COSEWIC
Assessment and Status Report

on the

Kentucky Coffee-tree
Gymnocladus dioicus

in Canada

THREATENED
2021

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:

COSEWIC. 2021. COSEWIC assessment and status report on the Kentucky Coffee-tree *Gymnocladus dioicus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 43 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Previous report(s):

COSEWIC 2000. COSEWIC assessment and update status report on the Kentucky coffee-tree, *Gymnocladus dioicus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 11 pp.

White, D.J., and M.J. Oldham. November 2000. Update COSEWIC status report on the Kentucky coffee-tree, *Gymnocladus dioicus* in Canada, *in* COSEWIC assessment and update status report on the Kentucky coffee-tree *Gymnocladus dioica*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-11 pp.

Ambrose, J.D. 1983. COSEWIC status report on the Kentucky coffee-tree, *Gymnocladus dioica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 31 pp.

Production note:
COSEWIC would like to acknowledge Joseph Lance and Patrick Deacon for writing the status report on Kentucky Coffee-tree, *Gymnocladus dioicus* in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Jana Vamosi and Bruce Bennett, Co-chairs of the COSEWIC Vascular Plants Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment and Climate Change Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
www.cosewic.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Chicot févier (*Gymnocladus dioicus*) au Canada.

Cover illustration/photo:
Kentucky Coffee-tree — Photo provided by authors.

Catalogue No. CW69-14/810-2021E-PDF
ISBN 978-0-660-39692-7

COSEWIC
Assessment Summary

Assessment Summary – April 2021

Common name
Kentucky Coffee-tree

Scientific name
Gymnocladus dioicus

Status
Threatened

Reason for designation
In Canada, this deciduous tree is found only in extreme southwestern Ontario. Searches have identified new subpopulations, and recovery efforts have established new sites, but the number of mature individuals remains very low. Most subpopulations are threatened by shading caused by fire suppression, and several occurrences on the Lake Erie islands are threatened by high densities of nesting Double-crested Cormorants. The ability of this species to respond to threats is limited by low rates of sexual reproduction, and by low seed production, which in turn restricts dispersal.

Occurrence
Ontario

Status history
Designated Threatened in April 1983. Status re-examined and confirmed in November 2000 and May 2021.

COSEWIC
Executive Summary

Kentucky Coffee-tree
Gymnocladus dioicus

Wildlife Species Description and Significance

Kentucky Coffee-tree (*Gymnocladus dioicus*) is a moderate-sized tree with large, doubly-compound leaves. Greenish-white flowers emerge in late spring after the new leaves. The fruit is a hard, dark, bean-like pod containing a small number of large, hard seeds that are reported to have sometimes been roasted and used as a coffee substitute.

Distribution

Kentucky Coffee-tree occurs in the United States from Minnesota east to New York state and south to Oklahoma, Arkansas, and Tennessee. In Canada, as a native tree, Kentucky Coffee-tree is restricted to extreme southwestern Ontario, in Middlesex, Essex, Kent, and Lambton counties including some Lake Erie islands. Its Canadian distribution represents the northeastern extent and 3% of its global range.

Habitat

Kentucky Coffee-tree mainly occurs in rich floodplain forests and edges of marshes in Canada, although it can occur in various types of soil and topography. Subpopulations on the Lake Erie islands are typically in open woodland over shallow limestone bedrock. This species is shade-intolerant and favours habitats that are susceptible to occasional flooding that inhibits canopy closure by competing species.

Biology

Kentucky Coffee-trees can live more than 100 years, reaching sexual maturity at 25-50 years. The species is usually dioecious, with male and female flowers occurring on separate trees. As male and female trees are not always near enough to cross-pollinate, reproduction occurs only rarely by seed; the species spreads mainly by root suckers. Thus, most subpopulations probably represent single-sex clones composed of many stems. As of 2020, only seven subpopulations are known or suspected to have sexual reproduction. Seeds may remain in the pods for several years until decay of the pod allows the seeds to fall out. Germination of seeds takes place only after the hard seed coat is broken but there are few natural processes that can accomplish this. The leaves and seeds have toxic properties that deter herbivory and seem to make it resistant to insect pests.

Population Sizes and Trends

The Canadian population is composed of 34 extant or presumed extant subpopulations, ranging from a forest dominated by Kentucky Coffee-tree, to stands that are predominantly clonal groups, to an individual mature tree. Four subpopulations may contain a single mature individual, and four have no mature individuals. It is estimated that the entire Canadian population contains fewer than 500 mature trees. Taken together, occurrence data suggest an increase in the overall population since the species was last assessed in 2000, but this is primarily due to the inclusion of eight planted or supplemented subpopulations as manipulated population components. Kentucky Coffee-tree is planted as a street or ornamental tree, and in conservation efforts to enhance existing subpopulations, often with the intention to establish mixed-sex stands.

Threats and Limiting Factors

A major threat to Kentucky Coffee-tree is canopy closure making habitat unsuitable. An increase in Double-crested Cormorant-nesting colonies on Lake Erie islands has had serious impacts on Kentucky Coffee-tree through defoliation, branch breakage and deposition of large quantities of guano. Destruction of trees also results from infrastructure development and agricultural activity. The ability of the trees to respond to threats is limited by low rates of sexual reproduction and limited seed dispersal.

Protection, Status and Ranks

Although globally ranked as Secure (G5), Kentucky Coffee-tree is ranked as Imperilled in Canada (N2) and Ontario (S2). It was designated Threatened by COSEWIC in April 1983 and confirmed Threatened in November 2000. It is listed as Threatened in Schedule 1 under the federal *Species at Risk Act* (SARA), and Threatened under Ontario's *Endangered Species Act, 2007*.

TECHNICAL SUMMARY

Gymnocladus dioicus

Kentucky Coffee-tree

Chicot févier

Range of occurrence in Canada (province/territory/ocean): 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)	40 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No. An inferred increase resulting from manipulated population components (see **Population Spatial Structure and Variability** and **Abundance**).
Estimated percent of continuing decline in total number of mature individuals within 2 generations	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last 3 generations.	Unknown
[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].	Unknown
[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.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Unknown, but possibly. b. Yes c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO) (7,351 km² including USA; 5,214 km² excluding unsuitable habitat)	7,205 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	384 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. Yes (see **Population Spatial Structure and Variability**)

Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	28-35
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, this results from the change from Extant to Extirpated status of the Thames River Floodplain ANSI EO
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No. Inferred increase, from introduced/re-introduced population components
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No, an observed increase (see **Fluctuations and Trends**).
Is there an [observed, inferred, or projected] decline in number of “locations”*?	No, an inferred increase from new subpopulations. “Location” was not quantified in last status report.
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, a decline in quality of habitat is observed on Lake Erie islands.
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 extant subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
A.W. Campbell CA	1-4
Bear Creek, Avonry, Sombra Township	2
Bear Creek, Mitchell’s Bay, Dover Township	2
Cairngorm, Middlesex	(not included in quantitative criteria)
Canard River Floodplain, Anderdon Township	25
Canard River, LaSalle	1
Comber, Tilbury West Township	0 (none mature)
Crawford’s Woods, Dover Township	13-15
East Sister Island, Lake Erie	45-65
Essex, Maidstone Township	0 (none mature)
Florence, Zone / Dawn Township	2
Grey Tract, Brooke / Mosa Township	16
Harrow, Colchester Township	42

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Highway 40, Dover Township	1
Middle Island, Lake Erie	20-25
Middle Sister Island, Lake Erie	0-1
North Harbour Island, Lake Erie	3
Paquette and Lukerville, Anderdon / Sandwich Township	0 (none mature)
Pelee Island, Lake Erie	7
Pelton, Sandwich Township	7
Petrolia, Enniskillen Township	42
Point Pelee National Park	8-10
Puce River, Maidstone Township	0-6
Saint Joachim, Lakeshore	30-50
Shetland Kentucky Coffee-tree Woods, Zone Township	43
Strathroy CA	(not included in quantitative criteria)
Sydenham River, Alvinston, Brooke Township	20
Sydenham River, Dresden, Camden Township	20-28
Sydenham River, Florence, Euphemia Township	6
Sydenham River, Wallaceburg, Sombra Township	2
Texas Road, Anderdon Township	0 (none mature)
Walpole Island First Nation, Population #1	25-30
Walpole Island First Nation, Population #2	20
Wilkesport, Sombra Township	26-52
Total	**429-527**
In order to avoid confusion about the number of subpopulations, subpopulations that have no mature individuals and manipulated population components not being included in the quantitative assessment are identified.	

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]?	Not done

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

High
Was a threats calculator completed for this species? Yes. i. Fire & fire suppression (High-Medium impact) ii. Problematic native species/diseases (Medium impact) iii. Storms & flooding (Medium impact) iv. Other ecosystem modifications (Medium-Low impact) v. Droughts (Low impact) vi. Utility & service lines (Low impact) vii. Roads & railroads (Low impact) viii. Logging and wood harvesting (Low impact) What additional limiting factors are relevant? Low levels of sexual reproduction; limited opportunity for seed dispersal.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Michigan (S3S4), Ohio (SNR)
Is immigration known or possible?	Possible
Would immigrants be adapted to survive in Canada?	Yes, from at least some parts of the United States population.
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	Yes
Are conditions for the source (i.e., outside) population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Designated Threatened in April 1983. Status re-examined and confirmed in November 2000 and May 2021.

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

Status and Reasons for Designation:

Status:	**Alpha-numeric codes:**
Threatened	D1

Reasons for designation:
In Canada, this deciduous tree is found only in extreme southwestern Ontario. Searches have identified new subpopulations, and recovery efforts have established new sites, but the number of mature individuals remains very low. Most subpopulations are threatened by shading caused by fire suppression, and several occurrences on the Lake Erie islands are threatened by high densities of nesting Double-crested Cormorants. The ability of this species to respond to threats is limited by low rates of sexual reproduction, and by low seed production, which in turn restricts dispersal.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No declines are known.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although meets thresholds for EOO and IAO and there has been a decline in EOO and quality of habitat, there are more than 10 locations and no extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Although there are fewer than 2500 mature individuals and there are no subpopulations with more than 250, there has been no decline in mature individuals. A decline in EOO and habitat may suggest a continuing decline without active management.
Criterion D (Very Small or Restricted Population): Meets Threatened D1 with fewer than 1000 mature individuals (only 429-527 known).
Criterion E (Quantitative Analysis): Not done.

PREFACE

Since the species was last assessed in 2000, Kentucky Coffee-tree (*Gymnocladus dioicus*) has experienced declines in available habitat and extent of occurrence (EOO). Conservation efforts continue, in part, in the form of translocations and supplemental plantings; these are considered part of the species' population as manipulated population components, following COSEWIC guidelines. The inclusion of these manipulated components has likely offset the loss of mature individuals in some subpopulations; as a result the estimated number of mature individuals in Canada has remained steady. Seven subpopulations are known to produce seed, five more than in the previous status report. Index of area of occupancy (IAO) was not calculated in the last status report so cannot be directly compared, but it is expected that IAO has increased as a result of new observation records and the inclusion of manipulated population components.

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 (2021)

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.

COSEWIC Status Report

on the

Kentucky Coffee-tree
Gymnocladus dioicus

in Canada

2021

TABLE OF CONTENTS

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE 4
Name and Classification 4
Morphological Description 4
Population Spatial Structure and Variability 5
Designatable Units 6
Special Significance 6
DISTRIBUTION 7
Global Range 7
Canadian Range 7
Extent of Occurrence and Area of Occupancy 9
Search Effort 9
HABITAT 10
Habitat Requirements 10
Habitat Trends 11
BIOLOGY 12
Life Cycle and Reproduction 12
Physiology and Adaptability 12
Dispersal and Migration 13
Interspecific Interactions 14
POPULATION SIZES AND TRENDS 14
Sampling Effort and Methods 14
Abundance 15
Fluctuations and Trends 15
Rescue Effect 16
THREATS AND LIMITING FACTORS 16
Threats 16
Limiting Factors 19
Number of Locations 20
PROTECTION, STATUS AND RANKS 21
Legal Protection and Status 21
Non-Legal Status and Ranks 21
Habitat Protection and Ownership 21
ACKNOWLEDGEMENTS 21
AUTHORITIES CONTACTED 22
INFORMATION SOURCES 23

BIOGRAPHICAL SUMMARY OF REPORT WRITERS 29
COLLECTIONS EXAMINED 29

List of Figures

Figure 1. Kentucky Coffee-tree in open canopy floodplain forest in Petrolia, Ontario. Photo by P. Deacon 4
Figure 2. North American distribution of Kentucky Coffee-tree (USGS 1999). 7
Figure 3. Extent of Occurrence and Index of Area of Occupancy of Kentucky Coffee-tree in Canada. 8

List of Appendices

Appendix 1. Threats calculation on Kentucky Coffee-tree. 30
Appendix 2. Summary of Kentucky Coffee-tree subpopulations in Canada. 35

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific name: *Gymnocladus dioicus* (L.) K. Koch (commonly spelled *G. dioica*), synonyms include *Guilandina dioicus* and *Gymnocladus canadensis*.

Common name: Kentucky Coffee-tree (English), chicot févier (French)

Family: Fabaceae

Major plant group: Angiosperms, Dicotyledoneae

Morphological Description

Kentucky Coffee-tree is a moderate-sized canopy tree with stout, widely spaced branches and a narrow crown (Figure 1); mature trees can grow to 18-30 m in height (USDA 2007). The genus name *Gymnocladus* is derived from the Greek *'gymno'* (naked) '*kladus'* (branch), in reference to the branches that are both late to leaf-out and early to drop their leaves. The large leaves are doubly-compound and may be up to 1 m long. Kentucky Coffee-tree belongs to the legume family and is the only member of its genus in North America. Greenish-white flowers in terminal clusters expand in May and June after the new leaves emerge. Male and female flowers are generally borne on separate trees. The fruit is a hard, dark, bean-like pod that often remains on the tree through the winter (Farrar 1995). Because the leaves develop late in the spring and are lost in early autumn, Kentucky Coffee-tree is leafless for more than half of the year.

Figure 1. Kentucky Coffee-tree in open canopy floodplain forest in Petrolia, Ontario. Photo by P. Deacon.

Population Spatial Structure and Variability

Canadian subpopulations of Kentucky Coffee-tree are limited to fragmented sites in southwestern Ontario, largely as a result of historical and recent land clearing and habitat fragmentation (Environment Canada 2014). Subpopulations occurring on Lake Erie islands are separated from each other and subpopulations on the mainland. The surficial geology of these islands is distinct from the nearby mainland (Boerner 1984), but Kentucky Coffee-tree is known to be tolerant of a wide range of soil and topographic conditions, including floodplains, slope-ravines, and upland flats (McClain and Jackson 1980; Environment Canada 2014). There is little chance of genetic mixing between the populations in Canada and the United States as they are separated by large bodies of water in lakes Erie, St. Clair, and Huron, and the Detroit and St. Clair rivers.

Kentucky Coffee-tree is frequently planted as an ornamental tree, including from non-native stock originating from the United States (Environment Canada 2014). Genetic analysis of samples from Canada and the United States found overall low levels of genetic variation throughout its range: percent polymorphic loci per population (PLP) was 6.58 (s.d. 5.47) from 48 samples (Ambrose and Carey 1987). Ontario samples (n=21) alone had a PLP of 4.18 (s.d. 4.24), significantly different (p=0.0108) from samples from the northern United States (n=27), which had a PLP value of 9.09 (s.d. 5.55) (Ambrose and Carey 1987). Lumb (2018) also found low levels of genetic diversity and variation, but because expected heterozygosity was not lower in Canadian stands, rejected the hypothesis that subpopulations near the edge of the species' range have lower genetic variation. Genetic similarities across the range of Kentucky Coffee-tree may be due, at least in part, to its propensity for vegetative (clonal) reproduction.

There are many documented instances of Kentucky Coffee-tree planted in the vicinity of existing subpopulations or at other sites both within and outside its natural range. The Ontario Government Response Statement notes that augmentation of single-sex subpopulations has been assessed and determined to be necessary and feasible to support the species' recovery at the provincial scale (MECP 2018). Some instances are being included in the present assessment of the species as supplemented population components or translocations, according to COSEWIC guidelines (COSEWIC 2018). Because suitable habitat remains within the natural range of Kentucky Coffee-tree in Canada, extra-limital introductions are not included in this assessment. Plantings that are not within the natural habitat of the species, such as street trees or those planted in anthropogenic landscapes, are also excluded. Supplemented population components are present at the Canard River Floodplain and Wilkesport, Sombra Township subpopulations. Translocations considered in this assessment are located at the following publicly managed sites: Point Pelee National Park (mainland); Puce River, Maidstone Township; Saint Joachim, Lakeshore; A.W. Campbell Conservation Area; Cairngorm, Middlesex; and Strathroy Conservation Area. Individuals at each of these sites will be considered part of the population of Kentucky Coffee-tree in Canada. Most will also be used in the application of COSEWIC's quantitative assessment criteria (e.g., EOO, number of mature individuals) except for the Cairngorm, Middlesex, and Strathroy Conservation Area sites, which are not expected to have a net positive impact to the species past the life of the trees present because of limited recruitment potential.

Designatable Units

Kentucky Coffee-tree has one designatable unit in Canada. All subpopulations fall within the Mixedwood Plains Ecozone (Wilken 1986). No subspecies have been described and genetic analysis to date has suggested that Kentucky Coffee-tree has high genetic similarity through much of its North American range (Ambrose and Carey 1987; Lumb 2018).

Special Significance

Kentucky Coffee-tree is the sole member of the genus *Gymnocladus* in North America (Row and Geyer 2014). With only six species including *G. dioicus*, the genus has relatively high biological disparity (POWO 2019); one of the six, Himalayan Soap Pod Tree (*G. assamicus*), is Critically Endangered (Saha *et al*. 2015).

The roasted seeds are reported to have been used by some Indigenous North American peoples for food and by early settlers as a coffee substitute (Farrar 1995; Abrams and Nowacki 2008). The glucose-rich pulp within each pod is reported to have been scraped and used as a sweetener (Reidhead 1984). The seeds, however, have toxic properties due to the presence of the alkaloid cytosine, which causes gastrointestinal disorders, irregular pulse and coma (Lewis and Elvin-Lewis 1977); livestock fatalities have been reported. Livestock producers that know of the toxicity of Kentucky Coffee-tree may remove trees within or adjacent to animal grazing or browsing areas (Mills and Craig 2008). The trees also contain non-protein amino acids (Oh *et al.* 1995), which act as a potent allelochemical deterrent to animal consumption (Rosenthal 1991). There has been some documented confusion of Kentucky Coffee-tree with Black Walnut (*Juglans nigra*) (Mills and Craig 2008); concerns over allelopathy may also lead a landowner or manager to remove Kentucky Coffee-tree in some cases.

Kentucky Coffee-tree is a hardy tree without serious disease or pest vulnerabilities (Waldron 2003) and, therefore, is frequently planted as an ornamental tree. While it is believed that local seed sources/stock have been used for some plantings in Canada, the genetic sources of these are often unknown and it is likely that material from outside the species' Canadian range has been used (Environment Canada 2014). Although genetic diversity across the species' North American range appears low (Ambrose and Carey 1987; Lumb 2018), the possibility remains that native Canadian genotypes can be altered via introductions, potentially resulting in phenotypic changes (e.g., cold tolerance). The sources of seed and plant material used in the horticultural industry, and the potential impacts of cross-pollination between non-indigenous and indigenous trees, have not been studied.

DISTRIBUTION

Global Range

Kentucky Coffee-tree occurs in the United States from Minnesota east to New York and south to Oklahoma, Arkansas, and Tennessee (USGS 1999; Figure 2).

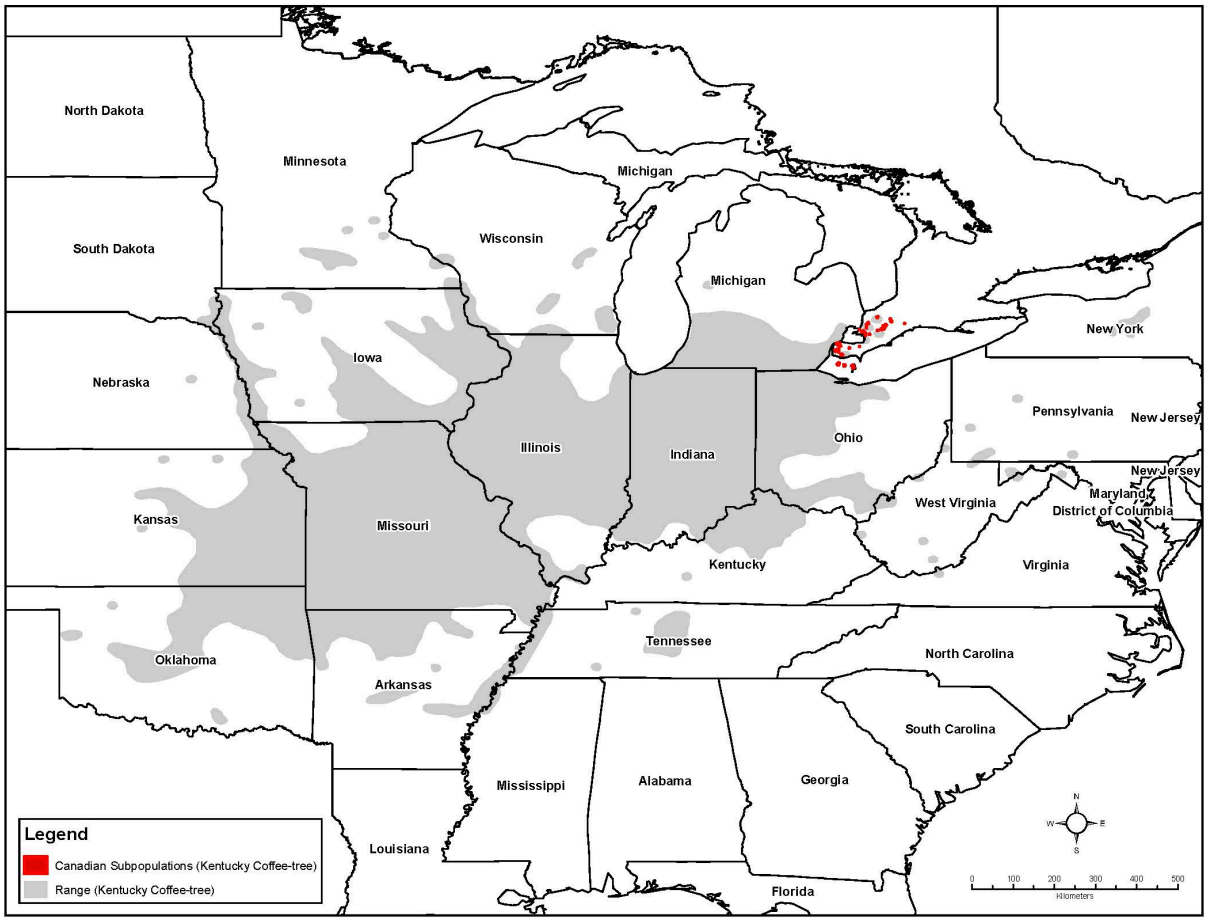

Figure 2. North American distribution of Kentucky Coffee-tree (USGS 1999).

Canadian Range

In Canada, native subpopulations of Kentucky Coffee-tree are restricted to the Carolinian life zone (Ecoregion 7E), specifically southwestern Ontario in Essex, Chatham-Kent, Lambton, and Middlesex counties. Only approximately 3% of its global range is within Canada (Figures 2 and 3). Extirpated subpopulations also occurred in Oxford and Norfolk counties (Environment Canada 2014).

It has been inferred that Indigenous peoples cultivated nut trees and other trees with large seeds, such as Kentucky Coffee-tree, because they are sometimes found in the vicinity of historical village sites (Day 1953; Zaya and Howe 2009; Jacobs pers. comm. 2012). Individuals that are presumed to be introduced occur within the aforementioned counties and others in Ontario. Planted individuals have been reported as far north and east as Ottawa (White 1968) and southern Quebec (Scoggan 1978-1979; Kartesz 2015). Previous status reports (Ambrose 1983; White and Oldham 2000) identify several sites that are suspected to be of cultivated origin and note the difficulty in determining the origin of trees growing in disturbed sites within the natural range of the species.

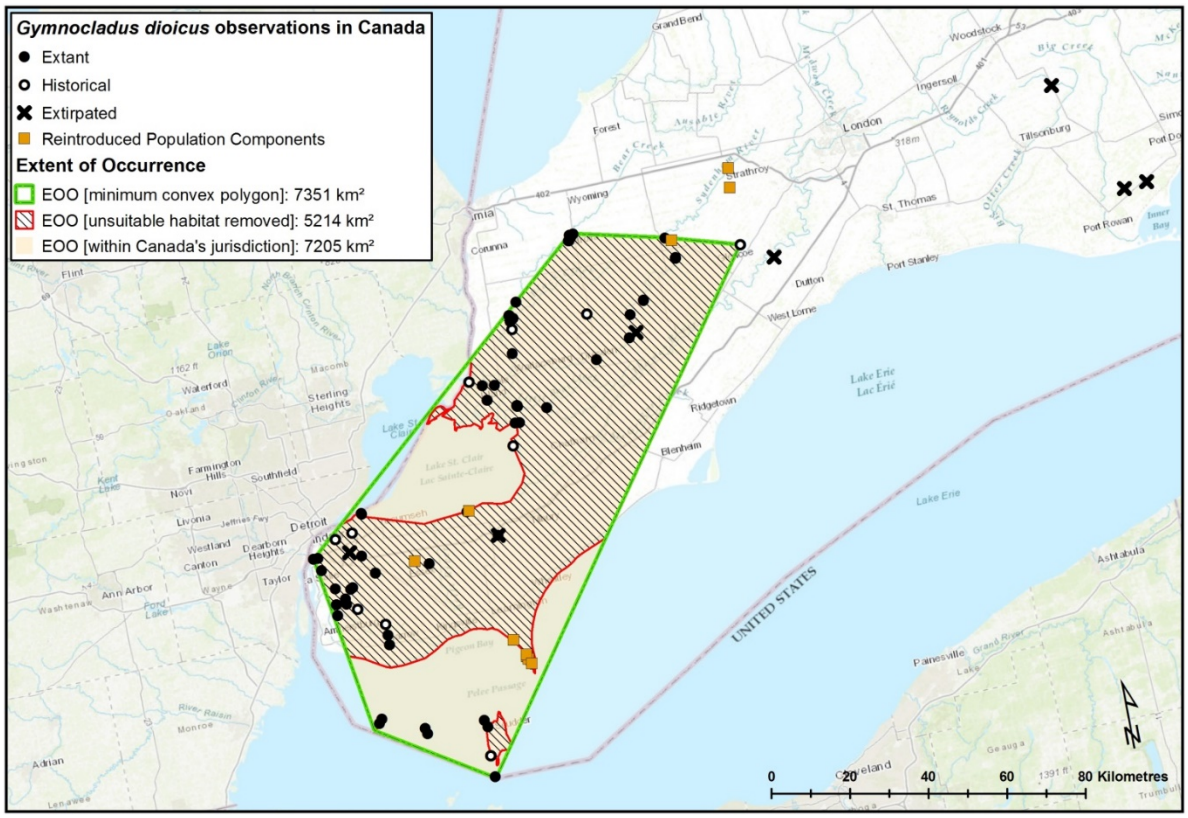

Figure 3. Extent of occurrence and index of area of occupancy of Kentucky Coffee-tree in Canada.

Assigning Status to Subpopulations and Manipulated Population Components

The present status of each subpopulation is classed as extant if individuals were observed during the past 20 years and not known to be recently extirpated; presumed extant if individuals were observed during the past 20-40 years and not known to be recently extirpated; historical if recent search effort is lacking or very limited but the species has been observed within the past 40 years and suitable habitat may persist; extirpated if failed to find on last thorough search or if the habitat is likely no longer suitable; and 'failed to find' if the occurrence was not found during a thorough search at a locality where it was previously reported, but the occurrence might still be confirmed to exist at that locality with

additional field survey efforts. These definitions are based on the NatureServe species occurrence ranking approach outlined by Hammerson *et al.* (2008), and the timeframe of 40 years was deemed to be more appropriate for this long-lived tree species. These definitions may differ from those used in earlier assessments for this species.

The latest federal recovery strategy reported 33 subpopulations, 23 of which were considered extant in 2010 (Environment Canada 2014). Since that time, one additional naturally occurring subpopulation has been reported and six translocated population components are included here, totalling 40 known subpopulations. Thirty-four of the subpopulations are classed as extant or presumed extant.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) for all known Canadian subpopulations of Kentucky Coffee-tree is 7,351 km^2 (or 7,205 km^2 in Canada's jurisdiction), calculated using a minimum convex polygon. If all unsuitable habitat is removed (i.e., waterbodies) the EOO is 5,214 km^2. The index of area of occupancy (IAO) for all but extirpated subpopulations is 384 km^2 (Figure 3). These indices were not included in the last status report (White and Oldham 2000), but by plotting the spatial limits of subpopulations using the online GeoCAT tool, it is estimated that the EOO associated with the previous status report was approximately 7,722 km^2. This represents a 9.3% decrease in EOO since the assessment in 2000. IAO is not available from 2000 so cannot be directly compared, but because six translocated population components have been added as subpopulations and one natural subpopulation has been found, the IAO value will have increased.

The EOO and IAO were calculated by plotting extant and historical observations and element occurrences (NHIC 2019a,b) over a 2 km x 2 km grid using the Canada Albers Equal Area Conic projection. IAO is calculated by adding the area of any grid square that is overlapped by an extant, historical, or manipulated population component record. The determination of the IAO assumes that locational data provided for each Element Occurrence (EO) are accurate. Two translocations were excluded from quantitative assessment criteria, including the calculation of EOO and IAO (Figure 3), because they are not expected to have a net positive impact to the species past the life of the small number of trees planted there. If these are shown to have a net positive impact, or if other manipulated population components are reported in the future, this could have a significant impact on EOO and IAO values.

Search Effort

Kentucky Coffee-tree was first documented in Canada in 1882 by John Macoun on Pelee Island (Macoun 1893; Dodge 1914). Since that time, many of the larger natural areas in southern Ontario where the species would be suspected to occur have been well-surveyed with targeted searches and incidental observations. Notable survey efforts before and since the last status report include: searches by Ambrose in the early 1980s associated with the first status report for Kentucky Coffee-tree (1983); searches by Lebedyk in 1994 within the jurisdiction of the Essex Region Conservation Authority (ERCA) (NHIC 2019b);

comprehensive surveys by Mills and Craig (2008) of properties belonging to St. Clair Region Conservation Authority (SCRCA); searches by Jalava in 2007 and 2011 that contributed updated information to the current recovery strategy (Environment Canada 2014); many records from Oldham (co-writer of the last status report) over the past four decades (NHIC 2019b); and 97 hours of search time in late summer 2017 at Middle Island, where crews were documenting Kentucky Coffee-tree along with other species (Dobbie *et al.* 2020).

Despite the extensive survey effort and the distinctive appearance of Kentucky Coffee-tree, it is conceivable that additional, undocumented subpopulations could be found, particularly on unsurveyed privately owned lands. Detailed information pertaining to extant and historical subpopulations was obtained from the Natural Heritage Information Centre (NHIC) in Ontario, Parks Canada, Ontario Parks, ERCA, and SCRCA. Various other agencies and specialists were contacted (see **Authorities Contacted**).

HABITAT

Habitat Requirements

Kentucky Coffee-tree is found in Canada mainly in rich floodplain forests and edges of marshes. Subpopulations on the Lake Erie islands are typically in open, Common Hackberry (*Celtis occidentalis*) dominated woodland over shallow limestone bedrock. Kentucky Coffee-tree is shade-intolerant, requiring open canopy conditions, such as those found on floodplains and along wetland edges. These habitats are susceptible to occasional flood damage that inhibits canopy closure by competing species (Ambrose 1983). The climate at all sites is moderated year-round by the influence of the large, open water of lakes Erie and Huron (Ambrose 1983).

Throughout its range, Kentucky Coffee-tree occurs in a variety of topographic positions and soil types including well-drained upland habitats (Limbird *et al.* 1980; McClain and Jackson 1980; Zaya and Howe 2009). Trees in bottomland habitats favour lighter textured alluvial soils (loam), neutral to basic in pH and with moderate moisture (McClain and Jackson 1980). At sites along the southern shore of Lake Erie, Limbird *et al*. (1980) described the species as inhabiting excessively well-drained sites with a shallow profile above a coarse sand and gravel horizon, and acknowledged that this differs from earlier descriptions of the species' preference for deep loamy soils with high levels of organic matter.

Kentucky Coffee-tree is a rare component of naturally occurring forest stands (USDA 2007) and is seldom abundant throughout its range (Ambrose 1983). At forested sites, common associate trees include Black Walnut, Common Hackberry, 'hard' maple (*Acer saccharum* or *A. nigrum*), Manitoba Maple (*A. negundo*) and, to a lesser extent, American Sycamore (*Platanus occidentalis*), ash species (*Fraxinus* spp.), and American Elm (*Ulmus americana*) (McClain and Jackson 1980; Mills and Craig 2008; Lance and Deacon pers. obs. 2019). A study conducted throughout the species' range in the U.S. found Common

Hackberry to be present at 62% of Kentucky Coffee-tree sites visited in both upland and lowland topography (Schmitz and Carstens 2018).

Habitat Trends

Although Kentucky Coffee-tree has probably been uncommon in Ontario's Carolinian forest for many decades, extensive deforestation has also occurred within the species' limited range in southwestern Ontario. Suitable habitat for Kentucky Coffee-tree in Canada is fragmented by a historical pattern of anthropogenic land clearing and settlement that, in some respects, continues to the present. Between 2000 and 2010, losses of overall natural cover were recorded in Essex County (31 ha), Chatham-Kent (376 ha), and Lambton County (45 ha), while Middlesex County gained 141 ha of natural cover (Carolinian Canada n.d.). Although many contemporary subpopulations occur on floodplain sites that are not often considered arable or accessible land and are sometimes afforded protection in planning policies, continued habitat loss is inferred from the net loss of natural cover in the species' range and the extirpation of one site (in Florence, Zone/Dawn Township) since the last status report (2000). At four subpopulations in Essex County the species persists as multi-stemmed clones along roadside ditches with little to no competition from other woody species. Owing to its shade intolerance and capacity to sucker readily, Kentucky Coffee-tree is adapted to withstand some amount of site disturbance if individuals are already present, but because seed dispersal and germination are infrequent the tree would have difficulty establishing at a new site.

Dramatic increases in Double-crested Cormorant (*Phalacrocorax auritus*) nesting on Lake Erie islands in the past three decades (Hebert *et al*. 2005, 2014) have had a marked impact on the quality of habitat for Kentucky Coffee-tree and other sensitive flora on these islands (Parks Canada Agency 2008; Environment Canada 2014). A negative relationship between cormorant nest density and forest cover has been demonstrated and cormorants were identified as being a primary factor in changes to island plant communities and soil chemistry (Hebert *et al*. 2005). Patterns of decline in forest cover at three Lake Erie islands differed but each saw a significant loss in habitat suitable for Kentucky Coffee-tree: between 2001 and 2010 forest cover declined at East Sister Island (54% to 17%) and Middle Sister Island (73% to 11%); on Middle Island forest cover declined from 1995 (88%) to 2006, stabilizing in 2009-2010 at 46% of total island area (Hebert *et al.* 2014). In 2008, Parks Canada began to implement the Middle Island Conservation Plan to manage the nesting cormorant population there through culling and other deterrents. From 2010 to 2016, LIDAR imagery showed an increase in dense forest cover, used as a measure of healthy forest (Dobbie *et al.* 2020). Although cormorant nest densities on Middle Island are still causing damage to forest canopy there is an overall improvement in tree health (branch damage and crown density) and a small reduction in tree mortality rates since management began in 2008 (Dobbie *et al.* 2020).

BIOLOGY

Kentucky Coffee-tree occurs naturally in Canada only in the Carolinian life zone of southwestern Ontario. It occurs as individual trees or in large clonal groups that dominate a particular site. Reproduction by seed occurs only rarely and the species spreads mainly by root suckers. Thus, most subpopulations probably represent single-sex clones. Little is known about the species' ecological role in Canada.

Life Cycle and Reproduction

Kentucky Coffee-trees can live more than 100 years (Row and Geyer 2014), reaching sexual maturity at 25-50 years. The species is usually dioecious, with male and female flowers occurring on separate trees (Herendeen *et al.* 2003; Zaya and Howe 2009). In Canada, reproduction of the natural population occurs only rarely by seed because many subpopulations contain only a single sex (Ambrose 1984; Environment Canada 2014) and are too far from other subpopulations for cross-pollination to occur. Most new stems arise from root suckers; these clonal individuals are known as *ramets*. Asexual reproduction of this kind allows younger stems to replace declining older stems where conditions are suitable; however, all ramets are genetically identical to the parent plant (composing a *genet*). Ramets appear to tolerate more shade than seedlings and often occur in partial shade (Environment Canada 2014).

Several subpopulations are known to have had fruit-bearing trees, although there is uncertainty regarding the viability of seed at some of these. The presence of pods alone cannot confirm sexual reproduction because female trees sometimes produce diminutive, seedless fruit (Ambrose 1984). Seven extant subpopulations are known or suspected to have reproduced sexually (Ambrose 1984; Environment Canada 2014; Lumb 2018).

The annual production of fruit on Kentucky Coffee-tree likely correlates with the degree to which a tree produced photosynthates through the course of a growing season, rather than stored resources (Janzen 1976). The seed coat is sufficiently hard to limit germination under contemporary natural conditions (Environment Canada 2014; Row and Geyer 2014). The length of time for which seeds remain viable is unknown. Pods are indehiscent and seeds may remain in the pods for several years until decay of the pod allows seed release. Scarified seed has been observed to remain dormant in potted soil for three years before germination occurred in the fourth year after production (Deacon pers. obs. 2017).

Physiology and Adaptability

Saplings form a large taproot in the first year of growth, which acts as an energy store for the tree in subsequent years. Trees with limited competition have been observed to grow as much as 1.5 m over the course of a single growing season making the species a vigorous colonizer of new canopy openings (McClain and Jackson 1980).

Kentucky Coffee-tree is well-adapted to both bottomland and upland habitats. Mature

trees can tolerate infrequent or brief flood events that may in turn assist with seed dispersal and deposition. The toxicity of the foliage and fruits deters mammals from browsing (Environment Canada 2014), which benefits the tree's fecundity but limits dispersal potential. Trees are also resistant to insects and pathogens (Zaya and Howe 2009). The stout terminal branching is somewhat resistant to wind and ice damage (Smith 1996; Row and Geyer 2014).

The tree can be readily propagated from root cuttings (Row and Geyer 2014; Schmitz and Carstens 2018; Lance pers. obs. 2019) or from seed after scarification by mechanical means or by acid solution (Wiesehuegel 1935; Ambrose pers. comm. 2020). A study of seed scarification and stratification techniques found that scarification using flame or compression had some success, while blunt force, prolonged immersion in water, mechanical scarification using a rock tumbler, and freeze-thaw trials did not result in germination (Lumb 2018).

Some trees grown from native seed source have been planted in Ontario with the intent of supplementing conservation efforts. Through the mid-1980s, Kentucky Coffee-trees were planted at some ERCA properties with the intention of producing viable seed to then disperse via watercourses (Waldron pers. comm. 2020). Today, sites such as Saint Joachim, Lakeshore have many row-planted trees bearing seed; however, recruitment throughout the larger area does not appear to be occurring (Deacon pers. obs. 2018).

The University of Guelph Arboretum maintains a collection of 87 trees grown from 26 wild Ontario provenances, including a gene bank seed orchard of 65 individuals that were field transplanted in the early 1990s (Fox 2012). Walpole Island First Nation (WIFN) has worked with the Sherwood Fox Arboretum at Western University to propagate trees for planting on Walpole Island, including 60 stems in 2007; seed production and germination is being studied and a database of occurrence information is being maintained (Government of Canada 2011).

Dispersal and Migration

The high proportion of agricultural lands in southern Ontario restricts the trees and their suitable habitat to natural corridors along watercourses and fragmented rural woodlots. As the fruit of Kentucky Coffee-tree is toxic to wildlife, present-day long-distance dispersal of Kentucky Coffee-tree relies largely on the flow of water in watercourses or ditches translocating seeds downstream. However, immigration is limited with this passive method of dispersal due to the generally low buoyancy of the pods and seeds, and their inability to germinate underwater (Zaya and Howe 2009; Lumb 2018; Schmitz and Carstens 2018).

Where fruiting trees are present, a reliance on natural scarification (gravelly riverbed or other means) is unlikely to facilitate a high proportion of seed germination due to the thick, hard coat. Active dispersal by humans is feasible where seeds can be collected, scarified, and dispersed directly to suitable habitats or propagated in a greenhouse for planting at select sites. Although treatments intended to break the seed coat using

sulphuric acid (Stilinovic and Grbic 1988) have proven effective, untreated seed shows a germination rate below 5% (Wiesehuegel 1935).

The popularity of Kentucky Coffee-tree in urban and rural street tree plantings has increased the dispersion of plant material across southern Ontario, most of unknown provenance. Horticultural cultivars are available in the United States (Row and Geyer 2014).

Interspecific Interactions

Kentucky Coffee-tree relies upon insect pollination where male and female trees are present (Ambrose 1983). The flowers, which are adapted to general insect pollination, emit a fragrance at night, attracting moths at night and bumble bees (*Bombus* spp.) at dusk (Ambrose and Kevan 1990). Given the general range of these pollinators, it is inferred that pollination between trees is feasible at a distance of up to 500 m (Ambrose and Kevan 1990). The toxicity of the foliage and seeds may act as a deterrent to pests and herbivory (Environment Canada 2014; Row and Geyer 2014).

The die-off of American Elm and ash species as a result of Dutch Elm Disease (*Ophiostoma ulmi*) and Emerald Ash Borer (*Agrilus planipennis*), respectively, has likely created canopy openings that can be exploited by Kentucky Coffee-trees. This change in site conditions may result in additional stems at some sites in response to increased access to sunlight.

Barlow (2000) and Zaya and Howe (2009) suggest that, historically, Kentucky Coffee-tree may have relied on large mammalian herbivores of the Miocene or Pleistocene epochs to scarify and disperse the hard-coated seeds. Given that the fruits are toxic to contemporary livestock, a surrogate mammal for adequately scarifying and dispersing seed is not known.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

For the purpose of this report, the report writers surveyed 15 known subpopulations in 2019 and 2020 with 38 hours of total search time, and attempted to visit an additional two but could not secure permission. Subpopulations were prioritized based on time since last observation, those that had discrepancies in the data, and those that were recommended by relevant documents to confirm reproductive status. Where past records were located, the number of stems was recorded in 10 cm diameter size classes. At subpopulations comprised only of small stems or ramets, individuals were fit into height classes in order to provide more detail than could be captured by a 10 cm diameter class. At sites where past records were not observed or there was a considerable amount of suitable habitat present, the sampling effort included area searches of habitat.

The subpopulation at Devonwood Conservation Area consists of a record of one tree approximately 15 cm diameter-at-breast-height (DBH) in 1977, not reported since that time. In 2019, the area around that record was visually searched by the report writers for one hour, radiating outward from the record in case coordinates were coarse from 1977. Following that, a visual search of the remaining forest was conducted from the footpath through the conservation area (three hours total search effort). If present, that tree could now be quite large and conspicuous; because no Kentucky Coffee-tree was observed but an occurrence might still be confirmed to exist with additional survey efforts, it has been classified 'failed to find' (see Hammerson *et al*. 2008).

Species data are a collection of field records from targeted surveys or incidental observations (see **Search Effort)**. Abundance data for subpopulations are usually in the form of a comprehensive count of Kentucky Coffee-tree stems at a given site, although disparities exist in how stem counts and sizes are reported. Securing permissions to access private lands and the feasibility of accessing Lake Erie island subpopulations are barriers to a full account of the species in Canada.

Abundance

Most abundance data are reported using DBH to classify tree size; trees with a DBH ≥20cm were considered mature. Forty subpopulations have been documented in Canada, of which 34 are considered extant or presumed extant. Within these 34 subpopulations it is estimated that there are approximately 429-527 mature trees. Following manipulated population guidelines (COSEWIC 2018) the number of mature individuals does not include planted trees of unknown origin. Four subpopulations may contain a single mature individual, and four have no mature individuals.

Fluctuations and Trends

Recent observations in or near two subpopulations previously thought to be extirpated (Environment Canada 2014) warranted their re-classification to extant (Bear Creek, Mitchell's Bay, Dover Township; Florence, Zone/Dawn Township). Records were updated for two historical subpopulations that are now extant or presumed extant (North Harbour Island, Lake Erie; Sydenham River, Wallaceburg, Sombra Township). One historical subpopulation has been reclassified 'failed to find' (Devonwood Conservation Area) after a thorough search of the site in 2019 resulted in no observations. One new subpopulation (Canard River, LaSalle) and six new translocated population components are included in this assessment. At the time of this assessment, 34 subpopulations are considered extant or presumed extant, compared to 23 in the last recovery strategy, which did not consider manipulated population components (Environment Canada 2014).

The latest federal recovery strategy (Environment Canada 2014) estimates that there are fewer than 500 genetically-distinct mature trees. This estimate is complicated by three factors: (i) No consensus has been reached for how to define a mature Kentucky Coffee-tree. Sexual maturity may be reached while a tree is comparatively small, but with a species that seldom reproduces sexually it is difficult to make that distinction. (ii) Field

observations cannot provide much certainty in determining genetic distinctness. Inferences can be made based on site characters and relative position, growth pattern, observable site history (e.g., evidence of past cutting), but interpretations may differ between observers. (iii) Manipulated population components (i.e., planted sites) are now being included (see **Canadian Range**). Abundance data for such components may not be complete.

For the sake of identifying trends, mature trees from the 34 extant and presumed extant subpopulations have been estimated at 429-527. No attempt to distinguish between genetically-distinct trees has been made. Therefore, depending on the assumptions made in preparing the recovery strategy, there is not a discernible change in the number of mature trees in the Canadian population. However, the addition of manipulated population components likely obscures the loss of mature individuals, both directly observed and unobserved. Over the coming decades, as supplemental plantings for conservation purposes become mature, this estimate may increase.

Rescue Effect

It is unlikely that propagules from the Kentucky Coffee-tree population in the United States could migrate to Canada to mitigate an overall population decline or the extirpation of Canadian subpopulations. The only known mode of contemporary natural dispersal is flowing water (Zaya and Howe 2009). While sufficient suitable habitat exists in Canada, it is improbable that seed or root fragments from the United States population could reach these habitats. First, the Canadian population is separated from the United States population by the Great Lakes and associated major rivers (i.e., the St. Clair and Detroit rivers); the pods of Kentucky Coffee-tree are not very buoyant and the seeds do not germinate under water and have been shown to sink after prolonged immersion (Zaya and Howe 2009). Therefore, seed would have difficulty in crossing natural barriers that separate the Canadian and United States populations. Second, the hard seed coat is difficult to break in order to allow for germination (Schmitz and Carstens 2018).

THREATS AND LIMITING FACTORS

Threats

The threats classification for Kentucky Coffee-tree in Canada is based on the IUCN-CMP (International Union for Conservation of Nature–Conservation Measures Partnership) unified threats classification system (Salafsky *et al*. 2008; Master *et al.* 2012) and follows a threats calculator exercise involving members of COSEWIC's Vascular Plant Specialist Subcommittee and other stakeholders (Appendix 1). The following discussion is based on available literature, direct field observations, and an assessment in the federal recovery strategy (Environment Canada 2014). The assigned overall threat impact is High, owing mostly to threats from fire suppression, high densities of cormorant nesting on Lake Erie islands, and the possibility of prolonged flooding in subpopulations on islands or at shorelines of lakes Erie and St. Clair (Appendix 1). The numbers associated with the threats correspond to the IUCN threat numbers and the threat calculator and are arranged in order of severity.

Threat 7. Natural System Modification (High-Medium impact)

7.1 Fire and fire suppression (High-Medium impact)

Alteration of the fire regime, through fire suppression, can contribute to forest succession leading toward closed-canopy conditions not optimal for Kentucky Coffee-tree growth. This may cause local extirpation of Kentucky Coffee-tree by preventing seedling establishment and ramet growth (White and Oldham 2000; Environment Canada 2014). Conversely, the role of forest fire as a scarifying agent is not well understood but may benefit the germination of viable seed (Environment Canada 2014). This threat is calculated as the most significant, potentially impacting 23 locations across a fragmented landscape, resulting in a pervasive (71-100%) scope. However, the variable ownership/management results in a large range in projected severity.

7.3 Other ecosystem modifications (Medium-Low impact)

This threat is calculated as medium to low impact and considers various modifications. The most likely threat to Kentucky Coffee-tree is that individuals could be removed by private landowners for agricultural or other reasons. Although not perceived to be a major threat to Kentucky Coffee-tree regeneration in Canada, the proliferation of invasive non-native species in floodplain habitat in southern Ontario such as Dog-strangling Vine (*Vincetoxicum rossicum* and *V. nigrum*), Garlic Mustard (*Alliaria petiolata*), and Dame's Rocket (*Hesperis matronalis*) may limit Kentucky Coffee-tree regeneration through competition, shading and allelopathy. A declining trend in pollinator populations could further limit cross-pollination potential. Conversely, canopy openings created by recent mortality in ash trees due to Emerald Ash Borer may benefit Kentucky Coffee-tree. This is the primary threat for two locations on private lands, which have experienced significant removals in recent years (Paquette and Lukerville; Texas Road, Anderdon Township).

Threat 8. Invasive and other Problematic Species and Genes (Medium impact)

8.2 Problematic native species (Medium impact)

The large population of Double-crested Cormorant in the western basin of Lake Erie threatens some island subpopulations due to defoliation from nesting and roosting, and the ammonium-rich guano that can acidify soils and be detrimental to vegetation (Hebert *et al*. 2005). This threat is documented to have impacted one location composed of the subpopulations at Middle Island, Middle Sister Island, and East Sister Island. A study to assess cormorant impacts on forest health on these islands documented a decline in tree canopy, including previously healthy stands of Kentucky Coffee-tree (Hebert *et al.* 2005). This study inferred that cormorants prefer stable, live trees within which to build nests, thus impacted areas of Kentucky Coffee-tree are subject to change from year to year as healthy trees are sought. A preference to build nests in tall trees puts mature Kentucky Coffee-tree at heightened risk of being impacted. Defoliation seems to impact the likelihood of germination of seeds borne on defoliated branches (Janzen 1976).

Beginning in 2008, Parks Canada has actively managed cormorant nesting on Middle Island which has resulted in a significant reduction in the loss of healthy forest canopy (Parks Canada Agency 2016). Forest cover has not stabilized at East Sister or Middle Sister islands where nest densities may have increased around the time that management at Middle Island began (Hebert *et al*. 2014). East Sister has been described as the largest subpopulation (Environment Canada 2014) but loss of mature trees has been inferred here (Gould pers. comm. 2020).

8.3 Introduced genetic material (Unknown impact)

Kentucky Coffee-tree is a popular ornamental tree of urban parklands and streetscapes because of its hardiness and relatively rapid growth rate. The genetic sources of these planted stocks are often unknown and when the trees mature, their genetic material may spread into the native Canadian population, thereby diluting the local gene pool. The likelihood of this, however, is diminished by the species' dioecy, distances between ornamental and native individuals, and the observed low germination rates without scarification.

More likely to introduce genetic material to native subpopulations are reintroductions or supplemental planting for conservation purposes. Such projects are sometimes regulated and often performed by conservation groups that would favour local plant material. The known supplemented subpopulations are at Canard River Floodplain, where significant planting efforts have taken place, and Wilkesport, Sombra Township where a small number of trees have been planted in a lawn near the natural site. The widespread belief is that local material is the best source for plantings because it is genetically adapted to local biophysical conditions (Environment Canada 2014), but that may need to be re-evaluated in light of forecasted climatic changes. If supplemental planting were to result in an observed decrease in the average fitness of individuals, that would constitute a net negative impact to the species and may result in the exclusion of certain manipulated population components (COSEWIC 2018).

<u>Threat 11. Climate Change and Severe Weather (Medium impact)</u>

11.4 Storms and flooding (Medium impact)

Individual Kentucky Coffee-trees have been shown to be very susceptible to mortality from heavy and prolonged flooding (Yin *et al.* 1994). While collecting seed pods in various parts of the United States range, Schmitz and Carstens (2018) noted that 82% of the trees sampled in floodplain habitats were restricted to very well-drained soils. The species is only able to withstand infrequent flooding of rather short duration (McClain and Jackson 1980). Lake Erie water levels have been high in recent years and this prolonged flood condition may cause further mortality at East Sister Island and the other Lake Erie islands, which are low and flat (Bershatsky pers. comm. 2020). Similarly, high lake levels have been observed recently at Bear Creek, Mitchell's Bay, Dover Township (Woodliffe pers. comm. 2019). This threat is the primary threat for two locations (North Harbour Island; Bear Creek, Mitchell's Bay, Dover Township).

11.2 Droughts (Low impact)

Kentucky Coffee-tree is adapted to a range of soil conditions, as shown by the literature and its adaptability to urban conditions. Additionally, its general position in Canadian subpopulations in lowland areas means that whatever water is available will be nearby. On Middle Island, there was a serious drought but its effect was eclipsed by the high abundance of cormorants and thus very difficult to estimate. Water stress (e.g., leaf loss) was observed.

Other threats calculated as low impact include:

4.1 Roads and railroads

Roadside sites could be impacted by infrastructure projects. An example is the permitted removal of a small number of Kentucky Coffee-tree that were determined to be planted and from unknown genetic stock, in relation to the construction of the Detroit River International Crossing project in Windsor, Ontario (Government of Ontario 2010).

4.2 Utility and Service Lines

Kentucky Coffee-tree subpopulations along roadside ditches may be subject to periodic cutting by road maintenance or line clearance crews. Two of the roadside locations visited in Essex County in 2019 appear to have been cut back due to infrastructure maintenance or encroachment on agricultural land, and it is reported that “mature trees” were lost from Paquette between 2016-2017 (Lumb 2018), but more details are not known.

5.3 Logging and wood harvesting

Kentucky Coffee-tree is generally not a targeted species for silvicultural operations but can be inadvertently taken or damaged by selective logging. Aerial imagery suggests that trees from Florence, Zone/Dawn Township were taken by the clear cutting of a forested parcel between 2011 and 2016. Field observations in 2019 found damage from harvesting activities to three mature trees at a forested subpopulation, even with a landowner amenable to conservation of Kentucky Coffee-tree (Lance and Deacon pers. obs. 2019).

Limiting Factors

Sexual Reproduction

The main limiting factor for Kentucky Coffee-tree in Canada is limited success in sexual reproduction, which is hindered by the fact that many subpopulations are composed of one or more genets that lack either male or female flowers. The fragmentation of suitable habitat and the large distances between subpopulations of single trees or small groves make cross-pollination difficult (Zaya and Howe 2009; Environment Canada 2014). The inability to outcross genetic material between subpopulations/locations has resulted in

single-sex stands of genetically identical trees (Environment Canada 2014). Although Kentucky Coffee-tree reproduces vigorously by vegetative means, only seven subpopulations in Canada are known or suspected to have had sexual reproduction. The presence of pods does not alone indicate viable seed.

Seed Dispersal

It has been inferred that the extinction of large prehistoric mammals, likely responsible for scarifying and dispersing seed, limited the ability of Kentucky Coffee-tree to reproduce sexually (Barlow 2000; Zaya and Howe 2009).

Seed pods have been observed to float in water for a brief period before sinking (Zaya and Howe 2009; Schmitz and Carstens 2018), suggesting that dispersal via watercourses is likely limited to movement over a relatively short distance during spring flooding. Because many subpopulations consist of a single-sex clone (Ambrose 1984) with few opportunities for out-breeding, there is very limited genetic diversity in the Canadian population (Ambrose and Carey 1987). Several subpopulations consist of roadside or fencerow trees that may have limited long-term viability and few chances to repopulate a natural habitat.

Number of Locations

Because four subpopulations may contain only a single mature individual, and four have no mature individuals, these may not be considered viable. Therefore, a range of 28-35 locations is proposed from among the extant and presumed extant subpopulations of this species. Historical, 'failed to find' and extirpated subpopulations have not been assigned locations.

The threat calculated to have the greatest impact (high to medium) is fire suppression and resultant canopy closure. Because of the fragmented distribution of subpopulations and variable nature of forest management decisions from one landowner to another, it was determined that fire suppression is the most plausible threat for 23 locations.

On Middle, East Sister, and Middle Sister Islands cormorant populations are creating canopy openings, so fire suppression is not the primary threat. Here, the defoliating action of nesting birds and the changes in soil chemistry from guano deposition present the greater threat (medium impact). These island subpopulations have been grouped into one location. North Harbour Island, however, is a privately owned, manicured site where canopy closure is not a threat and cormorant nesting has not been reported. This is counted, along with Bear Creek, Mitchell's Bay, Dover Township, as two locations where prolonged flooding is the most plausible threat (medium impact).

At two privately owned locations the most plausible threat is ecosystem modification, with a medium to low impact to the Canadian population. These locations are non-forested, inland sites where canopy closure or impacts from cormorants and flooding are not likely. The most likely threat is removal by landowners.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Ontario, the species is designated as Threatened by the Ontario Ministry of Environment, Conservation and Parks. General Habitat Protection came into effect under the *Endangered Species Act*, 2007 (ESA) on June 30, 2013. The individuals on Middle Island and the mainland portion of Pt. Pelee National Park are also protected by the *Canada National Parks Act*. The provincial recovery strategy (OMNRF 2017) adopted the federal recovery strategy (Environment Canada 2014) and recommended that the federal approach used to identify critical habitat be considered, along with new relevant scientific information, when developing a habitat regulation under the ESA. This approach identified critical habitat based on habitat suitability and site occupancy, and defines a site as a boundary drawn at a radial distance of 20 m around a known observation of a native extant Kentucky Coffee-tree (Environment Canada 2014).

The species is designated as Threatened under Schedule 1 of the federal *Species at Risk Act* (SARA). The critical habitat on Middle Island is protected as per subsection 58(1a) of SARA as these are federal lands (Parks Canada Agency 2015).

Non-Legal Status and Ranks

Kentucky Coffee-tree is considered globally Secure (G5) and nationally Secure (N5?) in the United States in the 32 states where it is reported, it is Unranked (SNR) in 16 states, and considered exotic (SNA) in four others (NatureServe 2019). In Canada, it is ranked Imperilled nationally (N2) and within Ontario (S2) (NHIC 2020). It is rare in each county where natural subpopulations occur (Oldham 2017).

Habitat Protection and Ownership

Of the extant and presumed extant subpopulations of Kentucky Coffee-tree, 17 (50%) are on privately owned lands; eight (24%) are on lands owned and managed by Conservation Authorities, including most of the manipulated population components; four (12%) are on federal lands, two managed by Parks Canada and two at Walpole Island First Nation; four (12%) are on lands known or suspected to be owned by municipalities (two of these may be in road rights-of-way); and one (2%) is managed by the Ontario Ministry of Natural Resources and Forestry (East Sister Island). Two of those listed under Conservation Authority ownership comprise more than one site, so there are parts of those extant subpopulations that are privately owned.

ACKNOWLEDGEMENTS

The report writers would like to thank all those that shared their expertise (see **Authorities Contacted**) and personal observations, especially Donald Craig and Allen

Woodliffe. Dan Lebedyk and Rob Davies from Essex Region Conservation Area, Tim Payne from St. Clair Region Conservation Area, and Mark Brown from Middlesex County were helpful in providing information and permissions with which to plan fieldwork. Similarly, our appreciation goes to each of the private landowners that generously allowed us access to their properties and shared their knowledge and memories. Many thanks are due to Scott Lumb, who shared with us details about his thesis research and fieldwork, to the benefit of this report.

Several reviewers have improved this report through their comments and participation in the threat calculations: Bruce Bennett, Vivian Brownell, Dan Brunton, Karen Samis (Vascular Plants Specialist Subcommittee); Michael Oldham, Colin Jones, Ken Elliott, Sam Brinker (Ontario Ministry of Natural Resources and Forestry); Eric Snyder (Ontario Ministry of Environment, Conservation and Parks); Marie Archambault, Ken Tuininga, Syd Cannings (Canadian Wildlife Service); Tammy Dobbie (Parks Canada); Dan Kraus (COSSARO).

Jana Vamosi provided invaluable guidance in the design of fieldwork and approach taken with the status report update, and Jessica Linton's editing and insight were indispensable. Jeff Carstens provided the data needed to prepare Figure 2; Kaitlin Filippov helped with data management and preliminary mapping; and Sydney Allen very graciously prepared mapping and EOO/IAO calculations. Photographs by Patrick Deacon.

AUTHORITIES CONTACTED

Name	Title	Affiliation
John Ambrose	Former Curator	University of Guelph Arboretum
Jeffrey Carstens	Agricultural Science Research Technician (Plants)	United States Department of Agriculture
Donald Craig	Registered Professional Forester	formerly of St. Clair Region Conservation Authority
Rob Davies	Forester	Essex Region Conservation Authority
Christina Davy	Wildlife Research Scientist, Species at Risk	Ontario Ministry of Natural Resources and Forestry
Tammy Dobbie	Park Ecologist, Point Pelee National Park	Parks Canada Agency
Jennifer Doubt	Curator, Botany	National Herbarium of Canada, Canadian Museum of Nature
Sean Fox	Manager of Horticulture/Curator	The Arboretum, University of Guelph
Judith Girard	Acting Head, Wildlife Biologist, Conservation Planning Unit	Canadian Wildlife Service
Henrik Hoyer	Retired General Superintendent	Essex Region Conservation Authority

Name	Title	Affiliation
Clint Jacobs	President	Walpole Island Land Trust
Jarmo Jalava	Chair	Carolinian Woodland Plants Recovery Team
Colin Jones	Provincial Arthropod Zoologist	Ontario Natural Heritage Information Centre
Ashley Kling	Senior Science Advisor	Fisheries and Oceans Canada
Dan Lebedyk	Biologist/Ecologist	Essex Region Conservation Authority
Scott Lumb	Forest Planner	First Resource Management Group Inc.
Rachel McDonald	Senior Environmental Advisor	Department of National Defence, Government of Canada
Arne Mooers	Professor	Simon Fraser University
Michael Oldham	Provincial Botanist	Ontario Natural Heritage Information Centre
Tim Payne	Manager of Forestry	St. Clair Region Conservation Authority
Ben Porchuk	Ecologist	Carolinian Canada Coalition
Shelley Pruss	Ecosystem Scientist III	Parks Canada Agency
Jana Vamosi	Professor, Department of Biological Sciences	University of Calgary
Gerry Waldron	Ecologist and Consultant	--
David White	Retired Biologist and Life Science Consultant	--
Allen Woodliffe	Retired Ecologist	Ontario Ministry of Natural Resources and Forestry
Jenny Wu	Scientific Project Officer, COSEWIC Secretariat	Canadian Wildlife Service

INFORMATION SOURCES

Abrams, M. and G. Nowacki. 2008. Native Americans as active and passive promoters of mast and fruit trees in the eastern USA. The Holocene 18(7):1123-1137.

Ambrose, J.D. 1983. Status report on the Kentucky Coffee-tree (*Gymnocladus dioica*) in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Canadian Wildlife Service, Ottawa. Unpublished report. 27 pp.

Ambrose, J.D. 1984. Why is Kentucky Coffee-tree rare in Canada? The Plant Press 2: 70-71.

Ambrose, J.D. and C.K. Carey. 1987. *Gymnocladus dioica* in Canada: the biology of a rare tree at its northern limits of distribution. XIV International Botanic Congress, Berlin, Germany (poster).

Ambrose, J.D. and P.G. Kevan. 1990. Reproductive biology of rare Carolinian plants with regard to conservation management. Pp 57-63. *in* G.M. Allen, P.F.J. Eagles and S.D. Price (eds.). Conserving Carolinian Canada, University of Waterloo Press, Waterloo, Ontario.

Ambrose, J.D. 2020. *Personal communications with Barb Boysen*, June 2020. Former Curator, University of Guelph Arboretum, Guelph, Ontario.

Barlow, C. 2000. The Ghosts of Evolution: Nonsensical fruit, missing partners, and other ecological anachronisms. Basic Books, New York. 304 pp.

Bershatsky, J. 2020. *Personal communications with J. Lance*, June 2020. Assistant Ecologist – Southwest Zone, Ontario Parks, London, Ontario.

Boerner, R.E.J. 1984. Forest composition on the Lake Erie Islands. The American Midland Naturalist 111(1):173-184.

Carolinian Canada. (n.d.). Big Picture Report Card Discussion Paper. Website: https://caroliniancanada.ca/sites/default/files/File%20Depository/Big%20Picture%20RC/CC-Big-Picture-Report-Card-Discussion-Paper-Apr-2015.pdf [accessed June 27, 2020].

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2018. COSEWIC Guidelines on Manipulated Wildlife Species. Approved by COSEWIC in November 2018. Website: http://cosewic.ca/index.php/en-ca/reports/preparing-status-reports/guidelines-manipulated-wildlife-species [accessed June 8, 2020].

Craig, D. 2019. *Personal communications with J. Lance*, October 2019. Registered Professional Forester, formerly of the St. Clair Region Conservation Authority.

Day, G.M. 1953. The Indian as an ecological factor. Ecology 34:329-46.

Dobbie, T., M. McCloskey, T. Degazio, and C. Lawrence. 2020. Draft Point Pelee National Park of Canada Middle Island Conservation Plan Summary Report, 2008-2017. Parks Canada Agency, Ottawa. Unpublished report. vii + 55 pp.

Dodge, C.K. 1914. Annotated List of Flowering Plants and Ferns of Point Pelee, Ont., and Neighbouring Districts. Canada Department of Mines, Ottawa, Ontario, Canada. 131 pp.

Dougan & Associates. 2007. Detailed Assessments for Plant Species at Risk. Prepared for Parks Canada Agency, Point Pelee National Park, Leamington, Ontario. 511 pp.

Elliot, K. 2020. *Personal communications with J. Lance: Review Comments on the Draft COSEWIC Status Report for Kentucky Coffee-tree*, February 2020. Integration Branch, Ontario Ministry of Natural Resources and Forestry.

Environment Canada. 2014. Recovery Strategy for the Kentucky Coffee-tree (*Gymnocladus dioicus*) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vi + 36 pp.

Essex Region Conservation Authority (ERCA). 2002. Essex Region Biodiversity Conservation Strategy - Habitat Restoration and Enhancement Guidelines (Comprehensive Version). Dan Lebedyk, Project Co-ordinator. Essex, Ontario. 181 pp.

Farrar, J.L. 1995. Trees in Canada. Fitzhenry and Whiteside Ltd. and Canadian Forest Service, Markham, Ontario. 502 pp.

Fox, S. 2012. Picking Up the Pawpaws: The Rare Woody Plants of Ontario Program at the University of Guelph Arboretum. Arnoldia 69(3):2-13.

Gould, R. 2020. *Personal communications with Tammy Dobbie*, January 2020. Protected Areas Specialist—Southwest Zone, Ontario Parks, London, Ontario.

Government of Canada. 2011. Species Profile: Kentucky Coffee-tree. Website: https://wildlife-species.canada.ca/species-risk-registry/species/speciesDetails_e.cfm?sid=222 [accessed May 28, 2020].

Government of Ontario. 2010. Permit under clause 17(2)(d) of the *Endangered Species Act*, 2007 (ESA 2007) to allow impact to one endangered species (Eastern Foxsnake) and seven threatened species (Butler's Gartersnake, Dense Blazing Star, Willowleaf Aster, Colicroot, Dwarf Hackberry, Common Hoptree, Kentucky Coffee-tree) during construction of Windsor-Essex Parkway portion of Detroit River International Crossing (DRIC) Project. Website: https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTA3NTMx&statusId=MTYxNDQ3&language=en [accessed June 29, 2020].

Hammerson, G. A., D. Schweitzer, L. Master, and J. Cordeiro. 2008. Ranking species occurrences – a generic approach. NatureServe Explorer. Website: https://www.natureserve.org/sites/default/files/eo_rank_specifications-generic_guidelines_and_decision_key_05.08.2020.pdf [accessed June 29, 2020].

Hebert, C. E., J. Duffe, D.V.C. Weseloh, E.M.T. Senese, and G.D. Haffner. 2005. Unique island habitat may be threatened by Double-crested Cormorants. Journal of Wildlife Management 69(1):68-76.

Hebert, C.E., J. Pasher, D.V.C Weseloh, T. Dobbie, S. Dobbyn, D. Moore, V. Minelga, and J. Duffe. 2014. Nesting cormorants and temporal changes in island habitat. Journal of Wildlife Management 78(2):307-313.

Herendeen, P.S., P.L. Gwilym, and A. Bruneau. 2003. Floral morphology in Caesalpinioid legumes: testing the monophyly of the "*Umtiza* Clade". International Journal of Plant Sciences 164(5 suppl.): S393-S407.

Hoyer, H. 2020. *Personal communications with J. Lance*, June 2020. Formerly General Superintendent, Essex Region Conservation Authority.

IUCN Standards and Petitions Committee. 2019. Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. Website: https://www.iucnredlist.org/resources/redlistguidelines [accessed June 25, 2020].

Jacobs, C. 2012. *Personal communications with Environment Canada*. Natural Heritage Coordinator, Walpole Island Heritage Centre. Cited in Environment Canada 2014.

Jalava, J.V., P.L. Wilson, and R.A. Jones. 2008. COSEWIC-designated Plant Species at Risk Inventory, Point Pelee National Park, including Sturgeon Creek Administrative Centre and Middle Island, 2007, Volume 1: Summary Report & Volume 2: Managed Area Element Status Assessments. Prepared for Parks Canada Agency, Point Pelee National Park, Leamington, Ontario. Vol. 1 vii + 126 pp., Vol. 2 ii + 103 pp.

Janzen, D. H. 1976. Effect of defoliation on fruit-bearing branches of the Kentucky coffee tree, *Gymnocladus dioicus* (Leguminosae). The American Midland Naturalist 95(2):474-478.

Kartesz, J.T., The Biota of North America Program (BONAP). 2015. *North American Plant Atlas.* (http://bonap.net/napa). Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)].

Lewis, W.H. and M.P.F. Elvin-Lewis. 1977. Medical Botany: Plants affecting man's health. John Wiley & Sons, New York.

Limbird, A., E. Hamilton and D. Preston. 1980. Soil-site characteristics of Kentucky coffeetree (*Gymnocladus dioica*) communities near Lake Erie. Canadian Field-Naturalist 94(2):139-147.

Lumb, S. 2018. Population genetics and scarification requirements of *Gymnocladus dioicus*. Unpublished M.Sc. Thesis. Trent University, Peterborough, Ontario, Canada. viii + 91pp.

Lumb, S. 2019. *Personal communications with Joseph Lance,* July 2019. Forest Planner, First Resource Management Group Inc., New Liskeard, Ontario.

Macoun, J. 1893. Notes on the Flora of the Niagara Peninsula and Shores of Lake Erie. Journal and Proceedings of the Hamilton Association 9:78-86.

Master, L.L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, and A. Tomaino. 2012. NatureServe conservation status assessments: factors for evaluating species and ecosystems at risk. NatureServe, Arlington, VA. Website: http://www.natureserve.org/sites/default/files/publications/files/natureserveconservationstatusfactors_apr12_1.pdf [accessed June 29, 2020].

McClain, L. M., and M.T. Jackson. 1980. Vegetational associates and site characteristics of Kentucky Coffeetree, *Gymnocladus dioicus* (L.). K. Koch. Proceedings of the Third Central Hardwood Forest Conference, University of Missouri, Columbia (H. E. Garrett and G.S. Cox, eds.), pp. 239-256.

Mills, C. and D. Craig. 2008. Woodland Species at Risk Inventory in the St. Clair Region Conservation Authority. St. Clair Conservation, March 2008.

Natural Heritage Information Centre (NHIC). 2010. NHIC Biotics Database. NHIC, Ontario Ministry of Natural Resources, Peterborough, Ontario. [accessed: July 30, 2010].

Natural Heritage Information Centre (NHIC). 2019a. *EOs_KentuckyCoffeetree* provided by the Ontario Ministry of Natural Resources and Forestry, Copyright Queen's Printer for Ontario [April 1, 2019].

Natural Heritage Information Centre (NHIC). 2019b. *Obs_KentuckyCoffeetree* provided by the Ontario Ministry of Natural Resources and Forestry, Copyright Queen's Printer for Ontario [May 16, 2019].

Natural Heritage Information Centre (NHIC). 2020. Vascular Plant Species List. Created January 17, 2020. Website: https://www.ontario.ca/page/get-natural-heritage-information [accessed June 29, 2020].

NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life. Version 7.1. NatureServe, Arlington, Virginia. Website: http://explorer.natureserve.org [accessed October 27, 2019].

Oh, C.H., T.J. Mabry, K.R. Kim, and J.H. Kim. 1995. GC–MS analysis of nonprotein amino acids in *Gymnocladus dioica* as N (O, S)-isobutyloxycarbonyl silyl derivatives. Journal of Chromatographic Science 33: 399–404.

Oldham, M.J. 2017. List of the Vascular Plants of Ontario's Carolinian Zone (Ecoregion 7E). Carolinian Canada and Ontario Ministry of Natural Resources and Forestry. Peterborough, ON. 132 pp.

Ontario Ministry of the Environment, Conservation and Parks (MECP). 2018. Kentucky Coffee-tree: Ontario Government Response Statement. Website: https://www.ontario.ca/page/kentucky-coffee-tree-government-response-statement [accessed June 30, 2020].

Ontario Ministry of Natural Resources and Forestry (OMNRF). 2017. Recovery Strategy for the Kentucky Coffee-tree (*Gymnocladus dioicus*) in Ontario. Ontario Recovery Strategy Series. Prepared by the Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario. v + 6 pp. + Appendix.
Parks Canada Agency. 2008. Middle Island Conservation Plan. Parks Canada Agency, Ottawa. 44 pp.

Parks Canada Agency. 2015. Description of critical habitat of Kentucky Coffee-tree, in Point Pelee National Park of Canada. Canada Gazette, Part I 149(7). Published by the Queen's Printer for Canada, February 14, 2015.

Parks Canada Agency. 2016. Multi-species Action Plan for Point Pelee National Park of Canada and Niagara National Historic Sites of Canada. *Species at Risk Act* Action Plan Series. Parks Canada Agency, Ottawa. iv + 39 pp.

Parks Canada Agency. 2017. Middle Island Species at Risk Tree Survey 2012 & 2017 [Unpublished data]. Provided January 2020 by Tammy Dobbie, Park Ecologist-Species at Risk and Greater Park Ecosystem, Point Pelee National Park, Leamington, Ontario.

Plants of the World Online (POWO). 2019. *Gymnocladus* Lam. Published online by the Royal Botanic Gardens, Kew. Website: http://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:22537-1 [accessed June 29, 2020].

Reidhead, V.A. 1984. A reconstruction of the presettlement vegetation of the middle Ohio Valley region. pp. 385-417, *in* P.J. Munson, (ed). Experiments and observations on Aboriginal wild plant food utilization in eastern North America, Indiana Historical Society.

Rosenthal G.A. 1991. Nonprotein amino acids as protective allelochemicals. Pp 1-34, *in* G.A. Rosenthal and M.R. Berenbaum (eds). Herbivores: their interactions with secondary plant metabolites. The chemical participants, vol 1, 2nd ed. Academic Press, New York.

Row, J.M. and W. Geyer. 2014. Plant Guide: Kentucky Coffee Tree. United States Department of Agriculture. Website: https://plants.sc.egov.usda.gov/plantguide/pdf/cs_gydi.pdf [accessed June 5, 2020].

Saha, D., D. Ved, K. Ravikumar, and K. Haridasan, 2015. *Gymnocladus assamicus*. The IUCN Red List of Threatened Species 2015: e.T50126611A50131355. Website: https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T50126611A50131355.en [accessed June 29, 2020].

Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology 22:897-911.

Schmitz, A. and J. Carstens. 2018. Exploring the Native Range of Kentucky Coffeetree. Arnoldia 76(1):2-16.

Scoggan, H.J. 1978-1979. Flora of Canada. 4 parts. Publications in Botany 7. National Museum of Natural Sciences, Ottawa, Ontario.

Stilinovic, S. and M. Grbic. 1988. Effect of various presowing treatments on the germination of some woody ornamental seeds. Acta Horticulturae 226:239-246.

United States Department of Agriculture (USDA). 2007. Plant Guide: Kentucky Coffee-tree. USDA Natural Resources Conservation Service, Plant Materials Center, Manhattan, Kansas & Kansas State University, Research Forestry. 6 pp.

United States Geological Survey (USGS). 1999. Digital representation of "Atlas of United States Trees" by Elbert L. Little, Jr. Reston, Virginia: US Geological Survey. Provided by Jeffrey Carstens, USDA.

Waldron, G. 2003. Trees of the Carolinian Forest. Boston Mills Press, Erin, Ontario. 275 pp.

Waldron, G. 2020. *Personal communications with J. Lance*, June 2020. Consulting Ecologist, former Carolinian Woodlands Recovery Team member.

Weisehuegel, E.G. 1935. Germinating Kentucky coffee tree. Journal of Forestry 33:533-534.

White, D.J. and M.J. Oldham. 2000. Update COSEWIC status report on the Kentucky coffee-tree, *Gymnocladus dioicus* in Canada, in COSEWIC assessment and update status report on the Kentucky Coffee-tree *Gymnocladus dioica*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-11 pp.

White, J. H. 1968. The Forest Trees of Ontario and the More Commonly Planted Foreign Trees. Ontario Department of Lands and Forests, Toronto. 119 pp.

Wilken, E. B. 1986. Terrestrial ecozones of Canada. Ecological Land Classification series. No 19. Lands Directorate, Environment Canada. Ottawa, Ontario. 26 pp.

Woodliffe, A. 2019. *Personal communications to Joseph Lance*, October 2019. Formerly Ecologist, Ontario Ministry of Natural Resources and Forestry.

Yin, Y., J. C. Nelson, G. V. Swenson, H. A. Langrehr, and T. A. Blackburn. 1994. Tree mortality in the Upper Mississippi River and floodplain following an extreme flood in 1993. pp. 4160, *in* Long Term Resource Monitoring Program 1993 Flood Observations. National Biological Service, Environmental Management Technical Center Report LTRMP 94-S011, Onalaska, Wis. 190 pp.

Zaya, D. N. and H. F. Howe. 2009. The anomalous Kentucky coffeetree: Megafaunal fruit sinking to extinction? Oecologia 161(2):221-226.

BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Joseph M. Lance is a consulting biologist with five years of experience conducting tree and forest inventories, and a Certified Arborist from the International Society of Arboriculture. He holds a Bachelor of Environmental Studies in Geography from the University of Waterloo.

Patrick W. Deacon is a consulting biologist with over 12 years of experience conducting botanical inventories throughout Ontario and western Canada. He holds a Bachelor of Environmental Studies in Environment and Resource Studies from the University of Waterloo.

COLLECTIONS EXAMINED

No collections were examined in preparation of this report.

Appendix 1. Threats calculation on Kentucky Coffee-tree.

Species or Ecosystem Scientific Name	*Gymnocladus dioicus*			
Element ID		**Elcode**		
Date:	02/01/2020			
Assessor(s):	Joseph Lance (report writer), Dwayne Lepitzki (facilitator), Tammie Dobbie (Point Pelee National Park), Dan Brunton (SSC), Vivian Brownell (SSC), Angele Cyr (COSEWIC Secretariat), Patrick Deacon (report writer), Jana Vamosi (VP SSC Co-Chair), Bruce Bennett (SSC)			
References:	Draft COSEWIC Status Report on Kentucky Coffee-tree (2019) by Joseph Lance and Patrick Deacon			
	Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	1	0
	C	Medium	2	3
	D	Low	2	2
	Calculated Overall Threat Impact:		Very High	High
	Assigned Overall Threat Impact:		**B = High**	
	Impact Adjustment Reasons:		The species has many threats but the survival of the species is buffered by its ability to sprout ramets. There is uncertainty in the fire and fire suppression threat (high-medium), which is having undue weight on the final score calculated.	
	Overall Threat Comments		Generation time is at least 25 years and 25-50 is used for the purposes of this threats calculation (which places the projections here at the maximum of 100 years). This species reproduces by suckering but the suckers rarely become mature individuals. Forty subpopulations, with some having only one individual (and are then should not perhaps be considered a viable subpopulation due to dioecious sexual system). Some subpopulations have no mature individuals (although have saplings). Three subpopulations in Lake Erie have had substantial tree death due to cormorants and the numbers of mature individuals may be subject to change. Numbers used in this threat calculation reflect best available survey information as of 2007 for these subpopulations, yet some more recent (2013) information is integrated, where applicable below.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						There is not a lot of known pressure from urbanization near Kentucky Coffee Tree (KCT) subpopulations. This is a lowland species, often in floodplains, that is not often developed for housing (development is even restricted).
1.2	Commercial & industrial areas						Not a lot of known upcoming pressure from industry and commerce near subpopulations.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas						Many subpopulations are on private property. Those on public lands are likely to be known and protected by Conservation Authorities, Parks Canada, etc.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						Clearing from agricultural operations has occurred to reduce shading (placed in 7.3).
2.2	Wood & pulp plantations						None of the known subpopulations are in or near plantations managed for timber harvest, and KCT is unlikely to exist under the dense canopies that characterize most plantation stands.
2.3	Livestock farming & ranching						Clearing of KCT by land managers to avoid toxicity to livestock (placed in 7.3)
2.4	Marine & freshwater aquaculture						While the subpopulations on Lake Erie islands are within a large body of water, aquaculture operations are not anticipated to have a direct impact on KCT.
3	Energy production & mining						
3.1	Oil & gas drilling						It is not known how active is the exploration and development of the oil and gas industry in the "Oil Heritage District", but because known localities of Kentucky Coffee-tree are from Lambton County, although it is possible that industry operations may impact the species. As little is known at this time, the impact of this threat will require further research.
3.2	Mining & quarrying						Possible simply because many subpopulations are on private property, although nothing is known about the mineral resources in the vicinity of such subpopulations.
3.3	Renewable energy						Many wind energy production facilities have been constructed in Essex and Chatham-Kent counties; more are possible. The scope of impacts from these would likely be minimal, perhaps mostly limited to roadside subpopulations being impacted by transmission corridors.
4	Transportation & service corridors	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	
4.1	Roads & railroads	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	KCT along roads are more likely to be impacted via activities such as road maintenance but it is possible that road widening could also impact individuals. Continual maintenance includes cutting suckers back. Subpopulations that could be impacted include those along Hwy 40, Dover Township (1 tree) and Walpole (with possible widening of roads).
4.2	Utility & service lines	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	KCT subpopulations along roadside ditches are subject to periodic cutting by road maintenance or line clearance crews. Two of the roadside subpopulations visited in Essex County in 2019 appear to have been cut back due to infrastructure maintenance or encroachment on agricultural land.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	KCT is not often targeted for wild plant collection, except perhaps collecting seed for the purposes of restoration efforts. Seed collection, when it occurs, is regulated and minimal. Only ~5 subpopulations actually produce viable seeds, such that this has a small scope. On Pelee Island, people have been observed pulling a ramet for use in native plant gardening. There is debate about whether the severity is negligible or slight due to uncertainty in how well collection of seeds and ramets can be regulated over the next 3 generations.
5.3	Logging & wood harvesting	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Kentucky Coffee-tree is generally not a targeted species for silvicultural operations but can be inadvertently taken or damaged by selective logging. Field observations in 2019 found damage done to mature trees in a forested subpopulation (Crawford Woods; not cut down but damage to a small number (3-5) mature stems). However, the damage was unlikely to kill individuals.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Large - Restricted (11-70%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities						Many subpopulations are on private property. Those on public lands are likely to be known and protected by CAs, Parks Canada, etc. Cutting down trees for trails is possible but the trails near subpopulations do not appear to impact the individuals.
6.2	War, civil unrest & military exercises						KCT is not known from lands owned/managed by Department of National Defence.
6.3	Work & other activities		Negligible	Large - Restricted (11-70%)	Negligible (<1%)	High (Continuing)	Genetic sampling is occurring. Effort is underway to document genetic diversity of this species but care is being taken to keep impact minimal (trees are tagged at Pelee subpopulations but care is taken such that this does not impact the tree).
7	Natural system modifications	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	
7.1	Fire & fire suppression	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	Fire suppression can contribute to forest succession leading toward closed-canopy conditions not optimal for Kentucky Coffee-tree growth. In East Sister and Middle Sister, this issue fire suppression is not an issue because the cormorants are keeping the canopy open. The lack of fire may be an issue with seeds not germinating as well.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/use						Many known subpopulations are in riverine/floodplain systems; management of these systems could impact KCT, though impact may vary by river or watershed. This species thrives with periodic flooding but cannot withstand prolonged flooding. No new dams are planned. With regard to the current dams there is a great deal of uncertainty as to whether it will impact this species.
7.3	Other ecosystem modifications	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Trees could potentially be cut down to reduce likelihood of livestock poisoning, and/or to reduce shading of crops. Ash tree death is opening habitat (which is impacted through the invasive species EAB). Invasive woody and herbaceous plants (Garlic Mustard, Dame's Rocket) that limit regeneration potential in subpopulations but do not impact mature individuals. Pollinators are declining as well.
8	Invasive & other problematic species & genes	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases						Invasive woody and herbaceous plants that limit regeneration potential in subpopulations (scored in 7.3).
8.2	Problematic native species/diseases	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	Cormorant nesting colonies on Lake Erie islands is a direct threat. Some recent surveying in this Park in 2013 estimate a 20-30% decline in trees. Ongoing management at Point Pelee of cormorant population was estimated to have resulted in 11% forest recovery in 2010 but still has less than 20% forest cover. Many cormorants still nest on these islands. On Middle Island, it is still very challenging to execute management operations but mitigation of cormorant impact is ongoing for forest recovery.
8.3	Introduced genetic material		Unknown	Large (31-70%)	Unknown	High (Continuing)	Genetic material from ornamental or restoration/enhancement plantings has some potential impact. Sources of seeds may not have a large impact on the Canadian population, because this species has low genetic diversity. However, Canadian population may have alleles for cold tolerance. More research is needed to document where planted subpopulations exist. Canard subpopulation has been enhanced. This information is difficult to retrieve with regard to boulevard planting, etc. Conservation efforts are usually regulated and encourage the use of native material.
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Domestic & urban waste water						It is unknown whether this threat is present for KCT subpopulations. Runoff from roads, road salt, is a possible threat to individuals near roadsides but there is no information on the effects. The trees in these localities are separated from the road by a drainage ditch.
9.2	Industrial & military effluents						It is unknown whether this threat is present for KCT subpopulations.
9.3	Agricultural & forestry effluents		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Many KCT are along rivers and floodplains in areas that are predominantly agricultural. Fertilizer burning and herbicide drift observed.
9.4	Garbage & solid waste						This threat is of little concern to the survival of the species in Canada.
9.5	Air-borne pollutants		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Tolerant of urban conditions with associated air pollutants, although most native subpopulations are in more rural areas. Lake Erie Island subpopulations have a great deal of air-borne pollutants.
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						Subpopulations are not known to be at the base of steep slopes.
11	Climate change & severe weather	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Lake level rise is a long-term habitat alteration that is a possible threat of unknown severity.
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	KCT is adapted to a range of soil conditions, as shown by the literature and its adaptability to urban conditions. Additionally, its general position in Canadian subpopulations in lowland areas mean that whatever water is available will be nearby. On Middle Island, there was a serious drought but its effect was eclipsed by the high abundance of cormorants and thus very difficult to estimate. Water stress (e.g., leaf loss) was observed.
11.3	Temperature extremes						
11.4	Storms & flooding	C	Medium	Restricted (11-30%)	Serious (31-70%)	High (Continuing)	The species is only able to withstand infrequent flooding of rather short duration. High lake levels of L. Erie has resulted in some mortality of trees in the last 25 years (the species is intolerant of extended flooding). Off the Pelee islands, prolonged flooding is less likely but some subpopulations are still subjected to this threat due to its riverine/floodplain habitat preferences.
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.*(2008).

Appendix 2. Summary of Kentucky Coffee-tree subpopulations in Canada.

Subpopulations in bold text are known or suspected to have reproduced sexually. Subpopulation names denoted by [1] are new to the Canadian population, and statuses denoted by [2] have changed since the publication of the last federal recovery strategy (Environment Canada 2014).

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Chatham-Kent	**Crawford's Woods, Dover Township** (NHIC EO_ID 31880)	Extant	2019	A record of "3 or 4 small stands" is undated and uncredited. (2002) Woodliffe observed about 10 medium sized trees. (2019) A total of 93 live stems observed. Central Kentucky Coffee-tree (KCT) stand: 10 mature stems and 50 saplings. Southwest KCT stand: 3 mature stems, 5 mid-aged, 25 saplings. 75% canopy cover. 2 other NHIC observations searched for but not found. Recent selective logging. D. Craig notes the presence of seed-bearing trees (at least 2 with numerous pods) in the past; no pods observed in 2019.	Private	--
Chatham-Kent	Highway 40, Dover Township (NHIC EO_ID 11216)	Extant	2020	(1983-1992) R. Thompson notes a single tree (60 cm DBH), and that another tree was cut from the backyard of the farm house across the road. (2000) D. Craig asserts that the tree produced seed until the other was cut down, stump of backyard tree has produced sprouts. (2004) M. Oldham reports fewer than 10 pods. (2020) Tree measured at 99 cm DBH and in good condition. 2 small root suckers and at least 1 pod developing.	Private	--
Chatham-Kent	Sydenham River, Dresden, Camden Township (NHIC EO_ID 11218)	Extant	2005	(1982-1992) Thompson reported 28 trees (15-30 inches DBH) with regeneration, possibly from same root system. Environment Canada (2014) reports these to have last been observed in 2005, listing 15-30 cm DBH. Discrepancy in unit measurement exists in NHIC data.	Private	--

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Essex	**Canard River Floodplain, Anderdon Township** (NHIC EO_ID 11226)	Extant	2017	(1981) Four floodplain sites 16 trees plus 43 saplings and sprouts; five trees (one of only two sites known to produce fruit); two small adjacent subpopulations (tree numbers unknown); and 15 trees plus 37 saplings and sprouts (Ambrose 1983). (2010) Three sub-populations: 14 trees (15.5-72 cm DBH); 2 trees (36 and 42 cm DBH) and 18 saplings or ramets (1.5-14 cm DBH); 9 trees (16.4-53 cm DBH) and 8 saplings or ramets (1.4-4.6 cm DBH). (2011) Between 2011-2014, ERCA carried out supplemental plantings, including at least 53 seedlings grown from local seed, in two CA properties as part of at least 1 permit from Ontario's Ministry of Natural Resources and Forestry (OMNRF). (2012) Oldham observed some young trees, likely planted, but most were dead. (2017) Lumb (2018) reported 4 trees >50cm DBH, 2 trees 40-50 cm, 3 trees 30-40 cm, 7 trees 20-30 cm, 7 trees 10-20 cm DBH, and 74 stems and shoots <10 cm DBH. (2018) ERCA staff report 25 young trees planted in 2016 for conservation purposes, connected with a permit from OMNRF.	Public (ERCA) / Private	Supplemented
Essex	Canard River, LaSalle[1]	Extant	2020	(2017) 1 tree 20-30 cm DBH, and 5 shoots <10 cm DBH (Lumb 2018). (2020) Confirmed presence of 1 tree 30-40 cm DBH bearing at least 20 pods, and 13 ramets <10 cm DBH. NHIC will need to confirm that this constitutes a separate element occurrence from Canard River Floodplain.	Public (Town of LaSalle)	--
Essex	Comber, Tilbury West Township (NHIC EO_ID 93627)	Extant	2020	(1994) 30-40 trees (< 5 ft). Reported as extant (Environment Canada 2014). (2020) 2 small trees planted in yard about 2005, in somewhat poor condition. These do not seem descended from the 1994 record. Further investigation of the vicinity may be warranted and NHIC may need to re-assess.	Private	--

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Essex	**East Sister Island, Lake Erie** (NHIC EO_ID 2112)	Extant	2013	(1981) 4 trees plus 4 saplings; and 10 trees plus 4 saplings (Ambrose, 1983). Both populations were reconfirmed as extant in 1988 by one of us (M.Oldham) (2007) Greater than 1200 trees, mostly young saplings and seedlings (<5cm DBH average); 47 trees with DBH >20 cm and 34 trees with DBH >15 cm (Environment Canada 2014). (2013) 12 trees 30-40 cm DBH, 44 trees 20-30cm, 129 trees 10-20 cm DBH, 307 trees 2.6-10cm, 559 stems 1-2.5 cm diameter, and 623 suckers/seedlings. Germination tests were performed on seeds from 4 trees--one tree had a 74% germination rate, one had 8% germination rate, seeds from the other two trees did not germinate. Comparing abundance data to 2007 data collected by Ontario Parks and MNRF suggests an annual loss of 2% of KCT from the island (Elliot pers. comm. 2020). Anecdotal evidence since that time suggests a decline in mature trees (Gould pers. comm. 2020).	Public (OMNRF)	--
Essex	Essex, Maidstone Township (NHIC EO_ID 11229)	Extant	2019	(1981) 100-200 suckers growing along a roadside ditch that are cut back every year by the landowner (Ambrose 1983). (1994) 100-200 ramets along 28 m strip. (2019) Trees on west side of road, beyond roadside ditch and adjacent to agricultural field. A total of 133-233 live stems observed: 100-200 young ramets, 30 stems 2-4m tall, 3 stems 4-6 m. The site to the north was surveyed with no trees observed.	Private	--
Essex	**Harrow, Colchester Township** (NHIC EO_ID 11227)	Extant	2017	(1981) 28 trees and approximately 100 sapling- or seedling-sized ramets. (1994) Hundreds of stems counted across three sites. (2017) At least 4 fruit-bearing trees observed among 8 trees 30-40 cm DBH, 34 trees 20-30 cm, 74 trees 10-20 cm DBH, and 239 stems and shoots <10cm DBH; genetic analysis indicates past sexual reproduction (Lumb 2018; Lumb pers. comm. 2019).	Private	--

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Essex	Middle Island, Lake Erie (NHIC EO_ID 5344)	Extant	2019	(1981) A single site of 3 trees plus an unknown number of saplings (Ambrose, 1983). (2007) At least 6 trees, 37 tree- or sapling-sized ramets, 147 sapling-sized ramets and 78 seedling-sized ramets. Combined with a 2002-2003 survey, these result in an overall total of up to 13 trees and 478 ramets (NHIC 2010). (2012) 89 trees >10 cm DBH, 205 sapling-sized (5-10 cm DBH, >2 m tall), and 311 seedling-sized (<5 cm DBH, <2 m tall), plus 26 records where size was not recorded. In each category, the greatest distribution lies in the 'moderate' health class (51-89% live crown) (Parks Canada Agency 2017). (2017) Comparison to 2012 is made difficult by greater search effort in 2017, when 75 trees >10 cm DBH, 222 sapling-sized, and 560 seedling-sized were found. Here, the greatest distribution in each size class was from 'healthy' trees (at least 90% live crown) (Parks Canada Agency 2017). Despite the greater search effort, fewer trees in the largest class were found. (2019) Subpopulation observed but detailed survey not conducted.	Public (Parks Canada)	--
Essex	Middle Sister Island, Lake Erie (NHIC EO_ID 2110)	Extant	2013	(1983) A few fruit-producing trees observed and specimen collected by Ambrose. (1996) One live tree with two of previous years' seed pods on ground. Reproductive status requires confirmation. (2013) Oldham notes "Several dead trees" and 1 small (10 ft.) live tree.	Private	--
Essex	Paquette and Lukerville, Anderdon / Sandwich Township (NHIC EO_ID 93629)	Extant	2019	(1994) Two "sub-populations": Paquette has a total of 140 trees (51 < 5 ft., 26 6-10 ft., 52 11-15 ft., 10 16-25 ft., and 1 +25 ft.), Lukerville a total of 121 trees. (2017) All mature trees at the eastern site of this subpopulation (Paquette) were cut between 2016 and 2017; root suckers present in 2017 (Lumb 2018). (2019) Paquette: species along roadside ditch. A total of 95 live stems observed (all <10 cm DBH). Lukerville: species along roadside ditch. 75 live stems observed: 63 stems <10cm DBH, 12 stems 10-20 cm.	Private	--
Essex	Pelee Island, Lake Erie (NHIC EO_ID 11228)	Extant	2012	(1981) Sheridan Point 2 nearby sites that may be part of the same clone. 6 trees plus 70 saplings; and a single tree (Ambrose, 1983). Confirmed as extant in 1994 but numbers were not recorded (Oldham 2000). (2010) Two "sub-populations": 6 trees + 70 sapling- / seedling-sized ramets; one large tree (Environment Canada 2014). (2012) Several roadside trees. (Oldham)	Private	--

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Essex	Pelton, Sandwich Township (NHIC EO_ID 93630)	Extant	2020	(1994) A total of 773 trees reported by Lebedyk (700 <5 ft., 40 6-10 ft., 20 11-15 ft., 4 16-25 ft., and 9 +25 ft.). (2020) This property has been in the family for generations; homeowner did not describe any event significantly impacting trees. Lance reported 2 trees 30-40 cm DBH, 5 trees 20-30 cm, 17 trees 10-20 cm, and 196 stems and suckers <10 cm DBH.	Private	--
Essex	Texas Road, Anderdon Township (NHIC EO_ID 93628)	Extant	2020	(1994) Total of 171 trees (all trees under 5 ft.). Reported as extant (Environment Canada 2014). (2020) 7 small suckers, most seedling-sized, in narrow grassy strip between field and roadside ditch.	Private	--
Essex	Puce River, Maidstone Township[1]	Extant	2016	(2016) Ten trees in suitable habitat, reported as planted (Lumb 2018).	Public (ERCA)	Translocated
Essex	Saint Joachim, Lakeshore[1]	Extant	2018	(1980s) A plantation of KCT established, likely using native seed source (Hoyer pers. comm. 2020). (2018) Dozens, maybe hundreds, of trees observed some bearing pods.	Public (ERCA)	Translocated
Essex	Point Pelee National Park[1]	Extant	2007 & 2016	(1976-1980) Collected by E. Hanna along road near White Pine picnic area, and by Koch at old nursery site (Dougan & Associates 2007). (2004-2005) Dougan & Associates noted several areas with saplings and trees but did not map its extent due to its perceived status in the Park as a horticultural introduction (Dougan & Associates 2007). (2007) A total of 8 tree-sized KCT, 25 sapling-sized, and 36 seedling-sized ramets at mainland Point Pelee National Park. These are believed to be from planted stock (NHIC 2010). (2007): T. Dobbie has seen pods regularly on at least 3 trees after the 2007 study was completed. (Jalava *et al*. 2008) (2016) Leaf samples collected from 43 planted trees at 5 sites. No other details available (Lumb 2018).	Public (Parks Canada)	Translocated
Lambton	Petrolia, Enniskillen Township (NHIC EO_ID 11215)	Extant	2019	(2011) Two "sub-populations": 51 trees (2 dead) and 9 saplings (9 dead) including 14 fruit-bearing trees with empty seed pods. (2019) Numerous mature trees along Bear Creek. North site: A total of 80 live stems observed: 2 trees 40-50cm, 19 stems 30-40cm, 18 stems 20-30cm, 19 stems 10-20cm, and 22 stems <10cm. 2 dead stems. No pods observed. South site: 3 trees 20-30cm DBH, 2 trees 10-20cm, 15 stems <10cm.	Public (SCRCA) / Private	--

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Lambton	Shetland Kentucky Coffee-tree Woods, Zone Township (Called Haggerty Creek in Oldham 2000) (NHIC EO_ID 2113)	Extant	2019	(1983) KCT is the dominant species in the stand, with 82 trees and 110 saplings or smaller. No fruit seen, only staminate flowers; the stand is possibly a male clone (Ambrose, 1983). (2011) J. Jalava reported 74 trees, 120 saplings and 123 seedlings/ramets plus 18 dead trees and saplings including 12 fruit-bearing trees (reproductive status requires confirmation). (2018) S. Lumb's genetic research concluded this is not a mixed-sex stand, so reproductive status still warrants further investigation (Lumb pers. comm. 2019). (2019) Large population with mature trees and much regeneration. 80% canopy cover in the area of concentration of KCT. A total of 233 live stems observed: 1 stem 80-90cm DBH, 8 stems 50-60cm, 5 stems 40-50cm, 11 stems 30-40cm, 18 stems 20-30cm, 40 stems 10-20cm, 150 stems <10cm DBH. Pods were not observed.	Private	--
Lambton	**Walpole Island First Nation, Population #1** (NHIC EO_ID 5346)	Extant	2011	(2011) C. Jacobs states there are two "sub-populations" along river: one male clone of ~ 95 trees and sapling-sized ramets; one female clone of ~5 trees and a sapling (Environment Canada 2014).	Public (Federal Lands)	--
Lambton	Walpole Island First Nation, Population #2 (NHIC EO_ID 5345)	Extant	2011	(2011) C. Jacobs notes approximately 20 trees (Environment Canada 2014).	Public (Federal Lands)	--
Lambton	Wilkesport, Sombra Township (NHIC EO_ID 11221)	Extant	2017 & 2019	(estimated 1982 to 1992) A site with over 200 root suckers (possibly all from the same root system) (Oldham 2000) (2005) Two "sub-populations": >200 ramets with some sapling-sized (8-10 cm DBH); “several” trees 10-30 cm DBH (Environment Canada 2014). (2017) The site along Black Creek reported to have 5 trees 30-40cm DBH, 20 trees 20-30cm, 15 trees 10-20cm, and 57 stems <10cm DBH (Lumb 2018). Further east is a record of 3 trees between 16-18cm DBH (Mills and Craig 2008) where Lumb sampled 1 tree in 2017; no corresponding NHIC observation record was found, so this should be assessed by NHIC. (2019) Many stems on either side of a drainage ditch on the north side of the Sydenham River. A total of 153 live stems observed: East bank of ditch with 15 stems 20-30cm, 33 stems 10-20cm, 48 stems <10cm, and 4 dead stems; West bank of ditch with 11 stems 20-30cm, 19 stems 10-20cm, 26 stems <10cm, and 6 dead stems. A single ramet approximately 20m west of main stand. The western site of this subpopulation was not observed, and the eastern site was not visited.	Public (SCRCA)	Supplemented

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Lambton / Middlesex	Grey Tract, Brooke / Mosa Township (NHIC EO_ID 5347)	Extant	2019	(1982 or 1983) A colony was found but not listed in the original status report (Oldham 2000) (1990) 34 trees (10-36 cm DBH), as well as sapling- and seedling-sized ramets (Oldham 2000). (2007-2008). East grove threatened by high water from obstructed channel. Two trees with small pods (Mills and Craig 2008). Craig observed small pods on the ground that may not have contained seeds (D. Craig pers. comm. 2019). (2019) A total of 19 live stems observed. Area 1: 6 mature live trees; 2 large stems broken. 1 young stem <10cm DBH. Several of the stems have stem wounds partially closed; some decay present. Area 2: 10 mature, 2 young stems; healthy stems with evidence of compartmentalized wounds. Ash decline from Emerald Ash Borer has resulted in some canopy gaps. No pods observed.	Public (Municipality of Southwest Middlesex)	--
Lambton / Middlesex	A.W. Campbell CA[1]	Extant	2008	1 of 4 planted trees producing pods (Mills and Craig 2008).	Public (SCRCA)	Translocated
Middlesex	Strathroy CA[1]	Extant	2008	3 trees planted in forested area near reservoir (Mills and Craig 2008).	Public (SCRCA)	Translocated
Middlesex	Cairngorm, Middlesex[1]	Extant	2008	3 trees planted in 1998, the largest producing pods. Seed source was a tree at St. Williams Forestry Station collected in 1995 (Mills and Craig 2008).	Public (SCRCA)	Translocated
Chatham-Kent	Bear Creek, Mitchell's Bay, Dover Township (NHIC EO_ID 11220)	Extant[2]	1950s & 2019	(1950s) "Single dense stand" reported. In 1983, there were nine trees and six saplings and shoots in the floodplain. This is a declining stand with many dead trees and little regeneration (Ambrose 1983). Reported as extirpated (COSEWIC 2000; Environment Canada 2014). (2019) A. Woodliffe observed 3 trees (1 produced pods in past) along Mitchell's Bay, near enough to the 1950s observation to likely be considered in the same subpopulation. NHIC will need to determine whether these constitute separate element occurrences.	Public	--

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Chatham-Kent	**Florence, Zone / Dawn Township** (NHIC EO_ID 11223)	Extant[2]	1950 & 2020	(1948) Species collected "Near Florence" by J. Smith. (1981) Site investigated but species not found; landowner recounted that tree and fencerow was removed. (2000) D. Craig observed 1 seed-bearing tree near Croton (and in subsequent years) along the north shore of the Sydenham River. This is a different site than 1948 collection. (2016) As evidenced by aerial imagery, woodland clearing around the 1948 record occurred between 2011 and 2016, suggesting that site is extirpated. (2020) Lance observed the site from south bank and recorded 1 tree 50-60 cm DBH, 1 tree 20-30 cm, 1 tree approximately 10 cm DBH, each in good condition. No pods visible, and no suckering observed. This subpopulation reported as extirpated (Environment Canada 2014). NHIC will need to determine whether these constitute separate element occurrences.	Private	--
Lambton	Sydenham River, Wallaceburg, Sombra Township (NHIC EO_ID 11214)	Extant[2]	2020	A single tree, found along a concession road (1982-1992) One tree. Not listed in the original COSEWIC status report but noted in Oldham (2000) (Site 14 of Figure 1). Reported as historical (Environment Canada 2014). (2017) Lumb (2018) reported 1 tree just north of the older record, and with a smaller diameter. This may mean that more than 1 tree is present, but warrants further investigation. (2020) Lance confirmed the presence of both previous records: original consists of 1 tree 40-50 cm DBH, 4 trees 10-20 cm, and 58 young suckers of varying size; 2017 record consists of 1 tree at 23 cm DBH.	Public (St. Clair Township)	--
Essex	North Harbour Island, Lake Erie (NHIC EO_ID 2111)	Presumed Extant[2]	1987	(1987) “Several trees in centre of island, no fruit.” (Oldham)	Private	--
Lambton	Sydenham River, Alvinston, Brooke Township (NHIC EO_ID 31856)	Presumed Extant[2]	1993	(1993) Craig observed 20 trees (45-65 cm DBH). Reported as extant (Environment Canada 2014).	Private	--
Lambton	Sydenham River, Florence, Euphemia Township (NHIC EO_ID 31854)	Presumed Extant[2]	1993	(1993) 6 trees (45-50 cm DBH), no information available regarding seed production or regeneration. (1996-1997) NHIC data reports "No seed or suckers observed in 1996 and 1997". Reported as extant (Environment Canada 2014).	Private	--

County	Subpopulation	Status	Last Observed	Description and Notes	Ownership / Management	Manipulated Population Component
Lambton	Bear Creek, Avonry, Sombra Township (NHIC EO_ID 31986)	Presumed Extant[2]	1999	(1983) 9 trees and 6 saplings and shoots. This is a declining stand with many dead trees and little regeneration (1983). (1999) "2 trees present. Owner says no fruit since a third one was cut down several years ago." (Craig)	Private	--
Essex	City of Windsor (NHIC EO_ID 11212)	Historical	1981	(1981) 3 mature trees, all male. Reported as "remnant mature trees" by Waldron.	Private	--
Essex	Devonwood Conservation Area, Sandwich Township (NHIC EO_ID 11213)	Failed to Find[2]	1977	(1977) One young tree, approximately 15 cm DBH (NHIC 2019a). (2019) Area around 1977 record thoroughly searched, no trees observed. Few canopy gaps; target species may no longer be present though a comprehensive search of the forest may be warranted. Reported as historical (Environment Canada 2014).	Public (ERCA)	--
Elgin / Middlesex	Thames River Floodplain ANSI, Ekfrid / Dunwich Township (NHIC EO_ID 11217)	Extirpated	1978	(1978) ~50 trees (15-20 cm DBH). None could be found in 1981 after land clearing (Ambrose 1983). None were found in 1991 (Bowles 1992). This site has probably been eliminated. Reported as extirpated (Environment Canada 2014).	n/a	--
Norfolk	Dedrick's Creek, St. Williams, Walsingham Township (NHIC EO_ID 31875)	Extirpated	1950	Reported as extirpated (COSEWIC 2000; Environment Canada 2014).	n/a	--
Norfolk	Forestville Creek, Forestville, Charlotteville Township (NHIC EO_ID 31878)	Extirpated	1955	Reported as extirpated (Environment Canada 2014).	n/a	--
Oxford	Norwich, Norwich Township (NHIC EO_ID 11224)	Extirpated	1927	Reported as extirpated (COSEWIC 2000; Environment Canada 2014).	n/a	--