of the suitable habitat for Pumpkin Ash within its Canadian range has been lost since European settlement, and conversion of deciduous swamps to agriculture is continuing within its range.

Biology

Pumpkin Ash reaches sexual maturity (i.e., produces flowers and fruit) later than most other ash species in Canada. Flowers are unisexual and trees are dioecious. Like other ash species, the flowers of Pumpkin Ash are small and wind-pollinated. The flowers emerge between late April and mid-May, generally at the same time as the leaves. Seeds mature from late summer to fall and are dispersed from October to December by wind and water. Seed production is infrequent. Pumpkin Ash seeds are generally short-lived with viability estimates ranging from a few months to two to three years after dispersal. For this reason, seedbanks are unlikely to persist at sites where sexually mature individuals have been killed by Emerald Ash Borer. Generation time for Pumpkin Ash is estimated at 60 years, which may be an underestimate for this species, but has been used for other ash species, including Black Ash.

Population Sizes and Trends

There are currently 13 extant subpopulations in Canada with a total of 417 individuals counted in the following size classes: 1) <5 cm - 350 seedlings/saplings; 2) 5-10 cm - 56 saplings; 3) 10-20 cm - 11 immature trees; and 4) >20 cm - two sexually mature individuals (females) were found, both of which showed evidence of Emerald Ash Borer infestation. Based on fieldwork conducted for this status report, 15 subpopulations are known to be extirpated or presumed extirpated representing a 38% decline in number of subpopulations. The status of 12 subpopulations is unknown.

Emerald Ash Borer has caused mortality of a large number of mature Pumpkin Ash trees within one generation, but exact numbers of individuals lost is difficult to quantify due to a lack of historical abundance information. The total decline in the number of mature individuals over the previous generation is estimated to be over 90%.

Threats and Limiting Factors

Pumpkin Ash is threatened by Emerald Ash Borer, an Asian wood-boring beetle that has caused significant mortality of ash in southeastern Canada. Emerald Ash Borer is well established across the range of Pumpkin Ash in Canada, and it is estimated that over 90% mortality of mature Pumpkin Ash has already occurred. Based on the IUCN threats calculator, the overall threat impact for this species is Very High.

Other threats to Pumpkin Ash include: 1) land conversion to agriculture; 2) roads and utilities; 3) logging and wood harvesting; 4) recreational activities; 5) climate change; 6) deer-browsing, and 7) ecosystem modification by non-native plant species.

Protection, Status and Ranks

Pumpkin Ash currently has no federal legal protection in Canada. In Ontario, habitat of Pumpkin Ash has some legal protection under provincial and/or municipal policies for the protection of woodlands, wetlands, and floodplains. The majority (54%) of extant Pumpkin Ash subpopulations are on private and municipal lands. Three extant subpopulations are on lands managed for conservation purposes (i.e., provincial parks and lands owned by groups such as the Nature Conservancy of Canada). Three subpopulations are on lands managed by conservation authorities for water resources and recreation.

Pumpkin Ash currently has a global conservation rank of Apparently Secure (G4) and a national conservation rank of Critically Imperilled (N1) in Canada and in Ontario, has a subnational conservation rank of Critically Imperilled (S1).

TECHNICAL SUMMARY

Fraxinus profunda

Pumpkin Ash

Frêne pubescent

Range of occurrence in Canada: Ontario

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	60 years (estimated); maximum age 200-300 years (see **Biology**)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, continuing declines observed and expected to be >90% because of Emerald Ash Borer as well as other threats.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations, whichever is longer up to a maximum of 100 years]	Unknown, but expected to be >90% within two generations due to Emerald Ash Borer.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations, whichever is longer up to a maximum of 100 years]	>90% suspected reduction over the last 10 years due to Emerald Ash Borer
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations, whichever is longer up to a maximum of 100 years].	Ongoing death of >90% individuals that reach maturity is suspected due to Emerald Ash Borer (see **Threats**).
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any period [10 years, or 3 generations, whichever is longer up to a maximum of 100 years], including both the past and the future.	>90% suspected reduction over 3 generations.
Are the causes of the decline a. clearly reversible, b. understood and c. ceased?	a. No, Emerald Ash Borer is well established and expected to persist across this species' range (see **Threats**) b. Yes, cause of decline is understood (see **Threats**) c. No, threats are persisting in Canada (see **Threats**)
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	7,930 km² (extant populations only) 14,620 km² (including unknown status)
Index of area of occupancy (IAO) (Always report 2x2 grid value).	68 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No. b. No.
Number of "locations"*	One (based on the threat of Emerald Ash Borer).
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, decline is observed and projected based on loss of subpopulations due to Emerald Ash Borer (see **Threats**)
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, observed and projected decline with loss of subpopulations is anticipated throughout its range due to Emerald Ash Borer (see **Threats**)
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, observed and projected loss of number of subpopulations is anticipated throughout its range due to Emerald Ash Borer (see **Threats**)
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Yes, observed and projected decline with loss of locations is anticipated throughout its range due to Emerald Ash Borer (see **Threats**)
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed and projected decline in area, extent and quality of habitat is expected to occur due to incremental woodland loss and invasive plant species (see **Threats**)
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Ontario	Two confirmed (estimated to be fewer than 10).
Total	2-10

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations whichever is longer up to a maximum of 100 years, or 10% within 100 years]?	Analysis has not been completed.

* See Definitions and Abbreviations on COSEWIC website and IUCN for more information on this term.

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes overall threat impact Very High i. Emerald Ash Borer (IUCN Threat 8.1 Invasive Non-native Species). Threat impact = Very High. ii. Logging and Wood Harvesting (ICUN Threat 5.3). Threat Impact = Medium. iii. Annual and Perennial Non-timber Crops (IUCN Threat 2.1). Threat Impact = Medium to Low. iv. Roads and Utility Lines (IUCN Threats 4.1 and 4.2). Threat Impact = Low.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Status in the United States is unknown. Populations occur in Michigan, but major declines have been observed there due to Emerald Ash Borer.
Is immigration known or possible?	Not known and unlikely. Water dispersal between the United States and Canada may be possible, but this has not been confirmed.
Would immigrants be adapted to survive in Canada?	Yes, habitat conditions are similar.
Is there sufficient habitat for immigrants in Canada?	No, given the presence of Emerald Ash Borer.
Are conditions deteriorating in Canada?+	Yes, Emerald Ash Borer is well established within this species' range and is expected to persist with no significant change in threat severity (see **Threats**)
Are conditions for the source (i.e., outside) population deteriorating?+	Yes, Emerald Ash Borer is persisting and killing mature ash trees (see **Threats**)
Is the Canadian population considered to be a sink?+	No. The Canadian population is not dependent upon immigration. Immigration is expected to be unlikely.
Is rescue from outside populations likely?	No. Immigration will not change impacts from Emerald Ash Borer.

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Designated Endangered in May 2022.

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect).

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** A2abcde+3bcde+4abcde; B2ab(i,ii,iii,iv,v); C1+2a(i); D1
Reasons for designation: This rare tree occurs in forested wetlands in the Carolinian Zone of southern Ontario, where it is estimated the number of mature individuals has recently declined by over 90% due to impacts of invasive Emerald Ash Borer. Only two mature individuals are known and fewer than ten are expected to remain in Canada, and these potentially face additional threats from logging and land conversion. Over 400 known seedlings and saplings are also at continued risk from Emerald Ash Borer.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A2abcde+3bcde+4abcde. There is an estimated 90% past, current, and future decline of mature individuals based on (a) direct observation, (b) extrapolation from declines in other ash species that share a common threat, (c) declines in IAO, EOO, and quality of habitat, (d) subject to the ongoing threat of logging and land conversion to agriculture, and (e) due to the effects of introduced Emerald Ash Borer.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered, B2ab(i,ii,iii,iv,v). IAO is <500 km², and the population is (a) known to exist at one location based on mortality caused by Emerald Ash Borer, and (b) experiencing continuing, projected declines in EOO, IAO, area, extent, and quality of habitat, number of subpopulations, and number of mature individuals.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered, C1 and C2a(i). There is an observed and projected continuing decline of 90% in number of mature individuals within the next 2 generations (C1) and no subpopulation contains >250 mature individuals (C2a(i)).
Criterion D (Very Small or Restricted Population): Meets Endangered D1. There are fewer than 250 mature individuals (2-10).
Criterion E (Quantitative Analysis): Not Applicable. Analysis not conducted.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2022)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Scientific Name: *Fraxinus profunda* (Bush) Bush

Original Description: Bush, Gard. & Forest 10: 515. 1897

Synonyms (Plants of the World Online 2020):
Calycomelia profunda (Bush) Nieuwl.
Calycomelia tomentosa Kostel.
Fraxinus americana var. *profunda* Bush
Fraxinus michauxii Britton
Fraxinus pennsylvanica subsp. *profunda* (Bush) A.E. Murray
Fraxinus pennsylvanica var. *profunda* (Bush) Sudw.
Fraxinus profunda var. *ashei* E.J. Palmer
Fraxinus tomentosa Michx.

English Common Name: Pumpkin Ash

French Common Name: Frêne pubescent

Family: Oleaceae (Olive Family)

Major Plant Group: Angiosperms – Eudicots (APG 2016)

Pumpkin Ash was first described by Michaux (1812-1813) as *Fraxinus tomentosa*, but Michaux apparently conflated this species with Green Ash (*Fraxinus pennsylvanica*) and its synonym *Fraxinus pubescens*. Bush (1897) was the first to describe *Fraxinus profunda* as a distinct species; therefore this name was given taxonomic priority (Nesom 2010). Nevertheless, the name *Fraxinus tomentosa* was used well into the twentieth century (e.g., Gleason 1952). The common name 'Pumpkin Ash' alludes to the pumpkin-like swollen trunk base which this species often develops in very wet sites and is a colloquial name for the tree used by residents of Lincoln County, Arkansas where the tree was first described by Bush (1897). No subspecific taxa are currently recognized for Pumpkin Ash.

Morphological Description

Pumpkin Ash is a broad-leaved deciduous tree (Figure 1) which attains a height of 15 to 30 m (rarely to 40 m) and can attain a diameter at breast height of 173 cm under optimal conditions (Putnam *et al.* 1960; Harms 1990; Nesom 2010; Atha and Boom 2017). In the United States, the largest known Pumpkin Ash has a height of 32 m and a diameter at breast height of 159 cm (American Forests 2020). Pumpkin Ash is notable for developing a conspicuous swollen, buttressed trunk base in very wet conditions, but it should be noted that Green Ash can also exhibit buttressing in very wet sites, so this characteristic alone is not a distinguishing feature of Pumpkin Ash (Figures 1, 2). Detailed morphological descriptions of the leaves, fruits and other features of Pumpkin Ash can be found in Nesom (2010) and Campbell (2017).

Figure 1. Pumpkin Ash (*Fraxinus profunda*) tree and buttressed trunk in Norfolk County, Ontario (left); Pumpkin Ash trees in Elgin County, Ontario (right). Photographs by W.D. van Hemessen.

Pumpkin Ash is very similar to other ashes in Section Meliodes (Nesom 2010; Campbell 2017) and is widely believed to have originated in the distant past as a fertile polyploid hybrid between Green Ash and White Ash (*Fraxinus americana*; Harms 1990; Arca *et al*. 2012; Nesom 2014; Whittemore *et al.* 2018). Identification of Pumpkin Ash is further complicated by the significant decline in the number of fruiting individuals over the last two decades, because samara characteristics are useful (but not required) to confidently distinguish Pumpkin Ash from Green Ash (Campbell 2017; Knight pers. comm. 2020; Reznicek pers. comm. 2020). Some occurrences of Pumpkin Ash in Canada were previously identified using samara width as a diagnostic feature, but this is not a definitive characteristic due to variability in samara size within and between the Meliodes ashes; the length of the fruiting calyx is more diagnostic because it is far larger on Pumpkin Ash samaras compared to other Meliodes ashes (Campbell 2017). Based on a review of multiple authoritative descriptions of North American ashes (Nesom 2010; Campbell 2017; Weakley 2020), the following combination of characteristics distinguish Pumpkin Ash from other ash species in Canada (Figure 2) (see also **Search Effort**):

- Underside (abaxial) of leaflets lacking tiny nipple-shaped outgrowths (papillae) or with only a few sparse papillae (>40x magnification)

- Average length of unwinged portion of petiolules >7 mm
- Petiole, rachis and abaxial surface of leaflets tomentose
- Base of leaflet blades rounded and truncate (only a short continuation of blade tissue extending down the petiolule, such that the petiolules are unwinged for most of their length)
- Fruiting calyx >4 mm long

Figure 2. Leaves and samaras of Pumpkin Ash (*Fraxinus profunda*) from Essex County (leaf) and Elgin County (fruits), Ontario. From left to right: the abruptly tapered, smooth-margined leaflets; densely tomentose abaxial leaf surface; samaras with large persistent calyxes. Photographs by W.D. van Hemessen.

Population Spatial Structure and Variability

In this document, population refers to the sum total of all Pumpkin Ash in Canada. Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is likely to be little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less). Subpopulation size is measured as numbers of mature individuals only (COSEWIC 2015). A mature individual is defined as a tree with a diameter at breast height (dbh) of 20 cm or more. Subpopulation corresponds reasonably well to the habitat-based plant element occurrence delimitation standards (NatureServe 2020) where a subpopulation is defined as a group of occurrences that are separated by less than 1 km; or if separated by 1 to 3 km, with no break in suitable habitat between them exceeding 1 km; or if separated by 3 to 10 km but connected by linear water flow and having no break in suitable habitat between them exceeding 3 km. An occurrence refers to a physical place where Pumpkin Ash occurs or has occurred. Location refers to a geographically or ecologically distinct area in which a single threatening event can rapidly affect all plants of Pumpkin Ash.

In Canada, all subpopulations of Pumpkin Ash are located in extreme southwestern Ontario. Distances between Canadian subpopulations are less than 100 km. As a wind-pollinated species, some gene transfer between nearby subpopulations (within a few kilometres) can be expected.

There has been very little research into genetic diversity in Pumpkin Ash and no known studies have made use of material from Canadian trees.

Designatable Units

Pumpkin Ash only occurs in one COSEWIC National Ecological Area (Great Lakes Plains) and constitutes a single designatable unit (DU). There are no recognized subspecific taxa or varieties of Pumpkin Ash. Natural disjunction between subpopulations is not sufficient to warrant separate DUs. Anthropogenic habitat fragmentation will be discussed under **Threats** and **Dispersal and Migration**.

Special Significance

In the United States, Pumpkin Ash is used to generate high value lumber for furniture, cabinets, paneling, door/window frames and flooring, as well as stock for tool and implement handles (Stevens and Pijut 2012). Due to its low abundance and population density in its Canadian range, it is expected that the use of Pumpkin Ash for timber in Canada is very limited.

No vascular plants or vertebrates are known to rely exclusively on Pumpkin Ash. In the United States, Pumpkin Ash may be a dominant or co-dominant species in some swamp communities, where it may function as a source of food and shelter for mammals, birds, arthropods, plants, and fungi (see **Interspecific Interactions**) (Elias 1987; Erdmann *et al.* 1987; Gandhi and Herms 2010; Wagner and Todd 2015). Pumpkin Ash contributes to the biodiversity of swamps within its Canadian range, but it is typically not abundant enough where it occurs to have known ecological implications.

ABORIGINAL (INDIGENOUS) KNOWLEDGE

Aboriginal Traditional Knowledge (ATK) is relationship-based. It involves information on ecological relationships between humans and their environment, including characteristics of species, habitats, and locations. Laws and protocols for human relationships with the environment are passed on through teachings and stories, and Indigenous languages, and can be based on long-term observations. Place names provide information about harvesting areas, ecological processes, spiritual significance or the products of harvest. ATK can identify life history characteristics of a species or distinct differences between similar species.

Cultural Significance to Indigenous Peoples

There is no species-specific ATK in the report. However, Pumpkin Ash is important to Indigenous peoples who recognize the interrelationships of all species within the ecosystem.

DISTRIBUTION

Global Range

Pumpkin Ash is found only in North America where it occurs from Louisiana in the west to New York in the east and from extreme southwestern Ontario in the north to northern Florida in the south (Figure 3). Its range is somewhat discontinuous, with a core area occurring in the lowlands of the Mississippi and Ohio river valleys and a second core area occurring in the Gulf and Atlantic coastal plains. Occurrences in Connecticut are believed to be introduced.

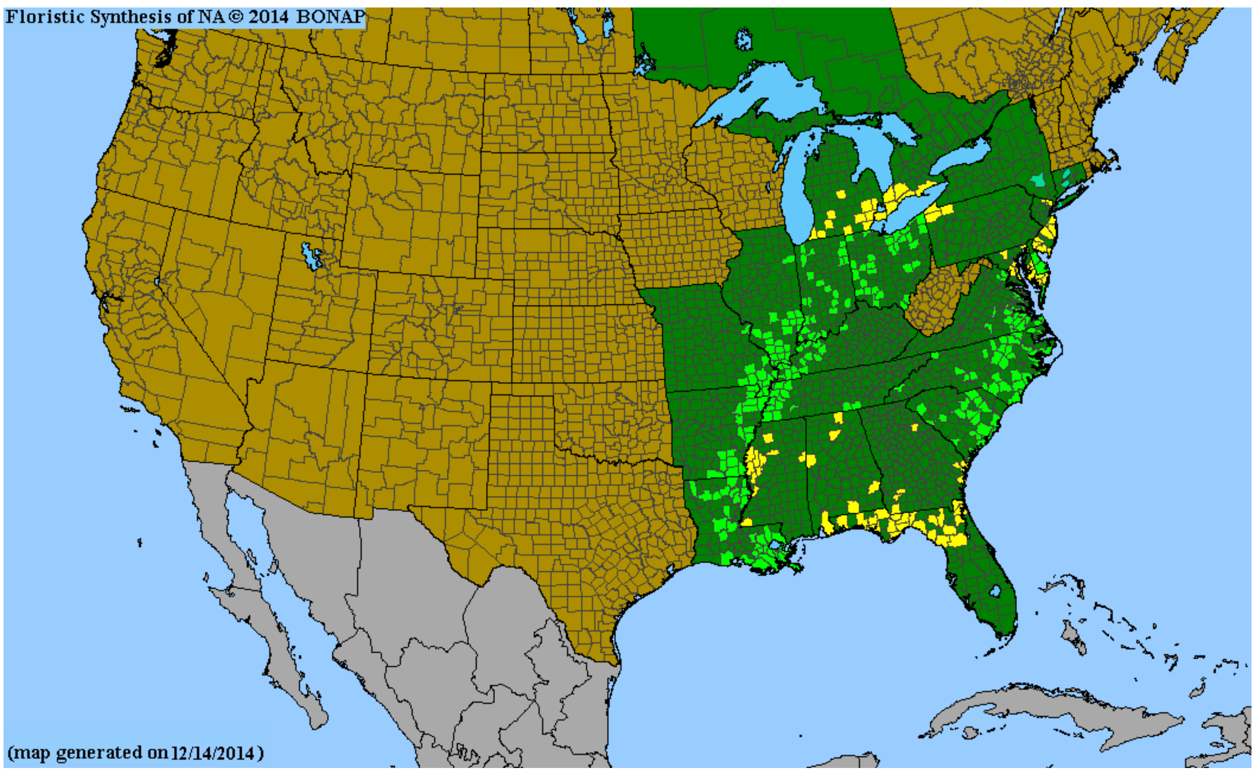

Figure 3. Global range of Pumpkin Ash (*Fraxinus profunda*) with dark green representing presence of Pumpkin Ash within the state/province. Presence at the county level is shown in light green (present and not rare) or yellow (present and rare). Map edited from BONAP (Kartesz 2015).

Canadian Range

Approximately 0.8% of the global range of Pumpkin Ash occurs in Canada where it occurs only in the Carolinian Zone of southern Ontario. The northernmost subpopulation in Canada is in Lambton County, Ontario at 43.2ºN. The easternmost subpopulation was historically in the Regional Municipality of Niagara, Ontario at 79.1ºW; however, that site is extirpated and the easternmost extant subpopulation is now in Norfolk County at 80.5ºW (Figure 4).

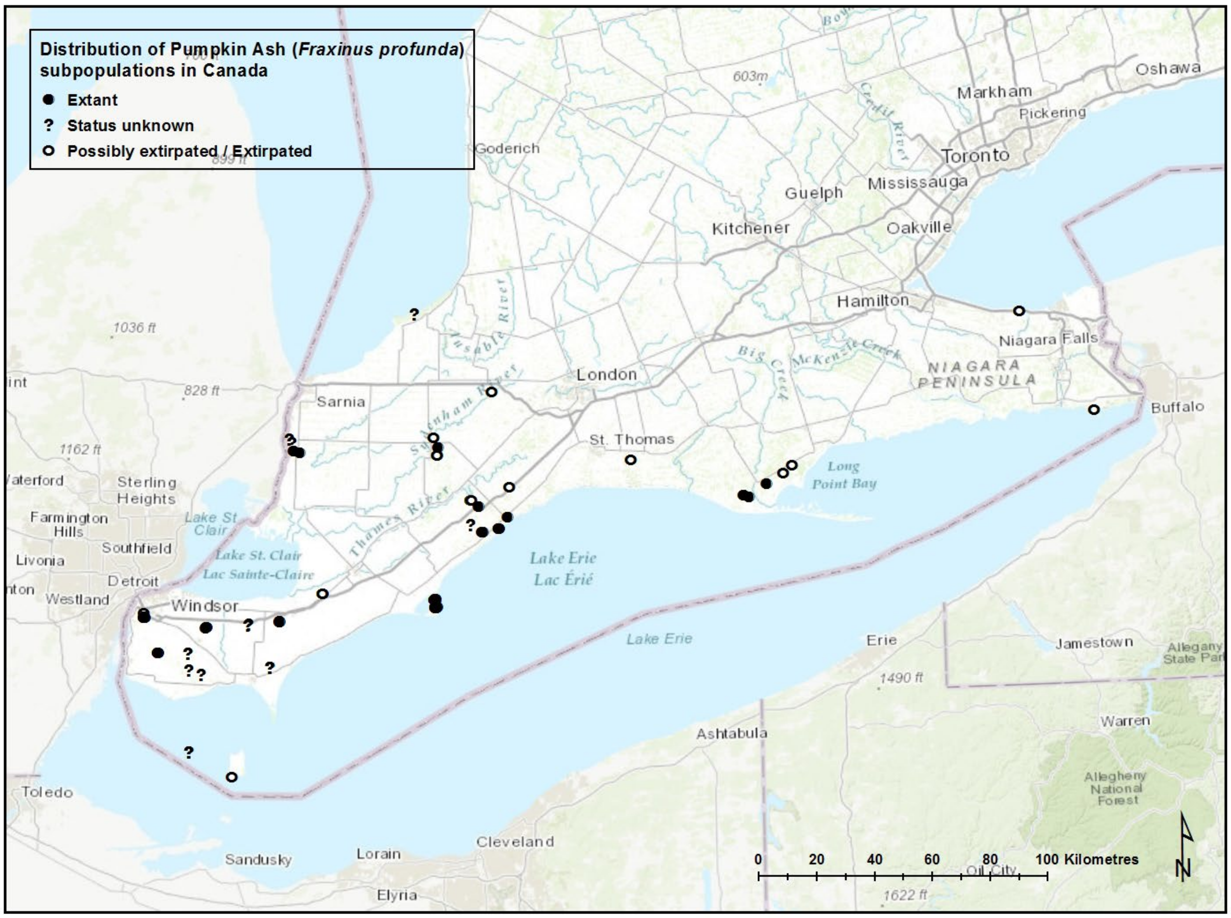

Figure 4. Canadian range of Pumpkin Ash (*Fraxinus profunda*). Map prepared by Alain Filion (COSEWIC Secretariat).

Twenty-five element occurrences (EOs) are accepted by Ontario's Natural Heritage Information Centre (NHIC 2020) and an additional 21 records in the NHIC database are EO Candidates, which have not yet been incorporated into EOs (Table 1). Additional occurrence data for Pumpkin Ash in Canada were provided by the Nature Conservancy of Canada (NCC). The NHIC and NCC data were analyzed and a total of 39 subpopulations are described in this report. Some records were amalgamated into one subpopulation, for example, at Lower Big Creek in Norfolk County. Two new sites, including one new subpopulation, were discovered through fieldwork in 2021. Based on a review of existing data and verified to the extent possible through fieldwork in 2021, there are currently 13 extant subpopulations in Canada (Table 1). Based on fieldwork conducted for this status report, three subpopulations are known to be extirpated and 12 are presumed extirpated. The status of 11 subpopulations (of which nine are on private lands) is unknown.

Table 1. Pumpkin Ash subpopulations in Canada.

NHIC EO	ID #	County	Natural Area Name	Ownership	Last Seen	Status
32649	1	Elgin	Blacks Road Woodlot (Aldborough)	Private	1993-06-27	Unknown
32634	2	Elgin	Eagle Woodlot	Private	2021-08-28	Extant
n/a	3	Elgin	Joe's Bush	Municipal	2021-08-28	Extant
32640	4	Elgin	Gray Line Woodlot (Port Glasgow)	Private	2021-08-28	Extant
32631	5	Elgin	Rodney (Ferndell Wetland Complex)	Private	1993-09-29	Presumed extirpated
n/a	6	Elgin	Salter Tract	Private	2005-08-23	Not found/Possibly extirpated
32637	7	Elgin	Springwater Conservation Area	Conservation Authority	1983-09-03	Presumed extirpated, specimen at UWO appears to be misidentified
32642	8	Elgin	West Elgin Natural Area Complex (West Lorne)	Private	2021-08-04	Extant
32644	9	Essex	Brunet Park	Municipal	2021-08-27	Extant
32623	10	Essex	Canard River	Private	1993-05-18	Unknown
32621	11	Essex	Canard Valley Conservation Area	Conservation Authority	2021-08-27	Extant
n/a	12	Essex	Cedar Creek	Private	2013-09-05	Unknown
32622	13	Essex	East Sister Island	Provincial	2000-06-15	Unknown, specimen on iNaturalist appears to be misidentified
32647	14	Essex	Fish Point Provincial Park Reserve	Provincial	1995-07-12	Possibly extirpated based on Waldron pers. comm. 2021
32639	15	Essex	Gosfield South	Private	1992-01-00	Unknown
32625	16	Essex	Leamington White Oak Woods	Private	1993-08-14	Unknown
32624	17	Essex	Maidstone Conservation Area	Conservation Authority	2021-08-27	Extant
n/a	18	Essex	Ruscom Wetland Complex	Private	2013-07-28	Unknown
32620	19	Essex	Spring Garden Road Prairie	Municipal	1994-07-19	Extirpated

NHIC EO	ID #	County	Natural Area Name	Ownership	Last Seen	Status
32627	20	Essex	Tilbury West Conservation Area	Conservation Authority	2021-08-27	Extant
n/a	21	Essex	City of Windsor	Municipal	2014	Extirpated
32626	22	Kent	Jeannette’s Creek Woods	Private	1993-08-12	Not found/Possibly extirpated or misidentified
32619	23	Kent	Rondeau Provincial Park	Provincial	2021-09-12	Extant
n/a	24	Kent	Turin Pawpaw Woods	NGO	2006-04-29	Presumed extirpated
n/a	25	Lambton	Bickford (Ladysmith)	Private/ Provincial	2021-09-02	Extant
32628	26	Lambton	Ipperwash	Federal	2015-01-01	Unknown
34310	27	Lambton	Lambton Generating Station	Private	2000-10-24	Unknown
32629	28	Lambton	Sydenham River East (Alvinston)	Private	1999-07-25	Presumed extirpated
32630	29	Lambton	Sydenham River South	Private	1999-07-25	Presumed extirpated
32633	30	Middlesex	Strathroy Conservation Area	Conservation Authority	1993-05-11	Presumed extirpated
32636	31	Niagara	Culp’s Woods	Private	1995-09-12	Extirpated
32632	32	Niagara	Marcy’s Woods	Private	1999-06-26	Presumed extirpated
n/a	33	Norfolk	Backus Woods south of Concession Road 4	NGO	2010-06-19	Presumed extirpated
n/a	34	Norfolk	Backus Woods north of Concession Road 3	NGO/ Municipality	2021-08-06	Extant
n/a	35	Norfolk	Bill’s Corners	Private	2003-09-26	Unknown
n/a	36	Norfolk	Hazen Road south of County Road 60	Unknown	1994-06-14	Unknown
n/a	37	Norfolk	Lower Big Creek (including South Walsingham Forest)	NGO/ Private	2021-08-06	Extant
n/a	38	Norfolk	St. Williams	Private	2004-10-27	Presumed extirpated
n/a	39	Lambton/ Middlesex	Sydenham River Nature Reserve	NGO	2021-08-22	Extant

The University of Guelph Arboretum has a cultivated specimen of Pumpkin Ash, which is not included in this assessment. Range information for this status report comes from a variety of sources, chiefly the NHIC, which has been verified to the extent possible through fieldwork.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) of Pumpkin Ash in Canada, calculated using the standard COSEWIC minimum area convex polygon method (COSEWIC 2015) and applied to the 2021 fieldwork results and dataset of EOs from Ontario's NHIC at the Ministry of Northern Development, Mines, Natural Resources and Forestry (NDMNRF; NHIC 2020), produces a value of 7,930 km^2 (extant populations only) or 14,620 km^2 (including unknown status).

The index of area of occupancy (IAO) was roughly calculated to be 68 km^2 by overlapping the occurrence dataset with a 2 km by 2 km grid (Figure 4).

Search Effort

After Pumpkin Ash was first discovered in Essex County, Ontario in 1992, after being overlooked, botanists searched extensively for the species in southern Ontario (Waldron *et al*. 1996). Because subpopulations of Pumpkin Ash have been severely impacted by Emerald Ash Borer (*Agrilus planipennis*) over the past two decades, field studies were undertaken to gather current information regarding the EOO and numbers of mature individuals, and to determine if regeneration of the species is occurring.

Pumpkin Ash is a challenging species to identify due to the considerable overlap in morphology and habitat with other Meliodes ash species. Notably, other ash species can produce buttressed trunks in wet environments, so this feature alone cannot be used to identify Pumpkin Ash. The report writers and above-noted surveyors used a conservative approach to identify Pumpkin Ash individuals based on the morphological characteristics detailed under **Morphological Description**. The taxonomic key found in Campbell (2017) was used. Leaves and fruiting material, where available, were collected from suspected individuals of Pumpkin Ash and were examined later to confirm their identity. Only individuals that could be definitively identified as Pumpkin Ash have been included in this report. Three individuals with marginal or intermediate characters were collected and may represent intraspecific variability in Pumpkin Ash, but these have not been included in this assessment due to identification uncertainty.

Pumpkin Ash records from the Canadian Museum of Nature Herbarium (CAN), University of Waterloo Herbarium (UWO), and the Agriculture Canada Herbarium (DAO) were requested, as well as Canadian specimens from the University of Michigan Herbarium (MICH). Digital material of Pumpkin Ash specimens from institutional herbaria and iNaturalist was examined; however, microscopic characteristics could not be verified and fruiting material could not be viewed if in packets.

Understanding of the taxonomic characters that are useful for identification of Pumpkin Ash has progressed since the initial discovery of the species in Ontario in 1992. Some of the EOs and candidate EOs in the NHIC database are based solely on observations of samaras, and many do not have supporting specimens. Campbell (2014) suggests that fruiting material should not be used in isolation to identify Pumpkin Ash, although the key in the Michigan Flora (Voss 1996) relies on that feature. As a result, several of the EOs and candidate EOs may be based on misidentifications.

Surveys for Pumpkin Ash in Canada were conducted between August 4th and September 12th, 2021, by P.K. Catling, W.D. van Hemessen, and V.R. Brownell. Assistance was provided by P.A. Landsborough, N. Doerr, and G. Otis. One mature individual was located by M. Spearing during seed collection activities in October. For the specific surveyors at each site, see Table 2. A total of 25 subpopulations were surveyed. Of these, seven sites were surveyed from the roadside because permission to enter could not be obtained. Additionally, six sites with potential suitable habitat were surveyed, one of which contained Pumpkin Ash. When examining aerial imagery, one subpopulation, Culp's Woods, was determined to be extirpated due to habitat conversion and this was not surveyed. Permission was not received to survey 10 subpopulations on private lands. The total time spent undertaking Pumpkin Ash surveys in 2021, excluding travel time, was 78.1 person-hours.

Table 2. Locations of field surveys completed to determine presence/absence of Pumpkin Ash in Ontario.

ID #	Site	Survey Date (dd/mm/yy)	Time (hrs)	Surveyors	Number known before 2021	Number of Pumpkin Ash Individuals
2	Eagle Woodlot	2021-08-28	2.5	PC, WV, GO		1
3	Joe's Bush	2021-08-28	5.5	PC, WV, GO		3
4	Gray Line Woodlot (Port Glasgow)	2021-08-28	2.5	PC, WV, GO	1	18
5	Rodney (Ferndell Wetland Complex)	2021-08-26	8.5	PC, WV		0
6	Salter Tract	2021-08-28	0.5	PC, WV		0
7	Springwater Conservation Area	2021-08-08	2.5	VB	1	0
8	West Elgin Natural Area Complex (West Lorne)	2021-08-04	2.0	VB		8
9	Brunet Park	2021-08-27	2.0	PC, WV		71
11	Canard Valley Conservation Area	2021-08-27	2.5	PC, WV		8
15	Gosfield South	2021-08-27	0.5	PC, WV		Unknown
17	Maidstone Conservation Area	2021-08-27	3.0	PC, WV		27
19	Spring Garden Road Prairie	2021-08-27	1.0	PC, WV	1	0
20	Tilbury West Conservation Area	2021-08-27	1.5	PC, WV		9
22	Jeannette's Creek Woods	2021-08-27	0.5	PC, WV		Unknown
23	Rondeau Provincial Park	2021-09-12	5.5	PC	11	219
24	Turin Pawpaw Woods	2021-08-27	0.5	PC, WV		0
25	Bickford (Ladysmith)	2021-09-02	10.0	WV, PL	30	4
28	Sydenham River East (Alvinston)	2021-08-22	0.5	VB		0
29	Sydenham River South	2021-08-22	2.0	VB		0

ID #	Site	Survey Date (dd/mm/yy)	Time (hrs)	Surveyors	Number known before 2021	Number of Pumpkin Ash Individuals
30	Strathroy Conservation Area	2021-08-05	2.5	VB		0
32	Marcy's Woods	2021-09-12	5.0	WV, ND		0
33	Backus Woods Concession Road 4	2021-08-06	0.5	VB	30	0
34	Backus Woods n of Concession Road 3	2021-08-06	1.5	VB		13
37	Lower Big Creek (including South Walsingham Forest)	2021-08-06	2.5	VB	7	16
39	Sydenham River Nature Preserve	2021-08-22	2.0	VB		22
n/a	West Lorne Woods (Tanager Tract)	2021-08-28	5.0	PC, WV, GO		0
n/a	Chippawa Creek Conservation Area	2021-09-12	6.0	WV, ND		0
n/a	Carolinian Road	2021-08-22	0.25	VB		0
n/a	Junction Road	2021-08-22	0.25	VB		0
n/a	Rowan Mills Tract	2021-08-22	0.25	VB		0

Surveyor initials:
VB = Vivian Brownell
PC = Pauline Catling
WV = William van Hemessen
GO = Gard Otis
PL = Payton Landsborough
ND = Natalie Doerr

The primary objective at each site was to locate previously reported individuals of Pumpkin Ash using coordinates provided by the NHIC and other sources, where available. The secondary objective was to search areas of suitable habitat at each site to locate additional individuals of Pumpkin Ash. Suitable habitat was broadly defined as wet to moist treed habitats (e.g., swamps, floodplain forests) and controlled intuitive sampling was used to focus survey efforts at microsites with the best probability of locating the species. Surveys in suitable habitat generally consisted of meandering through optimal habitat features and looking for ash, using binoculars where necessary. Greater search effort was undertaken in areas in proximity to previously reported individuals. Where Pumpkin Ash was encountered, GPS coordinates, general notes on condition (e.g., tree health, evidence of Emerald Ash Borer) and potential threats were recorded. All specimens collected were pressed and will be submitted to the Canadian Museum of Nature Herbarium (CAN).

The status of a subpopulation is indicated as 'possibly extirpated' if Pumpkin Ash was not located during field surveys, but additional suitable habitat existed and was not surveyed. Subpopulations that were surveyed extensively and where Pumpkin Ash was not located were presumed extirpated. In a few cases, the subpopulation record may have been based on a misidentified observation.

HABITAT

Habitat Requirements

Pumpkin Ash is a bottomland species throughout its range and occurs in swamps, floodplain forests, and tidal wetlands (Harms 1990; MacFarlane and Meyer 2005; Nesom 2010). It typically occurs in freshwater environments, but some coastal populations occur in brackish water (Harms 1990; Nesom 2010). In the northern part of its range, it occurs in wet depressions or "sloughs" in upland woods in addition to riverine swamps and Great Lakes coastal swamps (Nesom 2010). In Canada, Pumpkin Ash is an obligate wetland species with a coefficient of wetness of -5 (Oldham *et al.* 1995) within the Mixedwood Plains Terrestrial Ecozone, specifically in Ecoregion 135. It is a habitat specialist which occurs in both permanently and seasonally flooded habitats and is adapted to long periods of inundation. In Canada, it occurs in deciduous forest and swamp communities with other trees adapted to inundation. The adaptability of Pumpkin Ash to varying habitat characteristics is discussed under **Physiology and Adaptability**. The forests are usually intermediate to mature in age.

Associate species in Canadian subpopulations of Pumpkin Ash include Silver Maple (*Acer saccharinum*), Green Ash, Black Ash (*F. nigra*), Freeman's Maple (*Acer* x *freemanii*), elms (*Ulmus* spp.), Kentucky Coffeetree (*Gymnocladus dioicus*), Pin Oak (*Quercus palustris*), Swamp White Oak (*Q. bicolor*), and Bur Oak (*Q. macrocarpa*). Frequently associated groundcover species include False Nettle (*Boehmeria cylindrica*), Marsh Fern (*Thelypteris palustris*), and Spotted Jewelweed (*Impatiens capensis*).

Habitat Trends

A substantial amount of forest and wetland habitat has been lost within the Canadian range of Pumpkin Ash since the arrival of Europeans. The Great Lakes Plains National Ecological Area has been dramatically altered over the past 180 years (i.e., three generations of Pumpkin Ash). Wetland loss within the Ontario portion of the Mixedwood Plains Ecozone is estimated at 72% for wetlands larger than 10 ha (Ducks Unlimited 2010). This loss may be even greater in Ontario's Carolinian Zone, within which the entire Canadian range of Pumpkin Ash occurs. Although not every wetland in its range would have contained Pumpkin Ash historically, it is reasonable to assume that Pumpkin Ash was more abundant before European settlement when suitable habitat was more widespread.

Although provincial policies currently afford some legal protection to many of the remaining deciduous swamps and floodplain forests within the Canadian range of Pumpkin Ash, incremental conversion of woodlots to agriculture is continuing (Environmental Commissioner of Ontario 2018). Pumpkin Ash has been removed from two sites where woodlots were converted to agriculture: one subpopulation in the Regional Municipality of Niagara was removed between 2007 and 2009, and one of the five woodlots comprising the Bickford subpopulation in Lambton County was removed between 2019 and 2021.

BIOLOGY

There has been considerably less research into the life history and reproduction of Pumpkin Ash compared with more widespread ash species such as Black, White, and Green ash (Putnam *et al.* 1960; Harms 1990; MacFarlane and Meyer 2005). The best available knowledge is provided below and inferred from knowledge of other ash species, where appropriate.

Life Cycle and Reproduction

Harms (1990) reported that Pumpkin Ash does not flower or produce fruit until at least 10 years of age, but sexual maturity is believed to occur later in northern parts of the species' range. In Ontario and Michigan, Pumpkin Ash reach sexual maturity much later than other local ash species, by which time they are already susceptible to Emerald Ash Borer (Reznicek pers. comm. 2020). Based on studies of Green Ash in southern Ontario by Peper *et al*. (2014), the two fruiting Pumpkin Ash trees found in 2021 may be 20 to 30 years old. Trees are dioecious, which means that both male and female individuals are required in order to successfully reproduce. Flowers are unisexual and wind-pollinated, and emerge between late April and mid-May, generally at the same time as the leaves (Wallander 2008; Nesom 2010). The fruits are winged, single-seeded samaras, which mature from late summer to fall and are dispersed from October to December (Harms 1990). Wind is an important dispersal mechanism of Pumpkin Ash samaras but dispersal by water is likely also important because this species grows in permanently or seasonally flooded habitats (Harms 1990). Similar to other ashes, Pumpkin Ash experiences mast years of heavy seed production, although little information is available about periodicity of mast years. It has been reported that Pumpkin Ash does not produce seeds as prolifically as other ashes (Sterrett 1915).

Pumpkin Ash seeds are generally short-lived with viability estimates ranging from a few months to two to three years after dispersal (Harms 1990; Knight pers. comm. 2020). Seed banks are unlikely to persist at sites where sexually mature individuals have been killed by Emerald Ash Borer. Seeds preserved *ex situ* can remain viable for several decades (Knight *et al.* 2010). Pumpkin Ash seeds germinate best on bare soil with little competing vegetation and are tolerant of high soil moisture and shade (Harms 1990). Seedlings undergo rapid early growth and are reported to grow faster than Green Ash where the species co-occur, but growth slows down considerably after the first few years (Harms 1990).

Pumpkin Ash is known to sprout readily from roots and stumps (Harms 1990). Note that, while this has been called "vegetative reproduction" by some authors, it does not satisfy the definition of "reproduction" for this assessment because adventitious sprouts generally do not survive if separated from the mature parent tree. It is unknown whether true vegetative reproduction (i.e., survival of adventitious sprouts following the death of the parent tree) occurs in Pumpkin Ash.

There are no data available on the longevity of Pumpkin Ash specifically; however, Green Ash has been noted to live for over 250 years (Devall and Ramp 1992) and Black Ash can live for 200 to 300 years (COSEWIC 2018). Generation time for Pumpkin Ash is estimated at 60 years, which may be an underestimate but has been used for other ash species, including Black Ash (COSEWIC 2018). Generation time is estimated based on life span of ashes prior to the Emerald Ash Borer invasion of North America.

Physiology and Adaptability

Pumpkin Ash has been described as very slow growing (Harms 1990). However, like other ashes, its growth rate is largely dependent on hydrology and climate. In White Ash plantations in southern Ontario ranging in age from 20 to 38 years, the growth of the dominant and codominant trees averaged 3 to 5 mm per year in diameter and 0.2 to 0.8 m in height (Von Athen 1970). Peper *et al*. (2014) predicted based on allometric equations that the dbh of Green Ash growing in Ontario would be 22.0 cm at 20 years, 35.3 cm at 30 years, and 48.3 cm at 40 years. Pumpkin Ash is restricted to elevations below 300 m above sea level throughout its range.

Physiological characteristics make Pumpkin Ash adapted to wet bottomland habitats such as adventitious roots and concentration of nutrients in the roots and base of the trunk (Gomes and Kozlowski 1980; Gravatt and Kirby 1998). Pumpkin Ash is sensitive to drought and hydrological changes, which can cause canopy dieback and eventual death of trees (Harms 1990). Like most other bottomland trees, Pumpkin Ash has a shallow root system, which makes it susceptible to windthrow and could conceivably limit uptake of water and nutrients during dry conditions.

The seeds of Pumpkin Ash are shed with fully developed embryos in a state of physiological dormancy. Seeds typically germinate within the first year after being shed, although germination can occur up to three years later (Harms 1990; Knight pers. comm. 2020). A protocol for *in vitro* propagation has been developed (Stevens and Pijut 2012), but the success of transplanting propagated individuals has not been reported.

Pumpkin Ash seedlings and saplings are considered to be very shade-tolerant, but trees become less shade-tolerant as they mature (Harms 1990). Overall, Pumpkin Ash is described as moderately shade-tolerant (Harms 1990). It is very susceptible to death or injury from fire (Harms 1990; Ewel 1995).

Dispersal and Migration

Pumpkin Ash is wind-pollinated, and its seeds are wind-dispersed via its winged samaras. Similar to other winged fruits, the wings of Pumpkin Ash samaras function to reduce fall velocity and increase the distance they can be transported by wind (Norberg 1973). Dispersal distance of Pumpkin Ash seeds is unknown; however, Schlesinger (1990) noted that the seed of White Ash is dispersed by wind up to 140 m from the parent tree. Seed dispersal up to 1.4 km has been documented in other ash species (Bacles *et al.* 2006), but dispersal distance may be shorter for Pumpkin Ash because it has the largest samaras of any North American ash species (Atha and Boom 2017). Its seeds appear better adapted to water dispersal than wind dispersal, a theory which has also been proposed for Black Ash, which has similar fruits and grows in wet environments (COSEWIC 2018). Water dispersal of samaras over several kilometres has been documented for other ash species (Thébaud and Debussche 1991; Schmiedel and Tackenberg 2013). Other seed dispersal mechanisms for Pumpkin Ash may include seed-caching rodents, such as squirrels and chipmunks (Sciuridae), which move seeds over short distances (Moore *et al.* 2007). Waterfowl have been identified as a possible long-distance seed dispersal mechanism for Blue Ash (*Fraxinus quadrangulata*) and this may also be a possibility for Pumpkin Ash (COSEWIC 2014); however, it is unknown if germination of Pumpkin Ash seeds can occur after being ingested.

Interspecific Interactions

The biology of Emerald Ash Borer and its interactions with Pumpkin Ash are discussed under **Threats**.

No wildlife species are known to rely exclusively on Pumpkin Ash for feeding or reproduction nor are there any species that appear to have a preference for Pumpkin Ash over other ashes or suitable host plants. However, Pumpkin Ash can be assumed to host a variety of fauna that are exclusively associated with ashes as a genus. In North America, these include at least 43 species of mites (Acari), beetles (Coleoptera), flies (Diptera), true bugs (Hemiptera), wasps and relatives (Hymenoptera), and butterflies and moths (Lepidoptera) (Gandhi and Herms 2010).

Wagner and Todd (2015) identified six species of arthropods which are highly threatened by ash decline. While the decline of Pumpkin Ash in Canada will no doubt affect these and other ash-reliant species, the low abundance of Pumpkin Ash relative to other ashes means that its contribution to declines in ash-reliant fauna will probably be small.

Many mammals and birds have been observed feeding on ash seeds including squirrels and chipmunks, mice (Cricetidae), Wild Turkey (*Meleagris gallopavo*), Northern Cardinal (*Cardinalis cardinalis*), and Black-capped Chickadee (*Poecile atricapillus*) (Martin *et al.* 1951; Wagner and Todd 2015). White-tailed Deer (*Odocoileus virginianus*) feed on ash branches and twigs and can be assumed to feed opportunistically on Pumpkin Ash (Elias 1987; Erdmann *et al.* 1987). The effects of wildlife browsing on Pumpkin Ash are unknown but other ashes are relatively tolerant of wildlife browsing (Aldous 1952; Erdmann *et al.* 1987).

Birds use Pumpkin Ash opportunistically for nesting and other wildlife may use Pumpkin Ash for shelter. The decline of Pumpkin Ash in addition to other ash species within its range – Black, Blue, Green, and White ash – will likely have widespread ecological impacts because ashes are considered foundation species in many ecosystems (COSEWIC 2018). It has been hypothesized that the loss of Pumpkin Ash may have greater localized ecological consequences in terms of altered ecosystem functioning because of the innately low species diversity of the communities that contain this species (Granger *et al.* 2019).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

The abundance of Pumpkin Ash individuals was recorded by tallying individuals within four diameter at breast height (dbh) size classes (<5 cm, 5-10 cm, 10-20 cm, and >20 cm). All mature individuals are believed to be within the largest size class. In Rondeau Provincial Park, which was the largest site with previous records, areas of the park with records were searched; however, due to its extensive size and time constraints, not all areas of potentially suitable habitat could be searched. For Rondeau Provincial Park, the number of individuals confirmed is provided, but it is expected that numbers may be greater.

Dead canopy ash trees were noted at many sites, but because both Pumpkin Ash and Green Ash can exhibit buttressing when growing in wet environments, these species cannot be confidently distinguished when dead. If epicormic shooting was occurring from the base of a dead trunk, the individual was counted as alive and the diameter was recorded from the shoots.

Abundance

Table 2 provides data on the number of individuals recorded or estimated at each subpopulation. These data represent all known Pumpkin Ash subpopulations, including extirpated and presumed extirpated subpopulations. Prior to the inventory in 2021, the majority of observations obtained from the NHIC (2020) had no abundance information. For some sites, it’s difficult to determine whether multiple observations are of different individuals, or repeat observations of the same individual. Some occurrences had confusing observer-provided information (e.g., one observer provided diameter measurements separated by commas, so we assume each measurement is of an individual tree). Some observations were based solely on seeds collected from the ground with no mention of individual trees. As such, the historical abundance information (Table 2) is considered a minimum. The historical abundance for Rondeau, in particular, is almost certainly an underestimate as many observations from there did not have abundance information (van Hemessen pers. comm. 2022).

A total of 419 Pumpkin Ash individuals were recorded during surveys in 2021. These were in the following size classes: 1) <5 cm - 350 individuals or seedlings/saplings; 2) 5-10 cm - 56 saplings; 3) 10-20 cm - 11 immature trees; and 4) >20 cm – two mature individuals or trees. Only two sexually mature individuals (females) were found, both of which showed evidence of Emerald Ash Borer infestation. This represents a minimum decline of 97.5% based on the minimum historical estimates (Table 2).

The largest living Pumpkin Ash documented during fieldwork was a split stem tree with trunks of 20 and 24 cm in diameter in Elgin County. It was heavily infested with Emerald Ash Borer with one trunk nearly dead from the infestation.

A total of 419 individuals of Pumpkin Ash were found during fieldwork in 2021 that occupied approximately 1,800 ha of suitable habitat (approximately 23.3 individuals/ha). If an assumption is made that Pumpkin Ash is extant at previously known occurrences, which were not surveyed for this report, then there may be up to 58 additional individuals at these sites (approximately 250 ha of suitable habitat was mapped at unsurveyed sites using aerial imagery). The possibility that undiscovered occurrences of Pumpkin Ash persist in other suitable habitats within Ontario's Carolinian Zone could be considered: if a further assumption is made that there is four times as much suitable habitat within the known range of Pumpkin Ash in Canada as is currently known to contain Pumpkin Ash, then there may be up to 1,257 individuals that have not yet been discovered. Regardless, based on the best available information, there are estimated to be at a maximum fewer than 2,000 immature individuals of Pumpkin Ash remaining in Canada and fewer than 10 sexually mature individuals.

Fluctuations and Trends

Fluctuations and trends in the Canadian population of Pumpkin Ash have not been quantified. Pumpkin Ash was first identified in Canada in 1992 (Waldron *et al*. 1996; Waldron 1997) but was present in Canada long before its first detection and was probably more abundant prior to extensive land use change by European settlers.

Pumpkin Ash is a long-lived tree, so short-term fluctuations in the number of mature individuals are minimal in the absence of large-scale impacts (e.g., Emerald Ash Borer). The effects of Emerald Ash Borer on the Canadian population of Pumpkin Ash are difficult to quantify because the pre-Emerald Ash Borer abundance of Pumpkin Ash is unknown. Most Canadian subpopulations were probably affected by Emerald Ash Borer as early as 2012 because they are within a region which was impacted by Emerald Ash Borer within 10 years of its first detection in Canada.

Rescue Effect

Unassisted (i.e., natural) movement of Pumpkin Ash from the United States into Canada has not been observed. Long-distance dispersal of ash samaras by wind is possible during large storm events (Clark 1998), but wind dispersal of Pumpkin Ash samaras from the United States into Canada is predicted to be a rare event and not a significant contributor to rescue. The typical dispersal distance of ash samaras by wind (i.e., 1.4 km) is shorter than the distance from nearest United States population to suitable habitat in Canada. Water dispersal across the Detroit River, Lake Erie, and Lake St. Clair is possible, but unlikely to provide significant rescue. Overall, the immigration of gametes or individuals is unlikely to successfully mitigate the decline of Pumpkin Ash both in Canada and in the neighbouring sites in the United States. Additionally, researchers in the United States have not observed any apparent resistance to Emerald Ash Borer in Pumpkin Ash, so rescue from trees farther south is unlikely to be a sustainable method of preserving the species in Canada.

THREATS AND LIMITING FACTORS

Threats

Pumpkin Ash is of conservation concern because of its limited range in Canada, extensive historical habitat loss, and the current severe threat posed by Emerald Ash Borer. Only 12.1% forest cover remains within its Canadian range and agricultural conversion is causing ongoing incremental woodland loss (Environmental Commissioner of Ontario 2018). Other provincial or local scale threats include: logging and wood harvesting; annual and perennial non-timber crops; roads and railroads; utility and service lines; recreational activities; and other ecosystem modifications.

Threats to Pumpkin Ash assessed in this report are organized and evaluated based on the International Union for Conservation of Nature - Conservation Measures Partnership (IUCN-CMP) unified threats classification system (IUCN-CMP 2017). Threats are defined as the proximate activities or processes that directly and negatively affect the Pumpkin Ash population. These are outlined below in general order of highest to lowest impact. Results on the impact, scope, severity, and timing of threats are presented in tabular form in Appendix 1. The overall threat impact for this species is Very High.

<u>Invasive Non-native/Alien Species (IUCN Threat 8.1, Very High Impact)</u>

Emerald Ash Borer

The Emerald Ash Borer is native to north-eastern Asia (CFIA 2019; OISAP 2020) and is an Oleaceae-dependent species that can complete its life cycle in all native Canadian ash species, although susceptibility to the beetle differs among ash species (Rebek *et al.* 2008; COSEWIC 2014; Herms and McCullough 2014; Poland *et al.* 2015; COSEWIC 2018; Duan *et al.* 2018). Similar to Green and White ash, Pumpkin Ash is highly susceptible to infestation by Emerald Ash Borer and subpopulations of Pumpkin Ash in Michigan have been observed riddled with Emerald Ash Borer tunnels (Otis pers. comm. 2020). Because Pumpkin Ash has always been highly localized in Ontario, it is possible that Emerald Ash Borer could lead to its extirpation (Otis pers. comm. 2020).

Emerald Ash Borer attacks both healthy and stressed ash trees. Adult beetles feed on the foliage, while the larvae tunnel through the trees' vascular system and girdle the tree causing a decline in health (Hope *et al*. 2020; OISAP 2020). Adult beetles cause negligible defoliation, but females can produce between 40 to 70 eggs and beetle larvae are responsible for ash declines (Herms and McCullough 2014). Emerald Ash Borer takes one to two years to complete its full life cycle (Hope *et al.* 2020). Large-scale mortality (50 to 99%) of ash trees occurs within 4-10 years of Emerald Ash Borer's arrival to an area (Knight *et al.* 2008; Klooster *et al.* 2014; Hodge *et al.* 2015; Cuddington *et al.* 2018; Duan *et al.* 2018; Hope *et al.* 2020). The overall impacts of Emerald Ash Borer on the ash population within the Canadian range of Pumpkin Ash are unknown. Work in the City of London, Ontario provides a strong indication of the level of decline. As of 2013, the City of London had noted an 80% loss of ash trees despite trees on municipal lands being managed with insecticide (Rowland pers. comm. 2021). Even in large, healthy trees mortality can occur within three years, with modelling based on field observation suggesting 50% stand mortality after four years (Knight *et al*. 2008) and observation indicating 99% ash mortality (all species) by six years in Michigan and Ohio (Klooster *et al*. 2014). Given that the level of Emerald Ash Borer infestation is probably fairly uniform across the range of Pumpkin Ash, based on aerial survey data from NDMNRF, and insecticide treatments are very limited elsewhere, mortality of ash within the area currently occupied by Emerald Ash Borer in Canada probably exceeds 80%. Mortality of Pumpkin Ash specifically is estimated to be over 90% since 2002.

Emerald Ash Borer is believed to have been introduced to North America in the early 1990s (NRCAN 2020). As of 2019, Emerald Ash Borer was established in 36 US states and five provinces in Canada (Figure 5) (Hope *et al.* 2020). Emerald Ash Borer was first detected in Ontario in 2002 and was found to be widespread across the south and central regions of the province (i.e., the entire Canadian range of Pumpkin Ash) in 2012 (CFIA 2019, 2020b; Government of Ontario 2020; Invasive Species Centre 2020). The City of London, Ontario has a potential record of Emerald Ash Borer from 2002 that was described as "an unknown ash affliction", suggesting that Emerald Ash Borer has been present across a large portion of the Canadian range of Pumpkin Ash since then (Rowland pers. comm. 2021). Emerald Ash Borer has resulted in the mortality of millions of ash trees in southwestern Ontario (OISAP 2020). Quantification of the total number of ash trees (all species) thus far affected in Canada has not been attempted but it is likely to be in the tens of millions[1]. In Ontario, the spread of Emerald Ash Borer is monitored every two years through aerial surveys by the NDMNRF (Rowlinson pers. comm. 2021). As of 2018, aerial surveys estimated that 601,672 ha of ash trees have declined or died in Ontario (Rowlinson pers. comm. 2021; Figure 6).

It is important to note that much of the range of Pumpkin Ash overlaps with areas most highly infested with Emerald Ash Borer, which will be discussed further under *Threats*. The current status of Pumpkin Ash in the worst affected areas (i.e., Ontario, Michigan, Indiana, Ohio, and New York) is not well known at this time.

[1] The number of Pumpkin Ash killed thus far in Canada is likely fairly low by comparison, because all other ash species in Ontario are considerably more numerous than Pumpkin Ash. However, this may represent a more drastic loss for Pumpkin Ash because it was initially rare in Ontario.

Agencies in the United States and Canada have determined that eradication of Emerald Ash Borer is not possible and have focused efforts on slowing range expansion, population control measures, and developing resistant ash trees (Duan *et al.* 2018). Emerald Ash Borer typically disperse about 3 km from their host tree but can fly up to 20 km. Long-distance dispersal can occur through the movement of infested firewood, logs, lumber or woodchips (Taylor *et al.* 2005; Hope *et al.* 2020; Invasive Species Centre 2020; OISAP 2020).

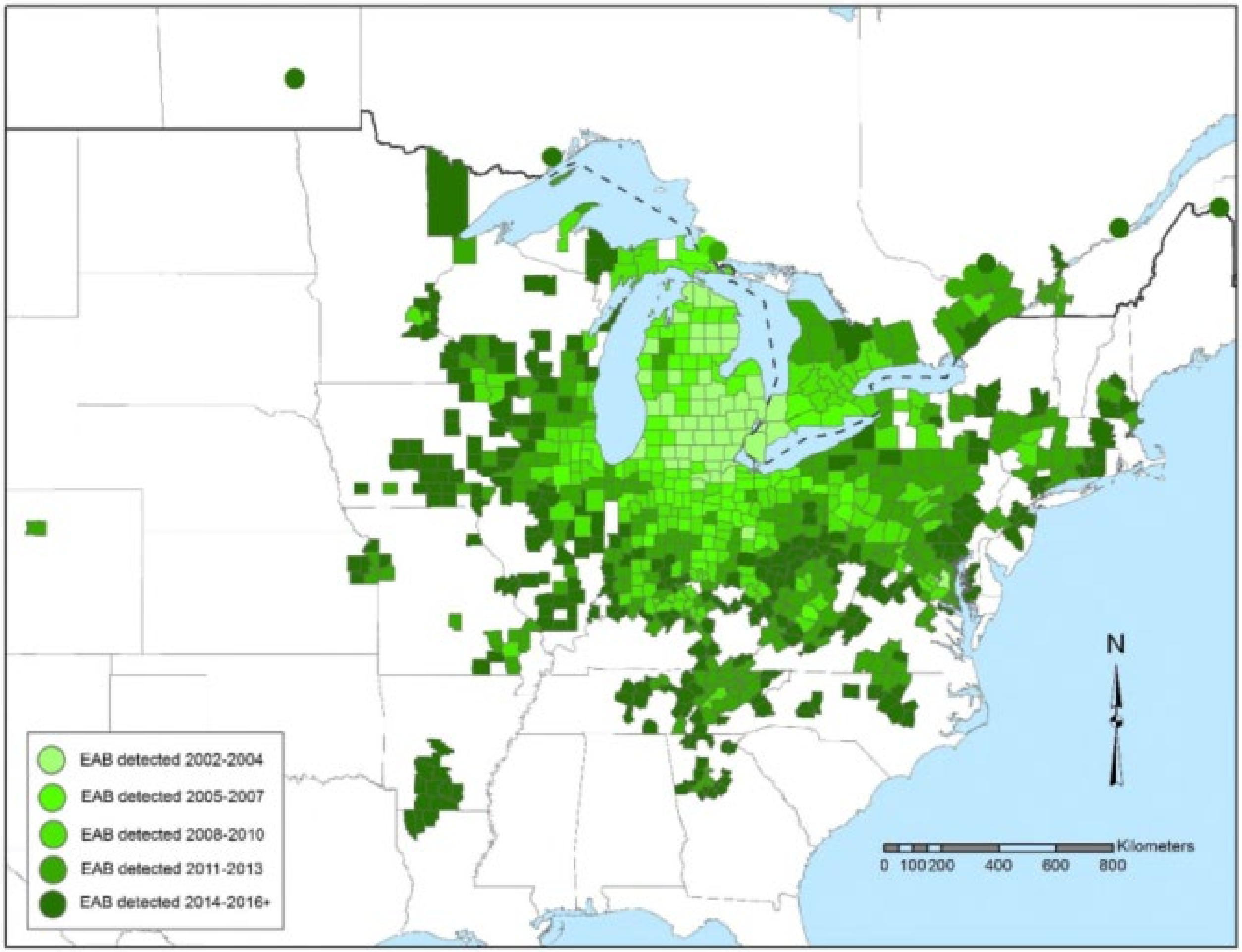

Figure 5. Documented occurrence of Emerald Ash Borer in North America by county or equivalent jurisdiction, except for Manitoba, northern Ontario, New Brunswick, and some Quebec occurrences where occurrences are given as precise dots within large jurisdictions (from COSEWIC 2018 based on data from APHIS 2016; CFIA 2017, 2018**).**

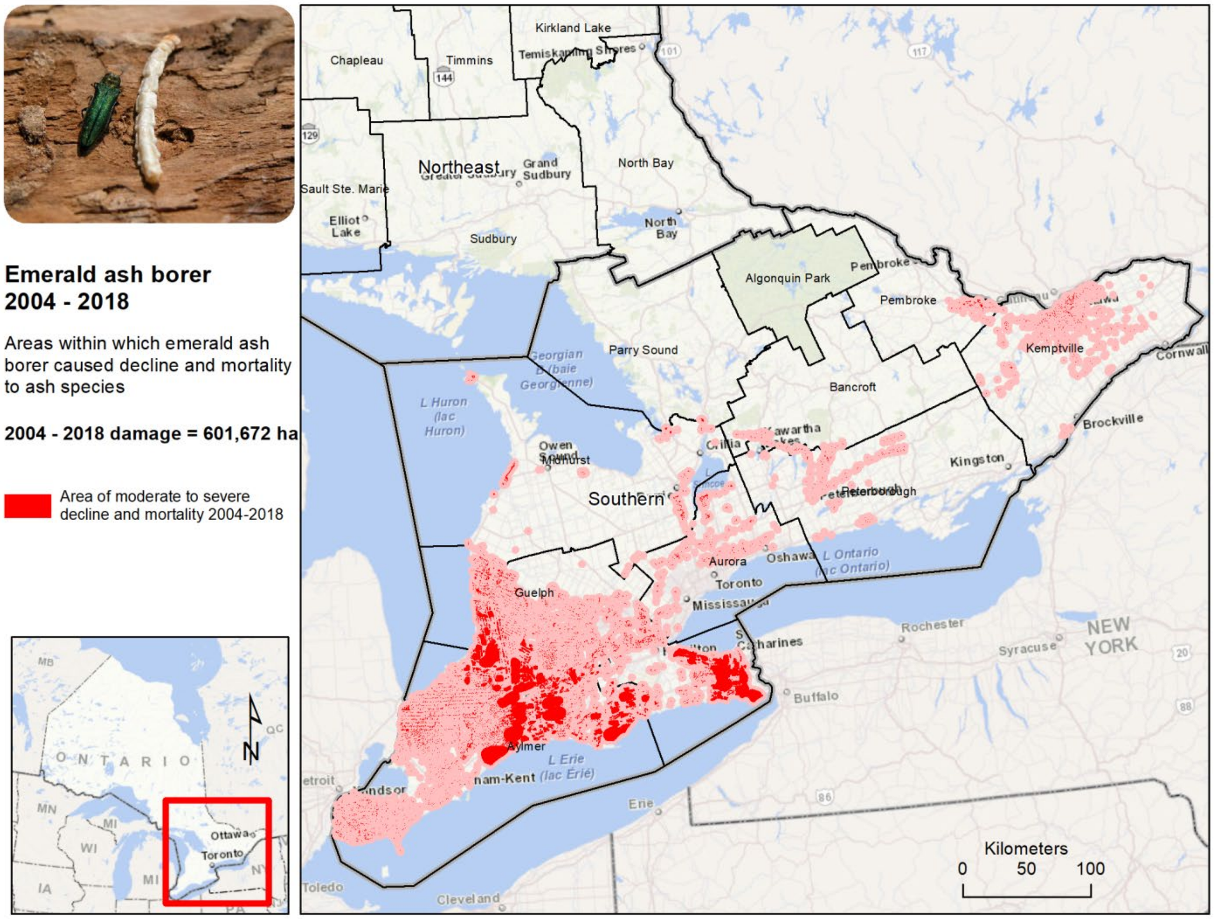

Figure 6. Emerald Ash Borer-caused ash decline and mortality in southern Ontario based on Ontario Ministry of Natural Resources and Forestry aerial surveys (Rowlinson pers. comm. 2021).

Because Emerald Ash Borer is well established in the entirety of the Canadian range of Pumpkin Ash, the further spread of Emerald Ash Borer across Canada is not a factor for this species. Rather, it is the continued presence of Emerald Ash Borer within the Canadian range of Pumpkin Ash that is an ongoing threat to this species. This report focuses on predicted Emerald Ash Borer trends and changes to the ash component of forests in areas where Emerald Ash Borer is already established (i.e., the regulated zone in Ontario). It is expected that the remaining ash trees within the regulated zone of Ontario and Quebec will be attacked by Emerald Ash Borer before 2035 (Hope *et al.* 2020).

Large-scale mortality of ash trees in an area results in an Emerald Ash Borer density collapse, but the insect remains present on surviving and regenerating trees (Prasad *et al.* 2010; Klooster *et al.* 2014; Bauer *et al.* 2015; Hodge *et al.* 2015; Sadof *et al.* 2017; Cuddington *et al.* 2018; Hope *et al.* 2020). Studies in southern Ontario have found that 7 to 43% (with an average of 19%) of regenerating ash saplings are infested with Emerald Ash Borer (Aubin *et al.* 2015). Emerald Ash Borer is capable of killing ash trees with diameters of 2.5 cm and greater (Klooster *et al.* 2014), often before the trees become sexually mature

(Kurmis and Kim 1989; Klooster *et al.* 2014). Emerald Ash Borer can persist at low levels for many years, feeding on saplings as they become large enough to be attacked (Klooster *et al.* 2014). In one United States study, where Pumpkin Ash represented at least 10% basal area of a plot, there was 84.2% with some seedling regeneration and 73.7% with sapling regeneration, which indicates that Pumpkin Ash was regenerating after Emerald Ash Borer infestation (Granger *et al.* 2017).

Because Pumpkin Ash reaches sexual maturity later than other ashes, and because Emerald Ash Borer can affect individuals as small as 2.5 cm in diameter, many Pumpkin Ash saplings are susceptible to Emerald Ash Borer infestation prior to setting seed. Furthermore, because Pumpkin Ash seeds are short-lived, the soil seed bank is rapidly depleted if mature trees are completely lost (Klooster *et al.* 2014). There are very few sexually mature Pumpkin Ash remaining in Canada: only two fruiting trees (both female) were found during fieldwork in 2021 and it is probable that other sexually mature trees are too isolated to be successfully pollinated.

The following factors may contribute to post-Emerald Ash Borer recruitment of ash: 1) prolonged post-infestation survival of canopy trees; 2) basal sprouting; 3) seedling and sapling establishment; and 4) seed produced by surviving trees (Kashian 2016). Epicormic shooting of heavily infested trees has been noted to be a common occurrence (62%) in other ash species (Kashian 2016). In southern Ontario, ash trees have been observed sprouting from the stump up to three times after each successive set of new stems has been killed by Emerald Ash Borer (Otis pers. comm. 2020). The post-Emerald Ash Borer ability of Pumpkin Ash to sprout vegetatively is unknown but may be lower than other ash species (Spearing pers. comm. 2021). Research in the United States has shown that regeneration of ash trees in mixed forests is lower than in pure ash stands, suggesting that interspecific competition for light or other resources reduces the ability of ash to regenerate (Klooster *et al.* 2014). Because Pumpkin Ash occurs in mixed swampy woodlands it is expected that competition may reduce the ability of this species to regenerate in Ontario.

Kashian (2016) suggested that pure ash stands may be more resistant to Emerald Ash Borer than mixed hardwood stands. Therefore, Pumpkin Ash in Canada may be more susceptible to Emerald Ash Borer due to trees generally occurring at low densities and mixed with other canopy species.

Ash trees survive for about five years after infestation by Emerald Ash Borer; however, the time for parasitic wasp populations to establish and increase is considerably longer (Kashian *et al*. 2018). Therefore, biological control measures may not stop the spread of Emerald Ash Borer in North America but are expected to assist in the management of Emerald Ash Borer and contribute to the regeneration of ash in areas where they have been established (Duan *et al*. 2018). The full impact of Emerald Ash Borer biological controls on ash trees is unknown (Kashian *et al*. 2018).

In 2004, 150,000 ash trees in Essex County were cut in an attempt to create a 'cut zone' that would act as a blockade to Emerald Ash Borer movement. This 'cut zone' occurred within the range of Pumpkin Ash and it is uncertain if sites where it occurs were cut.

Studies have shown that, in warmer climates, Emerald Ash Borer eggs and larvae develop faster, thereby reducing potential effectiveness of biological controls, due to a shorter period where they can be parasitized, and causing Emerald Ash Borer population growth rates to increase (Duan *et al.* 2018). Climate change may also alter synchrony between Emerald Ash Borer and parasitoid phenology, which could impact the success of biological controls (Duan *et al.* 2018).

Other Invasive Non-native/Alien Species

The fungal disease Chalara Dieback (*Hymenoscyphus pseudoalbidus*) is a potential future threat not yet recorded in North America. Chalara dieback has caused severe decline of European Ash (*Fraxinus excelsior*) in northern Europe (Kowalski 2006; Pautasso *et al.* 2013). Chalara dieback affects all developmental stages of ash trees. Symptoms include discolouration and wilting of foliage, dieback of twigs and branches, formation of epicormic shoots, bark cankers and eventual death of the tree (Halmschlager and Kirisits 2008; Kowalski and Holdenrieder 2009). It is uncertain how susceptible Pumpkin Ash may be to this disease.

It is uncertain to what extent other non-native species, such as Cottony Ash Psyllid (*Psyllopsis discrepans*), may impact Pumpkin Ash. This phloem feeding insect is native to Europe but has been introduced to Nova Scotia and several US states (Wamonje *et al.* 2020). This species has been noted to infest Black Ash (Wamonje *et al.* 2020) but has not yet been noted in Ontario or on Pumpkin Ash. Typically, psyllid infestation causes pseudogalls and a loss of canopy (Wamonje *et al.* 2020). The alpha proteo-bacteria *Candidatus* Liberibacter is associated with Cottony Ash Psyllid and it is uncertain if health declines observed are due to infestation by the psyllid or by the psyllid-transmitted bacterium (Wamonje *et al.* 2020).

<u>Logging and Wood Harvesting (IUCN Threat 5.3, Medium Impact)</u>

Ash is generally regarded as high-quality firewood (Alden 1994) and may be targeted for harvest in private woodlots throughout the species' range, but due to its low abundance, Pumpkin Ash is not specifically targeted for logging in Canada. However, wood harvesting is ongoing throughout the Canadian range of Pumpkin Ash and several subpopulations may be at risk of extirpation due to logging.

Health decline in ash species due to Emerald Ash Borer may increase the selective logging of ash trees generally for use as firewood. Public awareness of Emerald Ash Borer may have the unintended consequence of driving private landowners to actively target and cut down ash trees before they become infested and lose their value. In the same regard, municipalities may have opted to remove ash trees from public lands before they became hazardous.

Annual and Perennial Non-timber Crops (IUCN Threat 2.1, Medium-Low Impact)

Incremental conversion of woodlots to agriculture is ongoing throughout the Canadian range of Pumpkin Ash (Environmental Commissioner of Ontario 2018). Pumpkin Ash has been removed from two sites where woodlots were converted to agriculture: one subpopulation in Niagara Regional Municipality was removed between 2007 and 2009, and one of the five woodlots comprising the Bickford subpopulation in Lambton County was removed between 2019 and 2021.

Roads, Railroads, Utilities and Service Lines (IUCN Threats 4.1 and 4.2, Low Impact)

Some Pumpkin Ash occurrences in Canada are close to roads and transmission lines and could potentially be removed during maintenance of this infrastructure. Emerald Ash Borer-infested individuals in an advanced state of decline are at highest risk of removal because they may pose a hazard to roads and utilities. Pumpkin Ash were found to be cut as part of regular maintenance along a pipeline right-of-way.

Problematic Native Species (IUCN Threat 8.2, Unknown Impact)

Browsing by White-tailed Deer is likely to have a negative effect on regenerating ash and could have important implications for ash regeneration and persistence in North American woodlands (Kashian *et al.* 2018). Browsing by White-tailed Deer is considered a threat due to unnaturally high population numbers occurring within the range of Pumpkin Ash. White-tailed Deer may be significantly affecting Pumpkin Ash in Southern Ontario where they are also considered a threat to Blue Ash (COSEWIC 2014) and Black Ash (COSEWIC 2018).

Tiger Sawgill fungus (*Lentinus tigrinus*) has been noted to be potentially severe in mature Pumpkin Ash trees (Harms 1990). There are no published data on insect or disease problems specific to Pumpkin Ash. Native fungi have been noted to cause various conditions that impact ash tree health.

Problematic Species/Diseases of Unknown Origin (IUCN Threat 8.4, Unknown Impact)

Ash diseases of uncertain origin that have been noted in Canada include Ash Yellows (‘*Candidatus’ Phytoplasma fraxini*) (Pokorny and Sinclair 1994; Griffiths *et al.* 1999), White Ash Mosaic Virus (Machado-Caballero *et al.* 2013), and Cauliflower Gall Mite (*Aceria fraxinivorus*) (COSEWIC 2018). Due to the similarity of symptoms of these diseases with those of drought, flooding, and fungal parasites, these diseases may be native diseases that were overlooked until the 1980s (COSEWIC 2018). Ash Yellows has been confirmed in Ontario, but the extent to which this and other native pathogens affect Pumpkin Ash is unknown.

Diseases of Unknown Cause (IUCN Threat 8.6, Unknown Impact)

“Ash dieback” refers to progressive mortality of the twigs, branches and, ultimately, the core vascular tissues of ash trees, for which the specific cause cannot be determined. Ash dieback may be the result of a combination of stressors such as insect damage, disease, and environmental changes (COSEWIC 2018). Ash dieback has long been a recognized threat to ash trees and has been attributed to frost damage, excessive moisture or drought, and air pollution, among other factors (Tardif and Bergeron 1997; Ward *et al.* 2006; Auclair *et al.* 2010; Palik *et al.* 2011, 2012).

Climate Change & Severe Weather (IUCN Threat 11, Unknown Impact)

The current trajectory of climate change forecasted by the Intergovernmental Panel on Climate Change (IPCC 2014) can be expected to result in significant changes in forest composition and ecosystem processes in North America (Iverson and Prasad 2002; Iverson *et al.* 2008, 2016). Pumpkin Ash and other species that are not drought- or fire-tolerant may be negatively affected by climate change (Brinker *et al*. 2018). Alteration of hydrological regimes (i.e., changes in amount of precipitation, increased frequency of drought) could impact the species composition of deciduous swamp communities (e.g., increased competition for nutrients, water or sunlight) or cause direct mortality of Pumpkin Ash. Drying of swamp habitats due to drought may include increased prevalence of non-native invasive species, such as European Buckthorn (*Rhamnus cathartica*), which has been noted at sites where Pumpkin Ash occurs.

In the Climate Change Research Report (Brinker *et al*. 2018) Pumpkin Ash was noted to have a moderate vulnerability to climate change due to:

- its distribution relative to anthropogenic barriers (population restricted to areas of Southern Ontario within, bordering, or surrounded by intensive urban and agricultural development that generally act to limit natural connections between subpopulations);
- its historical hydrological niche (based on historical precipitation data input into the model, Pumpkin Ash has experienced relatively small precipitation variation in recent times 1961-1990); and

- its physiological hydrological niche (its degree of dependence on specific swamp/vernal pool wetland habitat) (Brinker pers. comm. 2020).

Pests and pathogens may also increase or become more pathogenic due to climate change through: 1) direct effects on the survival and dispersal of the pests or pathogens, 2) changes in tree physiology that reduce resistance, and 3) indirect effects that increase the abundance of insect vectors of pathogens (Ayres and Lombardero 2000; Sturrock *et al.* 2011; Weed *et al.* 2013; Brinker *et al.* 2018).

A warmer climate may allow for a northward range expansion of Pumpkin Ash, but habitat fragmentation, anthropogenic barriers, hydrological niche, and the species' methods of seed dispersal are expected to be barriers to range expansion.

Limiting Factors

Physiological Limitations

As an adaptation to wet habitats, Pumpkin Ash roots are shallow and may be more vulnerable to freezing if snowpack is insufficient. Naturally occurring frost damage can exacerbate the effects of other threats discussed above. Climate change may increase the potential for ash dieback due to variable environmental conditions and increased stress from drought or frost (Ward *et al.* 2006; Auclair *et al.* 2010; Palik *et al.* 2011).

During fieldwork in 2021, three instances of regenerating Pumpkin Ash saplings being crushed by falling dead mature ash trees were observed.

Lack of Gene Exchange

Pumpkin Ash has an extremely restricted distribution with habitat limited to swamps and floodplain forests in southern Ontario. Due to habitat fragmentation in this region, there is expected to be limited gene exchange occurring between subpopulations (Otis pers. comm. 2020).

Number of Locations

There are currently 13 extant and 15 extirpated or presumed extirpated subpopulations in Canada. Based on the COSEWIC definition of location[2], these subpopulations all represent one location due to the threat from Emerald Ash Borer. Emerald Ash Borer is considered the most significant threat to Pumpkin Ash, and the degree of that threat is consistent throughout the species' Canadian range. All subpopulations are within the CFIA's Regulated Zone for Emerald Ash Borer (CFIA 2020a; Figure 7), which is considered to be well established and persisting in that area.

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[2] ("…a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations." (COSEWIC 2019)

Logging and non-timber crops (i.e., conversion of woodlots containing Pumpkin Ash to agriculture) threaten at least 10 extant subpopulations. Other threats are more localized, affecting just one or two subpopulations.

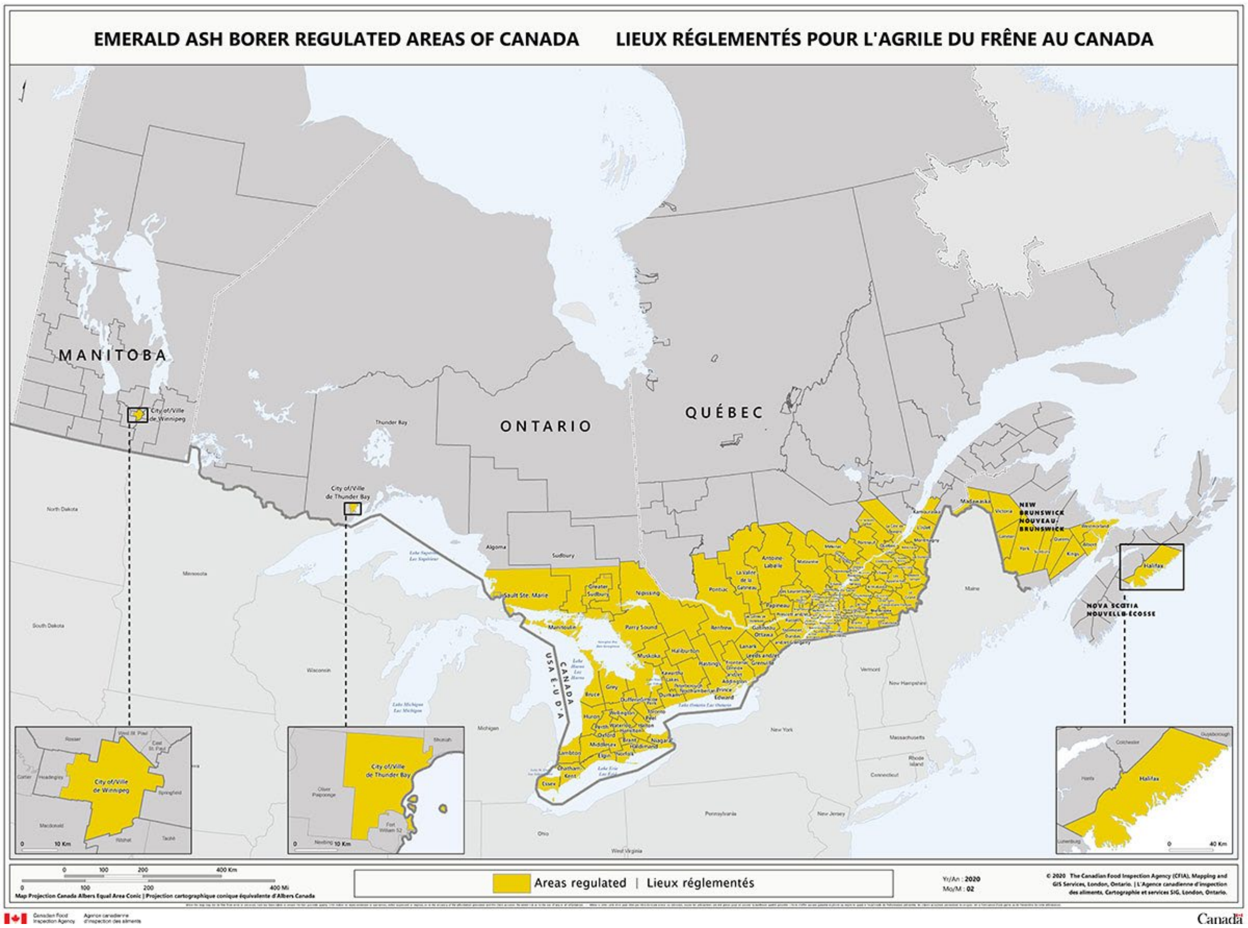

Figure 7. Areas regulated for Emerald Ash Borer in Canada as of February 2020 (CFIA 2020a).

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Pumpkin Ash currently receives no legal protection as a species in Canada. In Ontario, under the *Planning Act* (1990), habitat of Pumpkin Ash and other provincially rare species receives limited protection through the natural heritage policies of the Provincial Policy Statement (PPS) (2020). Additionally, under Ontario's *Municipal Act* (2001) municipalities below the provincial level have the authority to regulate loss of forest cover and cutting of trees through forest protection or tree-cutting bylaws. However, most tree-cutting bylaws have exemptions for dead or dying trees, which are hazardous to human safety or property. Pumpkin Ash trees succumbing to Emerald Ash Borer would likely be exempt from protection under these bylaws.

In the United States, Pumpkin Ash receives no federal legal protection. In Michigan, it is listed as Threatened and is protected under the state's *Natural Resources and Environmental Protection Act* (1994).

Non-Legal Status and Ranks

Pumpkin Ash currently has a global conservation rank of Apparently Secure (G4, rank review May 2021 with a note - The Conservation Status of this species should be reviewed frequently to detect changes in the impact of the borer, NatureServe 2021), a national conservation rank of Critically Imperilled (N1) in Canada and a national rank of Apparently Secure (N4) in the United States. In Ontario, Pumpkin Ash has a subnational conservation rank of Critically Imperilled (S1) (Brinker pers. comm. 2022). Pumpkin Ash has subnational ranks of Critically Imperiled (S1) in the New Jersey, New York, Pennsylvania, and the District of Columbia, Imperiled (S2) in Michigan, Vulnerable (S3) in Georgia, Mississippi, and Ohio, Apparently Secure (S4) in Maryland, North Carolina, and Virginia, and not ranked (SNR) in the 10 remaining states where the species occurs (NatureServe 2021). Pumpkin Ash is listed as Critically Endangered on the IUCN Red List of Threatened Species (Westwood *et al*. 2017).

Habitat Protection and Ownership

Some wetlands in Ontario that provide habitat for Pumpkin Ash receive protection under the PPS, which prohibits development and site alteration in wetlands determined to be provincially significant (Ontario Ministry of Municipal Affairs and Housing 2020). Most other wetlands receive only limited protection under the PPS. Additionally, as a provincially rare species, habitats of Pumpkin Ash receive limited protection under the PPS if the municipality is aware of their existence and the official plan is in accordance with the PPS. Pumpkin Ash and its habitats therefore receive limited legal protection across its entire Canadian range. However, there are exemptions under the PPS for certain agricultural and resource extraction activities and for other activities if it can be demonstrated that there will be no negative impact to protected features.

The majority (54%) of extant Pumpkin Ash subpopulations are on private and municipal lands (Table 2). Three extant subpopulations are on lands managed for conservation purposes (i.e., provincial parks and lands owned by groups such as the Nature Conservancy of Canada). Three subpopulations are on lands managed by conservation authorities for water resources and recreation. Despite being owned by conservation-focused organizations, logging may still be occurring on privately managed properties, and it is uncertain if these areas are managed for species protection.

Regulatory protection of woodlands and wetlands by regional and municipal agencies does not prevent incremental woodland loss, which occurs slowly over time. Agriculture is responsible for incremental woodland loss in southern Ontario (Environmental Commissioner of Ontario 2018) and this threat is expected to continue. Mortality of ash from Emerald Ash Borer may reduce canopy cover to the point that sites are no longer classified as forests (e.g., Lee *et al*. 1998) and are therefore no longer protected by municipal forest preservation policies. Information provided by the County of Middlesex, Ontario indicates that a large number of landowners have attempted to use ash mortality from Emerald Ash Borer as justification for clearing woodlands on their properties, but these requests have been denied and the county continues to consider regenerating ash forests as woodlands under their policies, even if canopy cover of mature trees has been reduced (Brown pers. comm. 2021). Other municipalities within the range of Pumpkin Ash may not apply this same policy interpretation.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Pauline Catling has an undergraduate degree in Wildlife Biology from the University of Guelph and a master's degree in Biology from the University of Manitoba where she studied the ecological classification of alvar vegetation in the Interlake region of Manitoba. From 2009 to 2013 she worked on various projects towards the conservation and monitoring of Species at Risk in Ontario. She currently works as a senior ecologist for North-South Environmental Inc. She has over 11 years of experience working on various research, monitoring or conservation projects in Ontario and Manitoba. She has written the COSEWIC status report for Western Prairie Fringed Orchid (*Platanthera praeclara*) and has developed standardized survey protocols for Small White Lady's-slipper and False Hop Sedge.

William van Hemessen holds a bachelor's degree in Environmental Studies from the University of Waterloo and is currently a senior ecologist with North-South Environmental Inc. in Cambridge, Ontario. William has over 10 years of professional experience in ecology and has authored peer reviewed articles pertaining to botany and natural areas management. He sits on the Board of Directors of the Field Botanists of Ontario and previously sat on the Board of Directors of the Thames Talbot Land Trust in London, Ontario.

COLLECTIONS EXAMINED

All Pumpkin Ash records from the Canadian Museum of Nature Herbarium (CAN), University of Waterloo Herbarium (UWO), and the Agriculture Canada Herbarium (DAO) were requested, as well as Canadian specimens from the University of Michigan Herbarium (MICH).

CAN had no Canadian specimens. Two specimens from Ontario were examined from DAO (885281, 885285). Five specimens from UWO were examined including three from Elgin County (43417, 40444, 44381) and two from Middlesex County (48387, 48388). Seventeen specimens were examined from MICH including twelve from Essex (1460606, 1460607, 1460608, 1460609, 1460612, 1460613, 1460614, 1460615, 1460616, 1460617, 1003307A and B), two from Kent County (1006948A and B) and three from Elgin County (1460610, 1460611, 1460618).

Canadensys (2020) has no records of this species in an Ontario herbarium. Records in Quebec are from a cultivated individual. The Global Biodiversity Information Facility (2020) database was reviewed to identify herbaria with specimens of Pumpkin Ash.

Appendix 1. Threats Calculator for Pumpkin Ash in Canada.

THREATS ASSESSMENT WORKSHEET			
Species or Ecosystem Scientific Name	Pumplin Ash, *Fraxinus profunda*		
Element ID	1054302	**Elcode**	PDOLE040E0
Date:	2021-10-08		
Assessor(s):	William D. van Hemessen and Pauline K. Catling (writers), Bruce Bennett (facilitator, Co-chair), Burke Korol (ECCC), Vivian Brownell (SSC), Sean Blaney (SSC), Sam Brinker (SSC), Anna Hargreaves (SSC), Jeanette Armstrong (SSC, ATK), Sydney Allen (Secretariat), Del Meidinger (Co-chair)		
References:			

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	1	1
B	High	0	0
C	Medium	2	1
D	Low	1	2
Calculated Overall Threat Impact:		Very High	Very High
Assigned Overall Threat Impact:		**A = Very High**	
Impact Adjustment Reasons:			
Overall Threat Comments		Generation time is 60 years (3 generations = 180 yrs). Population, for purposes of the call, considered individuals greater than 5 cm in order to consider threats to species survival -- 69 individuals. Present number of mature individuals is two, and these are both likely to be killed by Emerald Ash Borer. Some younger/smaller trees will mature in next 10 years.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						Pumpkin Ash occurs in wetlands and floodplains which are generally protected from development and site alteration under PPS, *Conservation Authorities Act*, etc. Most sites do not occur near expanding urban areas. Impacts to Pumpkin Ash from residential development would be indirect.
1.2	Commercial & industrial areas						No sites occur in areas likely to be developed for commercial/industrial uses within the next 10 years. Wetlands and floodplains would be generally protected from development and site alteration.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas						Some trees are in parks and close to trails/other amenities but the overall scope and severity of this threat is thought to be negligible. Individuals may be removed as part of maintenance activities with very limited impact on the population overall.
2	Agriculture & aquaculture	CD	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	High (Continuing)	
2.1	Annual & perennial non-timber crops	CD	Medium - Low	Restricted - Small (1-30%)	Extreme (71-100%)	High (Continuing)	Two woodlots containing Pumpkin Ash have been lost to agriculture in the last 20 years (including one being cleared and burned during field investigations) and others are likely at risk of conversion to agriculture. A total of 20 of all records of sites that once held Pumpkin Ash, including five where Pumpkin Ash is extant, which represent 26% of the population, occur at least in part on private lands. These may all be at risk of habitat conversion to expand adjacent agricultural areas, particularly in woodlots dominated by ash killed by EAB. The loss of two woodlots with records was not included in future threats. Only the subpopulations confirmed in 2021 were considered; however, it is assumed that the land use captured in 2021 surveys was representative of this threat scope across Canada and would still be consistent if all sites were surveyed.
2.2	Wood & pulp plantations						Conversion of Pumpkin Ash habitat to wood/pulp plantations has not been observed.
2.3	Livestock farming & ranching						Conversion of Pumpkin Ash habitat to livestock farming/ranching has not been observed. Site are located in areas better suited to row crops and orchards.
2.4	Marine & freshwater aquaculture						Sites do not occur on large waterbodies.
3	Energy production & mining						
3.1	Oil & gas drilling						Although several sites are within areas of historical and ongoing natural gas exploration, extraction in these areas is decreasing.
3.2	Mining & quarrying						Mining/quarrying has not been observed in habitat of Pumpkin Ash. Sites do not occur in aggregate resource areas.
3.3	Renewable energy						Wind and solar farms are being constructed in proximity to some sites. This was considered speculative potential and was not ranked.
4	Transportation & service corridors	D	Low	Small (1-10%)	Extreme - Moderate (11-100%)	High (Continuing)	Although occurring at difference sites, the combined scope is still considered small.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	D	Low	Small (1-10%)	Extreme - Moderate (11-100%)	High - Moderate	Some occurrences are near roads and it is possible that dead or dying Pumpkin Ash could be removed, as well as live ones during clearing of roadside vegetation. Salt spray and other road runoff may also cause negligible impact but the scope and severity of this aspect of roads is unknown. One site (Lower Big Crk) with 9% of the individuals was largely present in a ditch immediately adjacent to the road with saplings 10 ft tall. Clearing of roadside vegetation or road maintenance would cause damage to many of these individuals. Rondeau also has stems close to road but they don't do brushing.
4.2	Utility & service lines	D	Low	Small (1-10%)	Extreme - Moderate (11-100%)	High - Moderate	Some occurrences are near hydro lines and it is possible that dead or dying Pumpkin Ash could be removed for hazard management. One subpopulation is on a utility line (pipeline) - and one Pumpkin Ash was cut and it resprouted but pipeline RoW are continuously brushed.
4.3	Shipping lanes						n/a
4.4	Flight paths						n/a
5	Biological resource use	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						n/a
5.2	Gathering terrestrial plants						No culinary/medicinal/traditional uses of Pumpkin Ash are known. Not a species targeted for collection.
5.3	Logging & wood harvesting	C	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	Harvesting of dead and dying ash was observed at several sites along with selective harvesting of other trees. Dead and dying Pumpkin Ash (and possibly healthy Pumpkin Ash) are probably at risk of harvesting at most sites, including municipally/provincially owned sites. Wood harvesting may occur on all private lands, which represent over half of the subpopulations. No one is specifically targeting pumpkin ash, but are targeting dead/dying trees. However, forestry does recommend ash thinning as a response to EAB, so some risk. Logging may occur on conservation area lands. Conservation authorities do selective harvesting as a source of income. Trees could also be cut on sites where fire wood is harvested (e.g., Silver Maple swamps). One site had many of the Pumpkin Ash and Silver Maple were cut, presumably for firewood because smaller trees were being cut. Firewood harvesters are typically selecting larger trees. Falling trees or equipment could impact on smaller stems. Severity is likely at low end of class. With such a small population, even a small number of cut trees reaches the Moderate class.
5.4	Fishing & harvesting aquatic resources						n/a

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Recreational activity is ongoing at some sites, but most Pumpkin Ash are in sites not frequently accessed by people. Soil compaction may occur. ATV trails have been noted as a problem at one site. This impact includes trail maintenance at Rondeau--trail maintenance has cut ash trees at other sites. At Rondeau may just cut branches hanging across trails. Trails may be used for horseback riding or wagon rides. Trail maintenance may lead to the cutting of individuals. Boardwalk replacement could impact individuals but probably not occurring in next 10 years. Trampling of seedlings was not considered here but may be an impact to recovery.
6.2	War, civil unrest & military exercises						The site on DND land is not actively used. Permission was not granted to access the site.
6.3	Work & other activities						
7	Natural system modifications		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	
7.1	Fire & fire suppression						Pumpkin Ash is intolerant of fire but habitats of Pumpkin Ash are not fire prone. Fire suppression is expected to be of net benefit.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Invasive non-native plant species in the understory may impact regeneration. European Buckthorn and Common Reed (*Phragmites*) are the largest concern but also Multiflora Rose, Japanese Barberry, and Garlic Mustard were noted. Invasive species can deplete soil moisture and increase potential for drought. Effect of moisture stress and allelopathy puts population more at risk from EAB. Threat of restricting regeneration of new individuals through competition and allelopathy has not been considered here. Three subpopulations where this was noted as a potential problem: Rondeau and two others. Invasive species also decrease suitable habitat by restricting available sites for regeneration. 67% of population impacted at this time, but anticipate pervasive scope over time. Phragmites may overtop some small trees (those < 5 cm DBH) and kill them, but most trees >5 cm, which are used as a population indicator, are taller and therefore less likely to be directly killed.
8	Invasive & other problematic species & genes	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	Emerald Ash Borer is by far the largest threat. It is widespread across southern Ontario and was evident at all sites, and continues to impact Pumpkin Ash.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species/diseases		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Native species herbivory particularly by White-tailed Deer probably compounds with the threat of EAB. White-tailed Deer populations are very high in many sites. Deer commonly browse ash branches, twigs, seedling, and sprouts. Healthy trees may be able to tolerate browsing, but this impact may compound with the threat of EAB. Browsing by unnaturally abundant White-tailed Deer was assessed as a significant threat to Blue Ash (COSEWIC 2014). Threat may be higher with Pumpkin Ash than with Blue Ash as we are considering smaller individuals. Browsing is impacting recruitment, and is preventing individuals from growing to maturity, but it is uncertain if it is killing individuals. Browsing on Pumpkin Ash was observed. No studies have been completed on the impact of deer browse on Pumpkin Ash to suggest that deer are directly causing mortality of trees. Unable to actually quantify population decline due to this threat.
8.3	Introduced genetic material						Hybridization with other ashes has not been observed in Pumpkin Ash. Introduction of Pumpkin Ash genetics from elsewhere in North America is not expected to affect fitness (and could be of potential benefit if resistant genes are introduced).
8.4	Problematic species/diseases of unknown origin						Other diseases of ash have been observed in the US and the Canadian Maritimes and could arrive in Ontario in the future. But the scope and severity are unknown.
8.5	Viral/prion-induced diseases						Viral/prion diseases of Pumpkin Ash are unknown.
8.6	Diseases of unknown cause						Other diseases of ash have been observed in the US and the Canadian Maritimes and could arrive in Ontario in the future. But the scope and severity are unknown.
9	Pollution						
9.1	Domestic & urban waste water						Sewage/wastewater were not observed at any sites and the potential impacts of wastewater on Pumpkin Ash is expected to be negligible.
9.2	Industrial & military effluents						Potential for military effluents to impact the Ipperwash site is unknown because access to the site was not granted by DND.
9.3	Agricultural & forestry effluents						Approximately 1/3 of sites receive some agricultural runoff, but it is uncertain if or how this may impact Pumpkin Ash.
9.4	Garbage & solid waste						Garbage or solid waste was not observed at any sites and it is not expected solid waste would significantly affect individual trees.
9.5	Air-borne pollutants						Although some subpopulations occur in areas with known poor air quality (e.g., Bickford), the effects of airborne pollutants on Pumpkin Ash are unknown. Considered speculative and not ranked.
9.6	Excess energy						
10	Geological events						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration						
11.2	Droughts		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Pumpkin Ash is not a drought tolerant species and a major drought would likely affect the entire population. However, the timing of a major drought is uncertain. It is unlikely yet possible that a drought would affect the entire range of Pumpkin Ash at the same time due to differences in weather patterns across the Great Lakes region. The entirety of the range is generally experiencing a net drying according to climate change modeling. Drought impacted trees may be more susceptible to EAB, other insects or pathogens.
11.3	Temperature extremes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Pumpkin Ash is intolerant of temperature swings, especially extreme winter lows combined with the absence of insulating snowpack. Extreme winter lows and reduced snowfall in winters are likely to impact most of the Canadian range of Pumpkin Ash, but the timing of this type of event is uncertain.
11.4	Storms & flooding		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Pumpkin Ash is vulnerable to windthrow. There is some evidence that the range of Pumpkin Ash (i.e., southern Ontario) will experience more frequent storm events, and hence more strong winds, over the coming decades, but the timing or likelihood of these events is largely uncertain. The scope is likely to be more localized than other climate/weather threats because storms tend to be more localized and would not necessarily affect the entire range of Pumpkin Ash. Additionally, Pumpkin Ash saplings were noted to be crushed by falling ash snags at multiple sites. Species that are flood tolerant may be able to tolerant to flooding at particular times of year and flash flooding events later in the summer may have an unknown effect.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							