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Adopted under Section 44 of SARA

Recovery Strategy for the American Chestnut (*Castanea dentata*) in Canada

American Chestnut

2019

Government of Canada
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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

RECOVERY STRATEGY FOR THE AMERICAN CHESTNUT (*Castanea dentata*) IN CANADA

2019

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of Ontario has given permission to the Government of Canada to adopt the *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario* (Part 2) and the *American Chestnut – Ontario Government Response Statement* (Part 3) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the American Chestnut in Canada consists of three parts:

Part 1 – Federal Addition to the *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario,* prepared for the Ontario Ministry of Natural Resources[2].

Part 3 – *American Chestnut – Ontario Government Response Statement*, prepared by the Ontario Ministry of Natural Resources.

[2] On June 26th, 2014, the Ontario Ministry of Natural Resources became the Ontario Ministry of Natural Resources and Forestry.

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Part 1 – Federal Addition to the *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario*, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[3] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the American Chestnut and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Ontario Ministry of Natural Resources (now the Ontario Ministry of Natural Resources and Forestry) led the development of the attached recovery strategy for the American Chestnut (Part 2) in cooperation with Environment and Climate Change Canada. The Province of Ontario also led the development of the attached Government Response Statement (Part 3), which is the Ontario Government's policy response to its provincial recovery strategy and summarizes the prioritized actions that the Ontario government intends to take and support.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the American Chestnut and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

[3] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[4] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

[4] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgements

The initial draft of the federal addition was prepared by Holly Bickerton (Consulting Ecologist, Ottawa). Additional preparation and review of the document was completed by Angela McConnell, Krista Holmes, Marie-Claude Archambault and Lee Voisin (Environment and Climate Change Canada, Canadian Wildlife Service – Ontario) Justine Mannion and Marsha Smith (formerly Environment and Climate Change Canada, Canadian Wildlife Service – Ontario). Kathy St. Laurent, Rachel deCatanzaro, Lesley Dunn (Environment and Climate Change Canada, Canadian Wildlife Service – Ontario), Veronique Brondex (Environment and Climate Change Canada, Canadian Wildlife Service – National Capital Region), Vivian Brownell, Aileen Wheeldon, Eric Snyder and Michelle Collins (Ontario Ministry of Natural Resources and Forestry) and Clint Jacobs (Walpole Island Heritage Centre) reviewed and provided comments and advice during the development of this document.

Acknowledgement and thanks are given to all other parties that provided advice and input used to help inform the development of this recovery strategy including various Indigenous organizations and individuals, landowners, citizens and stakeholders who provided input and/or participated in consultation meetings.

Additions and Modifications to the Adopted Document

The following sections have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario* (Part 2 of this document, referred to henceforth as "the provincial recovery strategy") and/or to provide updates or additional information.

Environment and Climate Change Canada is adopting the provincial recovery strategy (Part 2) with the exception of section 2, Recovery. In place of section 2, Environment and Climate Change Canada has established its own performance indicators and population and distribution objectives that are consistent with the provincial recovery goal, and is adopting the government-led and government-supported actions set out in the *American Chestnut – Ontario Government Response Statement*[5] (Part 3) as the broad strategies and general approaches to meet the population and distribution objectives.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery strategy referring to protection of the species' habitat may not directly correspond to federal requirements. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

1. Species Status Information

The American Chestnut is listed as Endangered[6] on Schedule 1 of SARA. In Ontario, the American Chestnut is listed as Endangered[7] under the provincial *Endangered Species Act, 2007* (ESA).

The global conservation status for American Chestnut is Apparently Secure (G4) (Appendix A). Its national conservation status is Imperilled (N2) in Canada and Apparently Secure (N4) in the United States (Appendix A). The species is ranked as Imperilled (S2) in Ontario, the only Canadian province where it occurs, while its status ranges from Secure to Extirpated (S5 – SX) in the 29 American states where it occurs (NatureServe 2014; Appendix A).

It is estimated that less than 5% of the American Chestnut's global range occurs in Canada.

[5] The Government Response Statement is the Ontario Government's policy response to the recovery strategy and summarizes the prioritized actions that the Ontario Government intends to take and support.
[6] Endangered (SARA): A wildlife species facing imminent extirpation or extinction in Canada.
[7] Endangered (ESA): A species that lives in the wild in Ontario but is facing imminent extinction or extirpation.

2. Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, there are unknowns regarding the feasibility of recovery of the American Chestnut. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be technically and biologically feasible. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Unknown. The naturally occurring American Chestnut population in Ontario is unlikely to become self-sustaining without effective measures to control or halt the impact of chestnut blight. Less than 1 percent of the original population remains in southwestern Ontario. Although there are several hundred naturally occurring trees remaining across southwestern Ontario, the vast majority of these are immature or survive as remnant stumps that produce shoots. Large mature trees are considered extremely rare. In a survey of over 600 naturally occurring Ontario trees, Tindall et al. (2004) found that only 14 percent were reproductive. No trees were found with viable seed (i.e., filled nuts), and no evidence of seedlings was detected within 20 m plots surrounding any of the trees assessed. Across the former range of the species, the introduced chestnut blight fungus (*Cryphonectria parasitica*) limits the possibility of sexual reproduction, and in the United States, sprouts also rarely grow to reproductive maturity or produce viable seed (Paillet 2002). It is highly uncertain whether a sufficient number of individuals capable of reproduction currently exist to sustain the current population, or improve its abundance in the future. Non-reproductive sprouts exist and even spread vegetatively in parts of the species range (Paillet 2002), although vegetative propagation from cuttings is reportedly very difficult (Elkins et al. 1980). Efforts to establish blight resistance in American Chestnut are underway in Canada and the United States through the production of a modified American Chestnut with genes from a blight-resistant or blight-tolerant Chestnut species (to create resistant backcrossed[8] individuals (at least 94% genetically similar to *C. dentata*)), and these blight-resistant trees may be available within a few years (American Chestnut Foundation 2014; Boland et al. 2012; Canadian Chestnut Council 2017). However, the long-term success of this technique has not been proven, and there remains considerable uncertainty whether backcrossed trees will be able to support a sustainable American Chestnut

[8] Backcrossing is a horticultural technique in which a hybrid is bred with one of its parents, in order to achieve a genetic identity which is closer to that of the parent. In this case, backcrossing is used to introduce the genetic material from the disease-resistant Chinese Chestnut (*C. mollissima*) into the American Chestnut genome, while maintaining the genetic identity and the general characteristics of American Chestnuts (American Chestnut Foundation 2014).

population in Ontario. However, it is likely that planted trees will contribute to sustaining population abundance in the future. American Chestnut and other chestnut species are planted throughout Ontario as ornamental trees and to contribute to habitat restoration. While planted trees are not included in the objective of this strategy, planted American Chestnut trees that are healthy and capable of reproducing may contribute to the recovery of the species in the future.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. Sufficient habitat is available to support the species. Although loss of the Ontario Carolinian forest has been extensive, the predominant threat to this species, is an introduced fungal pathogen that causes chestnut blight. American Chestnut is not considered a habitat specialist, and has been found in over twenty different vegetation communities in southern Ontario (Boland et al. 2012). Many sites where American Chestnut trees occur exist within larger natural areas with additional suitable, but unoccupied habitat. There are also several large natural forested areas on upland, sandy soils within the range of the American Chestnut (e.g., especially within the Turkey Point - St. Williams Conservation Reserve area) that contain large amounts of unoccupied but potentially suitable habitat. Despite the availability of suitable habitat across the landscape, habitat fragmentation has led to isolation of individuals which hinders and prevents flowers from being successfully pollinated[9] and seeds from being dispersed. Enhancement of remaining Carolinian woodlots, through management and stewardship, could provide suitable microsites for establishment and growth of new trees, reducing the isolation of American Chestnut individuals.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Unknown. American Chestnut was a dominant forest tree species in northeastern North America until the early 1900's when populations were devastated by an introduced fungal pathogen that causes chestnut blight. Chestnut blight continues to be the greatest threat to American Chestnut in Ontario, infecting trees in cycles of infection, dieback, and re-infection (Boland et al. 2012). The fungus survives on sprouts and many alternative hosts, including many common overstory[10] and understory[11] species (Mooij 1997). It may be possible that the threat posed by chestnut blight can be partially or entirely mitigated by the introduction of artificially cultivated blight-resistant Chestnut in the coming years, or through other research techniques in development (e.g., hypovirulence[12]). However, it is not yet known if

[9] American Chestnut trees require cross-pollination to produce viable seeds as they cannot self-fertilize.
[10] Overstory: the uppermost layer of foliage that forms a forest canopy.
[11] Understory: an underlying layer of vegetation that grows underneath a forest's canopy.
[12] Hypovirulence is a method of blight control where a virus is introduced which infects the chestnut blight fungus in order to reduce its ability to cause disease.

these techniques will be successful. Other threats include the loss and degradation of habitat, hybridization and insect pests. Non-native chestnuts may pollinate nearby American Chestnut trees leading to hybridization. This threat can be avoided through education and stewardship. Loss of individuals (i.e. from logging or land clearing) and insect pests can be avoided or mitigated through management and stewardship activities.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Unknown. Extensive breeding programs initiated by the Canadian Chestnut Council and American Chestnut Foundation are underway, in which American Chestnut is backcrossed with the blight-resistant Chinese Chestnut in order to introduce resistance, while preserving the original genome. It is hoped that the first resistant stock will be ready for planting within a few years (Boland et al. 2012; American Chestnut Foundation 2014). However, re-introduction efforts have not yet begun or been proven to provide long-term resistance resulting in reproductively sustainable populations. The use of hypovirulence as a potential biological control on the chestnut blight fungus is also being examined in Canada (Boland et al. 2012). Hypovirulent samples have been collected from self-healing cankers at Ontario populations, tested, and used to inoculate cankers on infected trees. Early results have not been encouraging, but observation will continue. It is unknown if recovery techniques currently in development will achieve the population and distribution objectives. At this time, recovery efforts focus on continued collaboration with the province of Ontario on American Chestnut priorities which includes research into various blight control measures, as well as by supporting the conservation and enhancement of American Chestnut genetic diversity, promoting blight tolerance and preventing the spread of disease.

3. Species Information

3.1 Species Population and Distribution

The *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario* (2012) identifies 135 sites[13] containing American Chestnut in 13 counties of southwestern Ontario, 10 more sites than previously reported in the 2004 COSEWIC Assessment and Update Status Report, likely due to an increased survey effort. A standardized survey protocol now exists (Tindall et al. 2004); however, it should be noted that surveys conducted in years prior to the development of the survey protocol have differing methodologies and are not directly comparable.

[13] Site: a particular location where a single American Chestnut or multiple American Chestnut trees have been observed or surveyed.

Since the development of the *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario* (2012), 36 new locations of American Chestnut have been found. This information has not yet been incorporated by the Natural Heritage Information Centre (NHIC) into Ontario's provincially-tracked species database. The NHIC reports 165 element occurrences (EOs)[14] of American Chestnut in Ontario (NHIC 2014) based on observations up to 2007. Of these, 90 were identified as historic, 10 extirpated and the remaining 65 were considered extant. The impact blight has had on some of these populations is not known and their status is expected to change. Once these new locations have been assessed, it will likely result in the establishment of new EOs and/or modifications to existing EOs. This recovery strategy is based on all available observations of American Chestnut up to 2014. More current information on EOs and/or sub-populations is required to have a better understanding of the current status of American Chestnut in Ontario. In the future, the enumeration of American Chestnut populations (and locations identified as critical habitat (Section 6.0)) may better align with the provincial records of American Chestnut.

Of the 165 EOs previously recorded, 26 EOs (including some extant and some historical) indicated the presence of blight. It is possible these trees may no longer exist and further information is needed to assess the current population status (See Section 6.2, Table 1). There is limited information on the size of the Canadian population of American Chestnut since the introduction of the blight. The abundance and distribution estimates (more than 600 individuals in southern Ontario) largely reflect accessible sites on public lands, and these numbers are thought to under-represent the true population size of American Chestnut in Canada by as much as 30-70% (Boland et al. 2012). Accurate estimates of the population and distribution may continue to be challenging due to the number of potential locations and the difficulty in accessing sites on private lands for inventory. It is likely that additional American Chestnut trees may be discovered in the future with increased surveys.

4. Population and Distribution Objectives

Under SARA, a population and distribution objective for the species must be established. Consistent with the goal set out in the Government of Ontario's Government Response Statement, Environment and Climate Change Canada's population and distribution objective for the American Chestnut in Canada is to:

- Maintain and if feasible increase the current abundance and area of occupancy[15] of the American Chestnut in Canada.

[14] Element occurrence (EO): an area of land and/or water in which a species or natural community is, or was present. Throughout this document, the term "population" is considered to be synonymous with the term "element occurrence" as used by the NHIC and NatureServe.
[15] Area of Occupancy: a biological measure of the occupied habitat within a wildlife species' range, determined by COSEWIC using an Index of Area of Occupancy (IAO).

This objective is consistent with the province of Ontario's Government Response Statement developed under the provincial Endangered Species Act, which outlines the provincial government's goal for the recovery of the species and summarizes the prioritized actions the government intends to take (see Part 3 for more information). The Government Response Statement for the province of Ontario lists the following goal for the recovery of the American Chestnut in Ontario:

- The government's goal for the recovery of American Chestnut is to retain the current population level and distribution in Ontario while increasing genetic diversity and reproductive success, and where possible, explore the feasibility of implementing blight control measures to restore the species to a self-sustaining state.

The American Chestnut population distribution can be measured by the Index of area of occupancy, estimated by COSEWIC (2004) to be 12 km^2. although would likely now be larger due to new sites located since 2004. Tindall et al. (2004) and Boland et al. (2012) indicate the current population level or abundance in Canada to be greater than 600 individuals. There is limited information on how the blight continues to impact the distribution and overall size of the Canadian population of the American Chestnut. The loss of several large trees that were previously reproductive and healthy in the last few decades is a concern; whether they are being replaced by recruitment is inconclusive (COSEWIC 2004). Because of the lack of accurate population information, the focus of this recovery strategy is to improve current baseline information on distribution and abundance in Canada and halt the population decline in order to maintain the overall population and distribution (i.e., abundance and area of occupancy) of the species in Canada.

Further, Environment and Climate Change Canada supports increasing genetic diversity and reproductive success of the American Chestnut, and investigating the feasibility of implementing blight control measures to restore the species to a self-sustaining state. Implementing the broad strategies adopted from the *American Chestnut – Ontario Government Response Statement* (Part 3) will aid the recovery of this species, including the use of targeted surveys to obtain accurate information about the current distribution, abundance, and health of the species in Canada.

As research into blight control measures, such as hybridization, progresses and new information on the current status of trees emerges, the population and distribution objectives may be re-evaluated and updated in an amended recovery strategy.

American Chestnuts that were planted for purposes other than species recovery, ecological restoration/rehabilitation or habitat creation, are not currently being considered as existing populations (or portions thereof) in the above objective. Many American Chestnuts have been planted within the natural range of the species, as well as outside it. For example, between 1998 and 1999, approximately 1,300 American Chestnuts were planted at 24 demonstration sites, in a program undertaken by the Ontario Soil and Crop Improvement Association. American Chestnuts planted at these

demonstration sites are not considered in the above objectives until such a time that they have showcased results on their contribution to a viable native population. Life expectancy and reproductive success of planted trees can be variable. These trees would have to be considered healthy, stable and most likely viable for reproduction to be considered (e.g., as new populations or portions of existing populations) under the above objective.

5. Broad Strategies and General Approaches to Meet Objectives

The government-led and government-supported actions from *American Chestnut – Ontario Government Response Statement* (Part 3) are adopted as the broad strategies and general approaches to address the threats and meet the population and distribution objectives. Environment and Climate Change Canada is not adopting the approaches identified in section 2 of the *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario* (Part 2) that are inconsistent with the Ontario Government Response Statement.

6. Critical Habitat

6.1 Identification of the Species' Critical Habitat

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. Under SARA, critical habitat is "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

Identification of critical habitat is not a component of the provincial recovery strategy under the Province of Ontario's ESA. Under the ESA, when a species becomes listed as Endangered or Threatened on the Species at Risk in Ontario List, it automatically receives general habitat protection. The American Chestnut currently receives general habitat protection under the ESA; however, a description of the general habitat has not yet been developed. In some cases, a habitat regulation may be developed that replaces the general habitat protection. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species by the Province of Ontario. A habitat regulation has not been developed for American Chestnut under the ESA; however, the provincial recovery strategy (Part 2) contains a recommendation on the area for consideration in developing a habitat regulation.

This federal recovery strategy identifies critical habitat for the American Chestnut in Canada to the extent possible, based on this recommendation and on the best available information as of December 2014. Critical habitat is identified for 64 (of the 65)

assessed extant populations[16] and 90 historical populations. Critical habitat is also identified for an additional 31 (of 36) locations (i.e., locations not currently assessed for the provincial record of American Chestnut populations) (Appendix B). It is recognized that the critical habitat identified may be insufficient to achieve the population and distribution objectives for the species; there is a lack of certainty in the data of some individual tree locations, and details on the size and status of populations, especially where blight has been observed, is poor. A schedule of studies outlines the activities necessary to complete the identification of critical habitat (see Section 6.2). The identification of critical habitat will be updated when the information becomes available, either in a revised recovery strategy or action plan(s).

Critical habitat is currently identified for populations containing evidence of blight, until such time the population is assessed as no longer viable. Although the blight fungus is a threat to the American Chestnut, blighted trees may contribute to recovery of the species by persisting for many years and producing offspring which could be healthy or blight resistant (Anagnostakis 1992; Griffin 2000). If these infected trees are isolated, planting healthy trees in nearby suitable habitat may allow these trees to produce healthy offspring thereby, contributing to the recovery of the species in Canada. The American Chestnut generation time is estimated at 20 years (COSEWIC 2004); however, due to infection with the blight fungus, many trees fail to reach reproductive maturity. Trees noted as having evidence of blight will require additional surveys to confirm their persistence and reproductive potential.

At this time, critical habitat is not identified for trees that were planted as part of a restoration effort until there are measures to determine if the planting is a success (e.g., monitoring protocol). As new information becomes available, critical habitat may be added in the future. Though critical habitat is not being identified for planted individuals, these trees may contain important genetic material for recovery. Individual trees are protected under the *Species at Risk Act* (SARA) and the *Endangered Species Act*, *2007* (ESA).

Critical habitat for the American Chestnut is based on two criteria: habitat occupancy and habitat suitability, which are discussed in detail below.

6.1.1. Habitat Occupancy

This criterion refers to areas where there is a reasonable degree of certainty of current use by the species.

Habitat is considered occupied when:

- One or more naturally occurring American Chestnut individuals have been observed.

[16] The extant population identified at Point Pelee National Park is a planted tree and is currently not considered for critical habitat.

Habitat occupancy is based on available data from reports and survey information (e.g., Ambrose and Aboud 1986, Boland et al. 1997, COSEWIC 2004, Melzer and Boland 2004, NHIC 2014, Tindall et al. 2004). Records of American Chestnut may be of individual trees but more often reference a small stand or general location of trees within a larger habitat boundary (e.g., forest complex). A record must contain at least one living American Chestnut (which may include a ramet[17], sapling, or tree), and may also include dead individuals or standing snags (based on visual observations) because ramets can often be found in the vicinity of individuals which otherwise appear to be dead. American Chestnut is a long-lived tree species that can live between 200 and 300 years (Zon 1904; American Chestnut Foundation 2014). As a precautionary approach, all documented records from element occurrences (extant and historic) and currently available data are considered in the occupancy criteria until a field survey by a qualified individual (e.g., forester or biologist) determines that no living American Chestnut (e.g., ramets, saplings or trees) remains.

Individual trees or groups of trees which have been planted but are not part of a recognized restoration program (such as the Guelph Arboretum) and those that have clearly been planted for ornamental purposes, such as in urban gardens, are not considered to be naturally occurring, and therefore, will not be included in this critical habitat criterion. Trees that are confirmed hybrids between native American Chestnut and another non-native chestnut species such as the Chinese Chestnut (*C. molissima*), Japanese Chestnut (*C. crenata*) or European Chestnut (*C. sativa*), are also not considered to be occupying habitat for the purposes of identifying critical habitat. Until such time that blight resistance can be proven, while maintaining the American Chestnut genetic purity, hybridized American Chestnuts are not included.

6.1.2. Habitat Suitability

Habitat suitability relates to areas possessing a specific set of biophysical attributes that can support individuals of the species to carry out essential aspects of their lifecycle.

The American Chestnut is found in a variety of habitats with well-drained, acidic soils. In Canada, occurrences are predominately in upland forests or woodlands, or treed cliffs within the Carolinian Zone of southern Ontario, where the growing season is long and climate is moderated by the lower Great Lakes (Tindall et al. 2004). American Chestnuts are typically associated with Red Oak (*Quercus rubra*), Black Cherry (*Prunus serotina*), Sugar Maple (*Acer saccharum*), Red Maple (*Acer rubrum*), American Beech (*Fagus grandifolia*), White Ash (*Fraxinus Americana*), White Oak (*Quercus alba*), Sassafras (*Sassafras albidum*), Shagbark Hickory (*Carya ovate*), and Eastern White Pine (*Pinus strobus*) (Ambrose and Aboud 1986, COSEWIC 2004, Tindall et al. 2004). Habitat suitability is likely associated more with site conditions (e.g., canopy cover) than

[17] Ramet: An individual produced through asexual means such as vegetatively. In the case of American Chestnut, this would refer to suckers of a specific tree.

specific tree compositions. A well-developed tree canopy[18] (canopy greater than 70%) is an important attribute for the American Chestnut and is a condition under which the majority of American Chestnut trees are found in Ontario (Tindall et al. 2004). However, reduced canopy cover has proven to be important for seedling establishment (Jacobs 2007).

The biophysical attributes of suitable habitat include the characteristics described below:

- Acidic to neutral soils;
- Well-drained sandy or gravelly soils;
- Well-developed canopy where canopy cover exceeds 70%.

Based on the best available information, suitable habitat for the American Chestnut is currently defined as the extent of the biophysical attributes where the American Chestnut exists in Ontario. In addition, a critical function zone of 20 m (radial distance) is applied when the biophysical attributes around a tree extend for less than 20 m.

In Ontario, suitable habitat for the American Chestnut is described using the Ecological Land Classification (ELC) framework for Southern Ontario (from Lee et al. 1998). The ELC framework provides a standardized approach to the interpretation and delineation of dynamic ecosystem boundaries. The ELC approach classifies habitats not only by vegetation community but also considers soil moisture conditions and topography, and as such provides a basis for describing the ecosystem requirements (e.g., local effects of the associated hydrologic regime, canopy cover) and encompasses the biophysical attributes of suitable habitat for the American Chestnut. In addition, ELC terminology and methods are familiar to many land managers and conservation practitioners who have adopted this tool as the standard approach for Ontario.

Within the ELC system in Ontario, the ecosite[19] boundary best captures the extent of the biophysical attributes required by the species. The ecosite includes the areas occupied by the American Chestnut and the surrounding areas that provide suitable habitat conditions to carry out essential life processes for the species and should allow for natural processes related to population dynamics and reproduction (e.g., dispersal and pollination) to occur. This is especially important when reproduction success depends on pollen dispersal from nearby American Chestnut trees.

Tindall et al. (2004) and Boland et al. (2012) have described 11 ecosites for known or newly found (and accessible) American Chestnut (Appendix C). Additional habitat assessments are required to describe and map the specific ELC ecosites currently occupied by the American Chestnut in Canada.

[18] Tree Canopy: The uppermost layer of a forest or treed area created by mature tree crowns.
[19] Ecosite: land with specific physical characteristics including soil, vegetation and landforms.

The 20 m radial distance is based on the critical root zone radius definition, calculated as 1.5 feet of radius for each inch of the diameter at breast height (dbh) of a tree (or 18 cm per one cm of the dbh) (Johnson 2013). Given that the largest dbh for American Chestnut in Canada prior to the introduction of the chestnut blight was 100 cm (Kershaw 2001), the critical root zone radius is calculated to be 20 m (100 cm x 18 cm = 1800 cm rounded up to the nearest 5 m). The critical root zone radius defines a critical root zone area surrounding the tree to help prevent damage or disturbance (such as soil compaction) to the roots, dripline[20] and soil (Johnson 2013).

The area within the critical root zone may include both suitable and unsuitable habitat which are required to maintain individual American Chestnut trees, which may be found near the transition area/zone between suitable and unsuitable habitat (e.g., along the woodland or forest edges). At present, it is not clear at what distance physical and/or biological processes begin to negatively affect American Chestnut. Recent studies show that the magnitude and distance of edge effects will vary depending on the structure and composition of adjacent habitat types (Harper et al. 2005). This radial distance may be refined as new information on species' habitat requirements, site-specific characteristics, and newly germinated trees becomes available.

6.1.3. Application of the Criteria to Identify Critical Habitat for American Chestnut

Critical habitat for American Chestnut is identified as the extent of suitable habitat (6.1.2) where the occupancy criterion (6.1.1) is met. In cases where the suitable habitat extends for less than 20 m around the American Chestnut, a critical function zone capturing an area within a radial distance of 20 m is also included as critical habitat.

In Ontario, as noted above, suitable habitat for the American Chestnut is most appropriately identified as the ELC ecosite. At the present time, the ecosite boundaries (and some descriptions) are not available to support the identification of critical habitat for all populations in Ontario. In the interim, where ELC ecosite boundaries are not available, ELC community series[21] level is identified as the area within which critical habitat is found. When ecosite boundaries become available, the identification of critical habitat will be updated.

Application of the critical habitat criteria to the best available data identifies 201 units of critical habitat for the American Chestnut in Canada (Appendix B). This identification includes critical habitat for 64 extant populations and 90 historical populations (multiple units of critical habitat may be identified for a single population) as well as additional 31 locations, not included within current population assessments. Seven locations contained inadequate information to identify critical habitat and additional surveys are required. The critical habitat identified is considered a partial identification of critical

[20] Dripline: the area beneath a tree defined by the outermost circumference of the tree's canopy where water drips from the tree's foliage onto the ground.
[21] ELC community series polygons can be delineated using aerial photography. The scale of the ELC ecosite mapping requires field surveys for boundary verification.

habitat and is insufficient to meet the population and distribution objectives. Specifically, more precise locational information is required for some occurrences and the current status (i.e., continued presence and health) of occurrences that showed evidence of blight during surveys is also required. A schedule of studies (section 6.2) has been developed to provide the information necessary to complete the identification of critical habitat that will be sufficient to meet the population and distribution objectives.

Until population assessments are updated, critical habitat units may be used as a baseline for the distribution of the American Chestnut in Canada.

Critical habitat for the American Chestnut is presented using 1 x 1 km standardized UTM grid squares (Appendix B: Figure B-1 and B2, and Table B-1). The UTM grid squares are part of a standardized grid system that indicates the general geographic areas containing critical habitat, which can be used for land use planning and/or environmental assessment purposes. In addition to providing these benefits, the 1 km x 1 km UTM grid respects provincial data-sharing agreements in Ontario. Critical habitat within each grid square occurs where description of habitat occupancy (section 6.1.1) and habitat suitability (section 6.1.2) are met. More detailed information on critical habitat to support protection of the species and its habitat may be requested on a need-to-know basis by contacting Environment and Climate Change Canada – Canadian Wildlife Service at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

6.2 Schedule of Studies to Identify Critical Habitat

Table 1. Schedule of Studies to Identify Critical Habitat

Description of Activity	Rationale	Timeline
Confirm status and abundance, and survey habitat for 7 occurrence locations where there is insufficient information (e.g., locational uncertainty).	Precise locational information of element occurrences is required to delineate additional critical habitat.	2019-2029
Assess the populations' status by completing population surveys and health assessments of American Chestnut occurrences within populations noted as having blight; and assess habitat conditions at occupied sites.	Obtain a quantitative baseline of the distribution and abundance of the American Chestnut in Canada. Identify additional critical habitat as required.	2019-2029

6.3 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat was degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single activity or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described in Table 2 are examples of those likely to cause destruction of critical habitat for the species; however, destructive activities are not necessarily limited to those listed.

Table 2. Activities Likely to Result in the Destruction of Critical Habitat of the American Chestnut

Description of Activity	Description of effect in relation to function loss	Details of effect
Development and conversion of lands (e.g., to agriculture, commercial, road ways or residential use)	Development through land clearing or construction results in a direct loss of soil substrate which is required for successful germination of American Chestnut. Construction also results in a dramatic change in habitat features such as canopy structure, soil composition (e.g., alter soil pH), associated species, and hydrology[22] of an area which the species relies upon for basic survival, successful seed germination and seedling establishment, and may ultimately lead to its extirpation[23] from the site.	If this activity were to occur within the bounds of critical habitat at any time of the year, effects would be direct, and would be highly likely to result in the destruction of critical habitat by altering physical and biological properties. If this activity occurs adjacent to critical habitat at any time of the year, it can result in indirect destruction of critical habitat due to habitat alteration and edge effects.
Planting or introduction of non-native chestnuts (*Castanea* spp.)[24]	Planting or introduction of non-native chestnuts within critical habitat reduces or eliminates American Chestnut's ability to successfully reproduce. Non-native chestnut pollen can act as an "environmental pollutant" of its habitat preventing successful reproduction and recruitment of the species. American Chestnut flowers pollinated by non-native chestnut species produce a seed which is no longer considered an American Chestnut, due to hybridization, and thus can eliminate recruitment for that season.	If this activity occurs within the boundary of critical habitat, it may result in temporary habitat degradation. The addition of foreign pollen to the habitat prevents the species ability to successfully reproduce and therefore removes the critical habitat's ability to provide the necessities for survival. This activity is considered temporary as the non-native chestnut tree can be removed which would restore the quality of critical habitat.

[22] Hydrology of an area refers to the movement, distribution, quality, and quantity of water in that area.
[23] Extirpation: No longer existing at a particular site.
[24] Backcrossed trees that are planted for the purpose of species recovery and confirmed to be blight resistant would not contribute to this activity likely to destroy critical habitat.

7. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objective. Every five years, success of recovery strategy implementation will be measured against the following performance indicator:

- Population abundance and area of occupancy of American Chestnut have been maintained at or above current[25] levels.

8. Statement on Action Plans

One or more action plans will be completed for the American Chestnut and posted on the Species at Risk Public Registry by December 31, 2026.

9. Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[26]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[27] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

This federal recovery strategy will clearly benefit other species and ecosystem functions within the heavily altered Carolinian Zone. Several other species at risk and rare species share a similar preferred habitat (sandy upland forests of oak and/or maple) to

[25] Current abundance and area of occupancy is based on most recent available information. Area of Occupancy was estimated at a minimum of 12 km^2, as estimated by COSEWIC (2004). Since this estimate does not include sites found since 2004, it is expected to be larger than 12 km^2 and will be updated after the activities listed in the schedule of studies (Section 6.2) are complete. Surveys indicate the total population of American Chestnut in Canada to be greater than 600 individuals (Tindall et al. 2004; Boland et al. 2012).
[26] www.ceaa.gc.ca/default.asp?lang=E&n=B3186435-1
[27] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

the American Chestnut such as Eastern Flowering Dogwood (*Cornus florida,* Endangered), Bird's-foot Violet (*Viola pedata*, Endangered), Virginia Goat's-rue (*Tephrosia virginiana*, Endangered), Spotted Wintergreen (*Chimaphila maculata*, Endangered) and Eastern Hog-nosed Snake (*Heterodon platyrhinos*, Threatened), although it is not known whether any of these have been found at the exact sites currently occupied by American Chestnut.

The potential for this recovery strategy to inadvertently lead to adverse effects on other species was considered. Currently, recovery actions for the American Chestnut include monitoring and protecting Ontario populations, identifying blight-free populations, and conducting research into methods of chestnut blight control (OMNR 2013). These activities have very little potential to lead to adverse effects on other species that may share the habitat or range of the American Chestnut. Activities with potential impacts on other species, such as habitat management and re-introduction, are not recommended at this time. Government-supported actions (see Part 3) focus exclusively on inventory and monitoring, threat management, and increasing awareness.

Consequently, the SEA concluded that this strategy will clearly benefit the environment and will not entail significant adverse effects. For further details, the reader should refer to the following sections of the adopted provincial documents, in particular: habitat needs (Part 2, section 1.4), knowledge gaps (Part 2, section 1.7) and the government-led and government-supported actions tables from *American Chestnut: Ontario's Government Response Statement* for (Part 3).

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Appendix A: Subnational Conservation Ranks of American Chestnut (*Castanea dentata)* in Canada and the United States

American Chestnut (*Castanea dentata)*				
Global (G) Rank	**National (N) Rank (Canada)**	**Sub-national (S) Rank (Canada)**	**National (N) Rank (United States)**	**Sub-national (S) Rank (United States)**
G4	N2	Ontario (S2)	N4	Alabama (SNR), Connecticut (SNR), Delaware (S4), District of Columbia (S1S2), Florida (SX), Georgia (S3), Illinois (SX), Indiana (S3), Iowa (SNA), Kentucky (S1?), Maine (S4), Maryland (S2S3), Massachusetts (SNR), Michigan (S1S2), Mississippi (S1), Missouri (SNR), New Hampshire (SNR), New Jersey (S4), New York (S5), North Carolina (S4), Ohio (S3), Pennsylvania (S5), Rhode Island (SNR), South Carolina (SNR), Tennessee (S2S3), Vermont (SNR), Virginia (S4), West Virginia (S4), Wisconsin (SNR)

Rank Definitions (NatureServe 2014)

S1: Critically Imperilled - At very high risk of extirpation in the jurisdiction (i.e., N - nation, or S -state/province) due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.

S1?: Inexact numeric ranking/Critically Imperilled: Does not meet the definition of Critically Imperilled exactly.

S1S2: Imperilled to Critically Imperilled - At a high to very high risk of extirpation in the jurisdiction due to restricted to very restricted range, few to very few populations or occurrences, steep to very steep declines, severe threats, or other factors.

N2/S2: Imperilled - At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.

S2S3: Vulnerable/Imperilled: The risk of extirpation in the jurisdiction ranges from moderate to high due to a fairly restricted to restricted range, relatively few to few populations or occurrences, recent and widespread to steep declines, moderate to severe threats, or other factors.

S3: Vulnerable: At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

G4/N4/S4: Apparently Secure: At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.

S5: Secure – At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.

SNR: Unranked – National or subnational conservation status not yet assessed.

SNA: Not applicable: A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.

SX: Presumed Extirpated—Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation, or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

Appendix B: Critical Habitat for the American Chestnut (*Castanea dentata*) in Canada

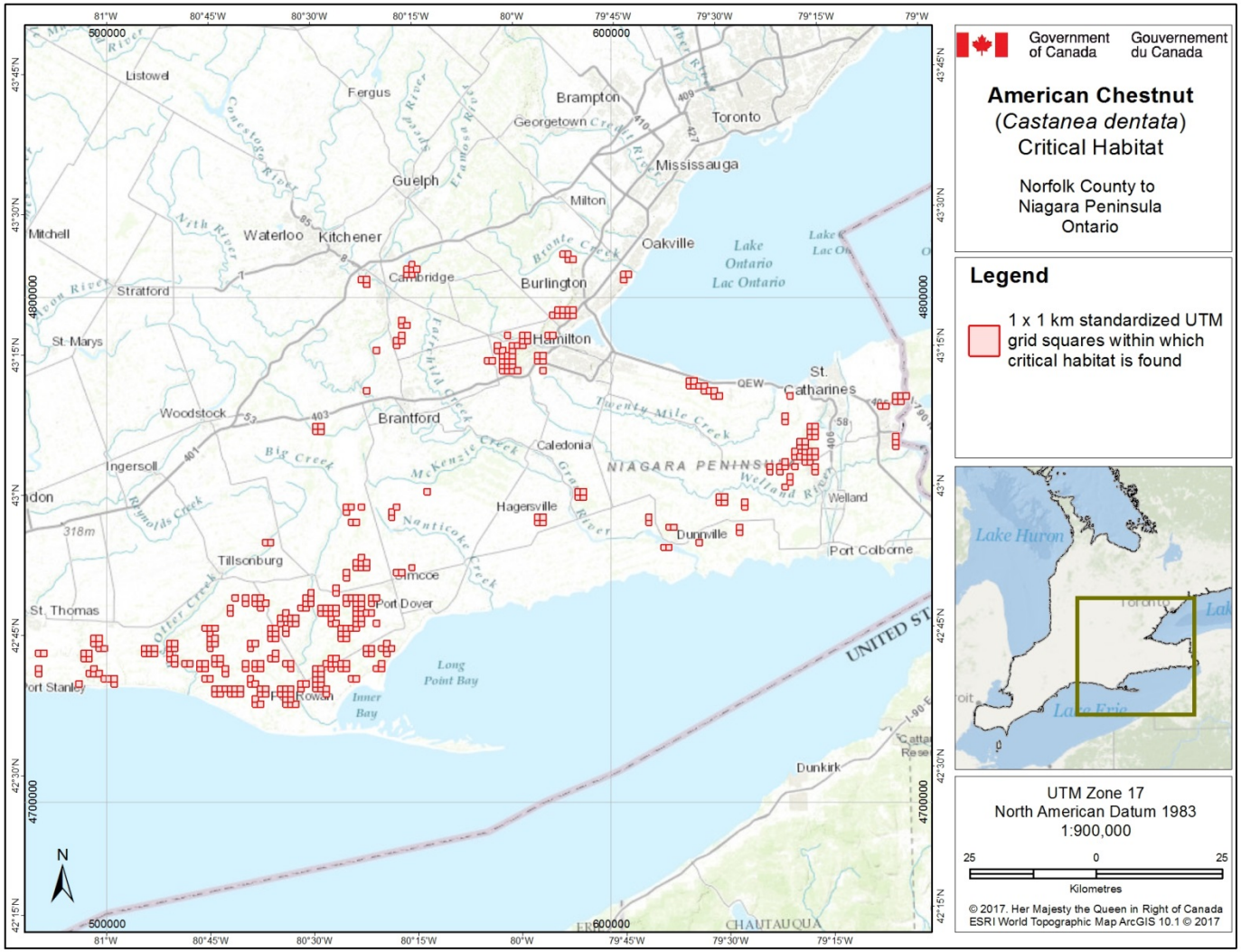

Figure B-1. Grid squares that contain critical habitat for the American Chestnut in Canada. Critical habitat for the American Chestnut occurs within these 1 x 1 km standardized UTM grid squares (red shaded squares), where the criteria described in Section 6.1 are met.

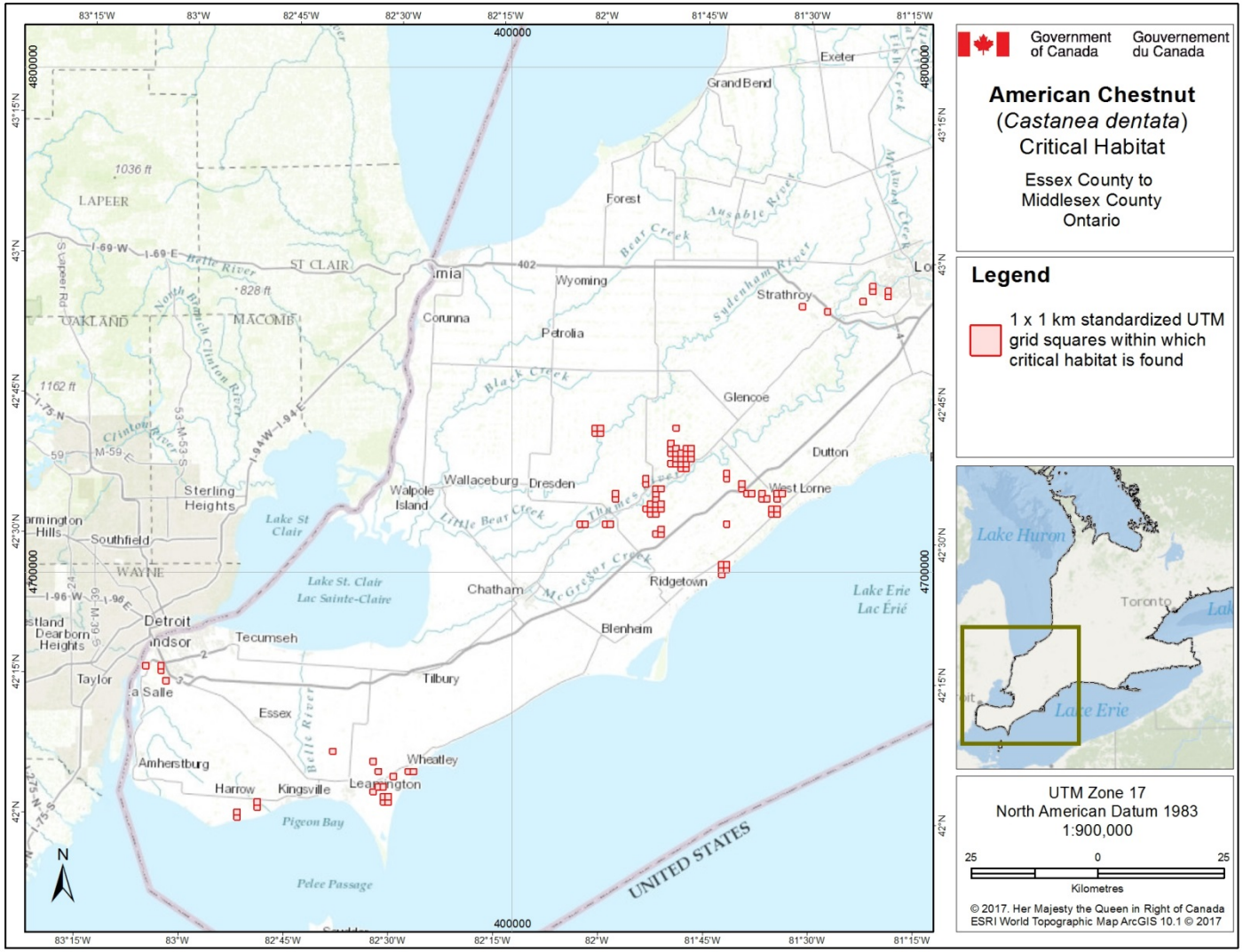

Figure B-2. Grid squares that contain critical habitat for the American Chestnut in Canada. Critical habitat for the American Chestnut occurs within these 1 x 1 km standardized UTM grid squares (red shaded squares), where the criteria described in Section 6.1 are met.

Table B-1 Grids square that contains critical habitat for the American Chestnut in Canada. Critical habitat for American Chestnut occurs within this 1 x 1 km standardized UTM grid where the criteria described in Section 6 are met.

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
1	17TNH4713 17TNH4714 17TNH4723 17TNH4724	Brant	541000 541000 542000 542000	4773000 4774000 4773000 4774000	Non-federal Land
2	17TNH5811		551000	4781000	
3	17TNH5970		557000	4790000	
4	17TNH5981 17TNH5982		558000 558000	4791000 4792000	
5	17TNH5839		553000	4789000	
6	17TNH5971 17TNH5981		557000 558000	4791000 4791000	
7	17TMH4194 17TMH4195	Elgin	449000 449000	4714000 4715000	Non-federal Land
8	17TMH5104		450000	4714000	
9	17TNH1228 17TNH1237 17TNH1238		512000 513000 513000	4728000 4727000 4728000	
10	17TNH2211 17TNH2212 17TNH2221 17TNH2222		521000 521000 522000 522000	4721000 4722000 4721000 4722000	
11	17TNH1320 17TNH1321 17TNH1330 17TNH1331		512000 512000 513000 513000	4730000 4731000 4730000 4731000	
12	17TNH9380 17TNH9390		498000 499000	4730000 4730000	
13	17TMH9371 17TMH9372 17TMH9381 17TMH9382		497000 497000 498000 498000	4731000 4732000 4731000 4732000	
14	17TNH0213 17TNH0214		501000 501000	4723000 4724000	
15	17TMH8265 17TMH8266		486000 486000	4725000 4726000	
16	17TMH9243		494000	4723000	
17	17TMH5111 17TMH5112 17TMH5121 17TMH5122		451000 451000 452000 452000	4711000 4712000 4711000 4712000	
18	17TNH2217 17TNH2218 17TNH2227 17TNH2228		521000 521000 522000 522000	4727000 4728000 4727000 4728000	
19	17TNH1257		515000	4727000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
20	17TNH9265 17TNH9275 17TNH9276 17TNH9285		496000 497000 497000 498000	4725000 4725000 4726000 4725000	
21	17TMH5124 17TMH5125 17TMH5135		452000 452000 453000	4714000 4715000 4715000	
22	17TMH8269 17TMH8279		486000 487000	4729000 4729000	
23	17TNH1286 17TNH1287		518000 518000	4726000 4727000	
24	17TNH1267		516000	4727000	
25	17TNH0279 17TNH0289 17TNH0299 17TNH0370 17TNH0380 17TNH0390		507000 508000 509000 507000 508000 509000	4729000 4729000 4729000 4730000 4730000 4730000	
26	17TNH1394 17TNH2303 17TNH2304 17TNH2314		519000 520000 520000 521000	4734000 4733000 4734000 4734000	
27	17TNH1296 17TNH1297		519000 519000	4726000 4727000	
28	17TMH4128 17TMH4129		442000 442000	4718000 4719000	
29	17TNH1294 17TNH2204		519000 520000	4724000 4724000	
30	17TMH4029		442000	4709000	
31	17TNH2300 17TNH2301 17TNH2302 17TNH2311 17TNH2312		520000 520000 520000 521000 521000	4730000 4731000 4732000 4731000 4732000	
32	17TMH4156 17TMH4157		445000 445000	4716000 4717000	
33	17TMH4165 17TMH4175		446000 447000	4715000 4715000	
34	17TMH9294 17TNH0204		499000 500000	4724000 4724000	
35	17TMH9258 17TMH9259 17TMH9268 17TMH9269		495000 495000 496000 496000	4728000 4729000 4728000 4729000	
36	17TLG4593 17TLG4594	Essex	349000 349000	4653000 4654000	Non-federal Land
37	17TLG7526		372000	4656000	
38	17TLG3718		331000	4678000	
39	17TLG3800 17TLG3801		330000 330000	4680000 4681000	
40	17TLG2871		327000	4681000	
41	17TLG6644		364000	4664000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
42	17TLG7544 17TLG7545 17TLG7554 17TLG7555		374000 374000 375000 375000	4654000 4655000 4654000 4655000	
43	17TLG7547		374000	4657000	
44	17TLG7537 17TLG7547		373000 374000	4657000 4657000	
45	17TLG7569		376000	4659000	
46	17TLG7530		373000	4660000	
47	17TLG4551 17TLG4552		345000 345000	4651000 4652000	
48	17TLG7622		372000	4622000	
49	17TNH4395 17TNH5395	Norfolk	549000 550000	4735000 4735000	Non-federal Land
50	17TNH4337 17TNH4338		543000 543000	4737000 4738000	
51	17TNH3399 17TNH3490 17TNH3491 17TNH4390 17TNH4400 17TNH4401		539000 539000 539000 540000 540000 540000	4739000 4740000 4741000 4739000 4740000 4741000	
52	17TNH5259 17TNH5340 17TNH5340 17TNH5351 17TNH5360		555000 554000 555000 555000 556000	4729000 4730000 4730000 4731000 4730000	
53	17TNH4363 17TNH4364 17TNH4373 17TNH4374 17TNH4384 17TNH4394 17TNH4395		546000 546000 547000 547000 548000 549000 549000	4733000 4734000 4733000 4734000 4734000 4734000 4735000	
54, 55	17TNH2235 17TNH2236 17TNH2276 17TNH2277		523000 523000 527000 527000	4725000 4726000 4726000 4727000	
56	17TNH2251 17TNH2252 17TNH2261 17TNH2262		525000 525000 526000 526000	4721000 4722000 4721000 4722000	
57	17TNH2283 17TNH2284 17TNH2293		528000 528000 529000	4723000 4724000 4723000	
58	17TNH2241 17TNH2242 17TNH2251 17TNH2252		524000 524000 525000 525000	4721000 4722000 4721000 4722000	
59	17TNH2199 17TNH2290 17TNH3109		529000 529000 530000	4719000 4720000 4719000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
60	17TNH3308 17TNH3309 17TNH3319 17TNH3400		530000 530000 531000 530000	4738000 4739000 4739000 4740000	
61	17TNH2450		525000	4740000	
62	17TNH5475 17TNH5485		557000 558000	4745000 4745000	
63	17TNH5578		557000	4758000	
64	17TNH5556 17TNH5557 17TNH6631		555000 555000 563000	4756000 4757000 4761000	
65, 66	17TNH3346 17TNH3347 17TNH3356 17TNH3357 17TNH3365 17TNH3366 17TNH3375 17TNH3376		534000 534000 535000 535000 536000 536000 537000 537000	4736000 4737000 4736000 4737000 4735000 4736000 4735000 4736000	
67	17TNH3345 17TNH3346		534000 534000	4735000 4736000	
68	17TNH4212 17TNH4213 17TNH4222 17TNH4223		541000 541000 542000 542000	4722000 4723000 4722000 4723000	
69	17TNH4214 17TNH4224 17TNH4225		541000 542000 542000	4724000 4724000 4725000	
70	17TNH4215 17TNH4216 17TNH4225 17TNH4226		541000 541000 542000 542000	4725000 4726000 4725000 4726000	
71	17TNH3283 17TNH3293		538000 539000	4723000 4723000	
72	17TNH3241 17TNH3242 17TNH3251 17TNH3252 17TNH3262		534000 534000 535000 535000 536000	4721000 4722000 4721000 4722000 4722000	
73	17TNH3159 17TNH3169 17TNH3179 17TNH3250 17TNH3251 17TNH3260 17TNH3261		535000 536000 537000 535000 535000 536000 536000	4719000 4719000 4719000 4720000 4721000 4720000 4721000	
74	17TNH4474 17TNH4475		547000 547000	4744000 4745000	
75	17TNH5566 17TNH5567		556000 556000	4756000 4756000	
76	17TNH4585 17TNH4595		548000 549000	4755000 4755000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
77	17TNH4577 17TNH4578 17TNH4588		547000 547000 548000	4757000 4758000 4758000	
78	17TNH6406		560000	4746000	
79	17TNH5408		550000	4748000	
80	17TNH4496 17TNH4497 17TNH5406 17TNH5407 17TNH5416 17TNH5417		549000 549000 550000 550000 551000 551000	4746000 4747000 4746000 4747000 4746000 4747000	
81	17TNH4451 17TNH4452		545000 545000	4741000 4742000	
83	17TNH4379 17TNH4470 17TNH4480		547000 547000 548000	4730000 4740000 4740000	
83, 84, 85	17TNH4398 17TNH4399 17TNH4490 17TNH5308 17TNH5309 17TNH5329 17TNH5400 17TNH5420 17TNH5430		549000 549000 549000 550000 550000 552000 550000 552000 553000	4738000 4739000 4740000 4738000 4739000 4739000 4740000 4740000 4740000	
86	17TNH5335		553000	4735000	
87	17TNH5317 17TNH5327		551000 552000	4737000 4737000	
88	17TNH4396 17TNH4397 17TNH5306 17TNH5307		549000 549000 550000 550000	4736000 4737000 4736000 4737000	
89	17TNH4372 17TNH4373		547000 547000	4732000 4733000	
90, 91	17TNH4338 17TNH4345 17TNH4346 17TNH4347 17TNH4348 17TNH4355 17TNH4357 17TNH4358		543000 544000 544000 544000 544000 545000 545000 545000	4738000 4735000 4736000 4737000 4738000 4735000 4737000 4738000	
92	17TNH4327 17TNH4328		542000 542000	4737000 4738000	
93	17TNH5219 17TNH5229 17TNH5310 17TNH5320		551000 552000 551000 552000	4729000 4729000 4730000 4730000	
94	17TNH5219 17TNH5229		551000 552000	4729000 4729000	
95	17TNH5236 17TNH5246 17TNH5247		553000 554000 554000	4726000 4726000 4727000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
96	17TNH4284 17TNH4294		548000 549000	4724000 4724000	
97, 98	17TNH4266 17TNH4267 17TNH4276 17TNH4277		546000 546000 547000 547000	4726000 4727000 4726000 4727000	
99	17TNH4237 17TNH4246 17TNH4247 17TNH4248 17TNH4257 17TNH4258		543000 544000 544000 544000 545000 545000	4727000 4726000 4727000 4728000 4727000 4728000	
100	17TNH4231 17TNH4232		543000 543000	4721000 4722000	
101	17TNH3282		538000	4722000	
102	17TNH3257 17TNH3266 17TNH3267		535000 536000 536000	4727000 4726000 4727000	
103	17TNH3228 17TNH3238 17TNH3239		532000 533000 533000	4728000 4728000 4729000	
104	17TNH3388 17TNH3398		538000 539000	4738000 4738000	
105	17TNH3201 17TNH3202 17TNH3211 17TNH3212		530000 530000 531000 531000	4721000 4722000 4721000 4722000	
106	17TNH2232		523000	4722000	
107	17TNH2380 17TNH2381 17TNH2391		528000 528000 529000	4730000 4731000 4731000	
108	17TNH4362 17TNH4363		546000 546000	4732000 4733000	
109	17TNH3353 17TNH3354		535000 535000	4733000 4734000	
110	17TNH2347 17TNH2348		524000 524000	4737000 4738000	
111	17TNH2296 17TNH2297 17TNH3206 17TNH3207		529000 529000 530000 530000	4726000 4727000 4726000 4727000	
112	17TNH2399 17TNH2490 17TNH3309 17TNH3400		529000 529000 530000 530000	4739000 4740000 4739000 4740000	
113	17TNH5508		550000	4758000	
114	17TNH2379 17TNH2470		527000 527000	4739000 4740000	
115	17TNH3322 17TNH3332		532000 533000	4732000 4732000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
116	17TNH3323 17TNH3324 17TNH3333 17TNH3334		532000 532000 533000 533000	4733000 4734000 4733000 4734000	
117	17TPH1514 17TPH1524	Haldimand	611000 612000	4754000 4754000	Non-federal Land
118	17TPH1571		617000	4751000	
119	17TPH0575 17TPH0576		607000 607000	4755000 4756000	
120	17TPH1500 17TPH1510		610000 611000	4750000 4750000	
121	17TNH9630 17TNH9631 17TNH9640 17TNH9641		593000 593000 594000 594000	4760000 4761000 4760000 4761000	
122	17TNH8555 17TNH8556 17TNH8565 17TNH8566		585000 585000 586000 586000	4755000 4756000 4755000 4756000	
123	17TNH9916 17TNH9917 17TNH9926 17TNH9927	Halton	591000 591000 592000 592000	4796000 4797000 4796000 4979000	Non-federal Land
124	17TNJ9008 17TNJ9017 17TNJ9018 17TNJ9027		590000 591000 591000 592000	4808000 4807000 4808000 4807000	
125, 126	17TPJ0023 17TPJ0024 17TPH0034		603000 602000 603000	4803000 4804000 4804000	
127, 128	17TNH8986 17TNH8996 17TNH8997 17TNH9906 17TNH9916		588000 589000 589000 590000 591000	4796000 4796000 4797000 4796000 4976000	
129	17TNH9907		590000	4797000	
130	17TNH7885 17TNH7886 17TNH7895 17TNH7896 17TNH7897 17TNH8805 17TNH8806 17TNH8807 17TNH8815 17TNH8816	Hamilton	578000 578000 579000 579000 579000 580000 580000 580000 581000 581000	4785000 4786000 4785000 4786000 4787000 4785000 4786000 4787000 4785000 4786000	Non-federal Land
131	17TNH7887 17TNH7888 17TNH7897 17TNH7898		578000 578000 579000 579000	4787000 4788000 4787000 47880000	
132	17TNH7857 17TNH7867		475000 476000	4787000 4787000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
133	17TNH8857 17TNH8856 17TNH8867 17TNH8868		585000 585000 586000 586000	4787000 4788000 4787000 4788000	
134	17TNH7879 17TNH7889 17TNH7970 17TNH7980		577000 578000 577000 578000	4789000 4789000 4790000 4790000	
135	17TNH8972 17TNH8982		587000 588000	4792000 4792000	
136	17TNH8921 17TNH8922 17TNH8931 17TNH8932		582000 582000 583000 583000	4791000 4792000 4791000 4792000	
137	17TNH8809 17TNH8819 17TNH8900 17TNH8910 17TNH8920 17TNH8921		580000 581000 580000 581000 582000 582000	4789000 4789000 4790000 4790000 4790000 4791000	
138	17TNH7992		579000	4792000	
139	17TNH7897 17TNH7898 17TNH8807 17TNH8808		579000 579000 580000. 580000	4787000 4788000 4787000 4788000	
140	17TNH8865		586000	4785000	
141	17TMH1039 17TMH1040	Chatham-Kent	413000 414000	4709000 4709000	Non-federal Land
142	17TMH2185 17TMH2186 17TMH2196		428000 428000 429000	4715000 4716000 4716000	
143	17TMH2167 17TMH2168		426000 426000	4717000 4718000	
144	17TMG4919 17TMH4010 17TMH4011 17TMH4020 17TMH4021		441000 441000 441000 442000 442000	4699000 4700000 4701000 4700000 4701000	
145	17TMH2104 17TMH2105		420000 420000	4714000 4715000	
146	17TMH1089 17TMH1099		418000 419000	4709000 4709000	
147	17TMH2087 17TMH2097 17TMH2098		428000 429000 429000	4707000 4707000 4708000	
148	17TLG7690 17TLG8600		379000 380000	4660000 4660000	
149	17TMH6521	Middlesex	462000	4751000	Non-federal Land
150	17TMH7515 17TMH7516		471000 471000	4755000 4756000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
151	17TMH3213 17TMH3214 17TMH3223 17TMH3224		431000 431000 432000 432000	4723000 4724000 4723000 4724000	
152	17TMH3221 17TMH3222 17TMH3223 17TMH3230 17TMH3231 17TMH3232 17TMH3233 17TMH3234 17TMH3240 17TMH3241 17TMH3242 17TMH3243 17TMH3244 17TMH3252 17TMH3253 17TMH3254		432000 432000 432000 433000 433000 433000 433000 433000 434000 434000 434000 434000 434000 435000 435000 435000	4721000 4722000 4723000 4720000 4721000 4722000 4723000 4724000 4720000 4721000 4722000 4723000 4724000 4722000 4723000 4724000	
153	17TMH6593		469000	4753000	
154	17TMH5572		457000	4752000	
155	17TMH3211		431000	4721000	
156	17TMH7544		474000	4754000	
157	17TMH3228		432000	4728000	
158	17TMH7545		474000	4755000	
159	17TMH3215		431000	4725000	
160	17TPH3615 17TPH3616	Niagara	631000 631000	4765000 4766000	Non-federal Land
161	17TPH3635 17TPH3636		633000 633000	4765000 4766000	
162	17TPH3636		633000	4766000	
163	17TPH3635		633000	4765000	
164	17TPH3668 17TPH3678		636000 637000	4768000 4768000	
165	17TPH57383 17TPH5748		653000 654000	4778000 4778000	
166	7TPH3688		638000	4768000	
167	17TPH3792 17TPH3793 17TPH3794 17TPH4702 17TPH4703 17TPH4704		639000 639000 639000 640000 640000 640000	4772000 4773000 4774000 4772000 4773000 4774000	
168	17TPH2919 17TPH2929 17TPH2610 17TPH2620		621000 622000 621000 622000	4759000 4759000 4760000 4760000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
169	17TPH3689 17TPH3770 17TPH3771 17TPH3780 17TPH3781		638000 637000 637000 638000 638000	4769000 4770000 4771000 4770000 4771000	
170	17TPH5870 17TPH5880		657000 658000	4780000 4780000	
171	17TPH5760 17TPH5761 17TPH5762		656000 656000 656000	4770000 4771000 4772000	
172	17TPH5769 17TPH5779 17TPH5760 17TPH5770		656000 657000 656000 657000	4779000 4779000 4780000 4780000	
173	17TPH5738		653000	4778000	
174	17TPH3850		635000	4780000	
175	17TPH3745 17TPH3746		634000 634000	4775000 4776000	
176	17TPH1852 17TPH1853 17TPH1862 17TPH1863		615000 615000 616000 616000	4782000 4783000 4782000 4783000	
177	17TPH1872 17TPH1881 17TPH1882 17TPH1891		617000 618000 618000 619000	4782000 4781000 4782000 4781000	
178	17TPH2800 17TPH2801 17TPH2810		620000 620000 621000	4780000 4781000 4780000	
179	17TPH2568 17TPH2569		626000 626000	4758000 4759000	
180	17TPH3642		634000	4762000	
181	17TPH3653 17TPH3654		635000 635000	4763000 4764000	
182	17TPH3636		633000	4766000	
183	17TPH3646		634000	4766000	
184	17TPH3647		634000	4767000	
185	17TPH3666		636000	4766000	
186	17TPH4605		640000	4765000	
187	17TPH4605 17TPH4606		640000 640000	4765000 4766000	
188	17TPH3669		636000	4769000	
189	17TPH3687 17TPH3697 17TPH3698		638000 639000 639000	4767000 4767000 4768000	
190	17TPH4608 17TPH4609		640000 640000	4768000 4769000	
191	17TPH3687		638000	4767000	
192	17TPH3699 17TPH4609		639000 640000	4769000 4769000	
193	17TPH4704		640000	4774000	

Critical Habitat units	1 x 1 km Standardized UTM Grid Square ID[1]	County	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
194	17TPH2553		625000	4753000	
	17TPH2554		625000	4754000	
195	17TNJ5002	Waterloo	550000	4802000	Non-federal Land
	17TNJ5003		550000	4803000	
	17TNJ5012		551000	4802000	
	17TNJ5013		551000	4803000	
196	17TNH5984		558000	4794000	
	17TNH5985		558000	4950000	
197	17TNH5994		559000	4794000	
198	17TNJ5094	Wellington	559000	4804000	Non-federal Land
	17TNJ5095		559000	4805000	
	17TNJ6004		560000	4804000	
	17TNJ6005		560000	4805000	
	17TNJ6006		560000	4806000	
	17TNJ6015		561000	4805000	
199	17TMH2162		426000	4712000	
	17TMH2171		427000	4711000	
	17TMH2172		427000	4712000	
	17TMH2173		427000	4713000	
	17TMH2181		428000	4711000	
	17TMH2182		428000	4712000	
	17TMH2183		428000	4713000	
	17TMH2184		428000	4714000	
	17TMH2192		429000	4712000	
	17TMH2193		429000	4713000	
200	17TNH3511	Oxford	531000	4751000	Non-federal Land
	17TNH3521		532000	4751000	
201	17TMH1267	Lambton	416000	4727000	Non-federal Land
	17TMH1268		416000	4728000	
	17TMH1277		417000	4727000	
	17TMH1278		417000	4728000	

[1] Based on the standard UTM Military Grid Reference System (see http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789), where the first 2 digits and letter represent the UTM Zone, the following 2 letters indicate the 100 x 100 km standardized UTM grid, followed by 2 digits to represent the 10 x 10 km standardized UTM grid. The last 2 digits represent the 1 x 1 km standardized UTM grid containing all or a portion of the critical habitat unit. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See http://www.bsc-eoc.org for more information on breeding bird atlases).

[2] The listed coordinates are a cartographic representation of where critical habitat can be found, presented as the southwest corner of the 1 x 1 km standardized UTM grid square containing all or a portion of the critical habitat unit. The coordinates may not fall within critical habitat and are provided as a general location only.

[3] Land tenure is provided as an approximation of the types of land ownership that exist where critical habitat has been identified and should be used for guidance purposes only. Accurate land tenure will require cross referencing critical habitat boundaries with surveyed land parcel information.

Appendix C: Ecosites for Known or Newly Found (and Accessible) American Chestnut (Tindall et al. 2004; Boland et al. 2012)

ELC Community Series (ELC Code)	ELC Ecosite (ELC Code)
Treed Cliff (CLT)	
Deciduous Forest (FOD)	- Dry-fresh Oak Deciduous Forest Ecosite (FOD1) - Dry-fresh Oak-Maple-Hickory Deciduous Forest Ecosite (FOD2) - Dry-fresh Deciduous Forest Ecosite (FOD4) - Dry-fresh Sugar Maple Deciduous Forest Ecosite (FOD5) - Fresh-moist Sugar Maple Deciduous Forest Ecosite (FOD6) - Fresh-moist Lowland Deciduous Forest Ecosite (FOD7) - Fresh-moist Oak-Maple-Hickory Deciduous Forest Ecosite (FOD9)
Mixed Forest (FOM)	- Dry-Oak-Pine Mixed Forest Ecosite (FOM1) - Dry-fresh White Pine-Maple-Oak Mixed Forest Ecosite (FOM2)
Coniferous Forest (FOC)	- Dry-fresh Pine Coniferous Forest Ecosite (FOC1)

Part 2 – *Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario,* prepared for the Ontario Ministry of Natural Resources

Ali en Woodliffe

American Chestnut
(Castanea dentata) in Ontario

Ontario Recovery Strategy Series

Recovery strategy prepared under the *Endangered Species Act, 2007*

Natural. Valued. Protected.

Ministry of Natural Resources

Ontario

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the Endangered Species Act (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. There is a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources Species at Risk webpage at: www.ontario.ca/speciesatrisk

RECOMMENDED CITATION

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Cette publication hautement spécialisée Recovery strategies prepared under the *Endangered Species Act, 2007*, *n'est disponible qu'en Anglais en vertu du Règlement 411/97 qui en exempte l'application de la Loi sur les services en français. Pour obtenir de l'aide en français, veuillez communiquer avec Pamela Wesley au ministère des Richesses naturelles au 705-755-5217.*

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DECLARATION

The recovery strategy for the American Chestnut has been prepared in accordance with the requirements of the *Endangered Species Act,* 2007 (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

RESPONSIBLE JURISDICTIONS

Ontario Ministry of Natural Resources
Environment Canada, Canadian Wildlife Service – Ontario Region

EXECUTIVE SUMMARY

American Chestnut (*Castanea dentata)* was a dominant forest tree species in northeastern North America before populations were devastated by the introduction in 1904 of the fungal pathogen, *Cryphonectria parasitica*, which causes chestnut blight. By the 1950s, American Chestnut had been devastated throughout its native range. In southwestern Ontario, populations of American Chestnut were reduced to far less than one percent of the original 1.5 to 2.0 million trees estimated to have been present. Recent surveys in 2001 to 2003 confirmed that Ontario has at least 601 mature and immature individuals of American Chestnut, but this estimate likely represents 30 to 70 percent of the total number in Canada. The native range in Ontario accounts for 3.9 percent of the native range of American Chestnut in North America. In 1987, American Chestnut was designated as a threatened species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and in 2004 was re-designated as endangered. American Chestnut is listed as endangered on the Species at Risk in Ontario (SARO) List and receives protection under the *Endangered Species Act, 2007* (ESA).

American Chestnut's native range extends from southern New England to the southern Appalachian mountains. It still survives as remnant populations and individuals throughout this range, mainly by resprouting from collars of surviving root systems. During a survey conducted from 1994 to 1997, American Chestnut was identified at 135 sites in southwestern Ontario. Approximately 58 percent of the sites contained only one tree or regenerating clump. Between 2001 and 2003, 601 individuals were located at 94 sites (average of 6.5 per site); nearly 50 percent of these were less than 10 m tall and greater than 10 cm in diameter at breast height. At least 60 of the 601 individuals showed evidence of flowering or producing burs, however, these trees produced no detectable seed. Approximately one half of the sites containing surviving chestnut were located in Elgin, Haldimand and Norfolk counties.

The goal of this recovery strategy is to restore American Chestnut populations in Ontario to a self-sustaining state, whereby natural recruitment results in the maintenance or an increase of current population size throughout the species' native range. The objectives of this recovery strategy are to:

1. survey suitable habitat and/or formerly occupied habitat for American Chestnut, and protect and monitor known populations within the species' native range in Ontario;
2. promote protection and public awareness of American Chestnut;
3. develop and evaluate management measures to control threats; and
4. secure Ontario sources of germplasm originating from blight-free trees.

Initiation and/or completion of these objectives will contribute to increased knowledge and conservation of remnant populations of American Chestnut in Canada and assess strategies for improved management of chestnut blight.

Chestnut blight continues to have the greatest negative impact on populations of American Chestnut. Other factors such as loss and degradation of habitat, possible hybridization with other *Castanea* species, and the possible introduction of oriental gall wasp (*Dryocosmus kuriphilus* Yasumatsu) from the United States are also of concern.

Until the impact of chestnut blight can be reduced, restoring American Chestnut to a more secure position in the Carolinian forest is unlikely. Therefore, approaches to control chestnut blight are critical. Potential approaches include hypovirulence (a viral infection that weakens the blight fungus), natural resistance to disease and breeding for disease resistance. Although hypovirulence has been successful in controlling blight in Europe, there has been less success using this approach in North America. Further research may identify factors that contribute to increased efficacy. Qualitative or complete resistance to blight has not been observed in surviving populations of American Chestnut, but concerted attempts have been and continue to be made to identify and select quantitative or incomplete resistance. Finally, breeding programs using resistance genes from Asian chestnut species are underway in the United States and more recently in Canada. Here emphasis has been placed on incorporating this resistance into germplasm adapted to environmental conditions within the native range of American Chestnut in southwestern Ontario.

It is recommended that the Ecological Land Classification (ELC) ecosite types where one or more American Chestnut trees currently occur or where one or more individuals were previously documented in written reports or surveys (for example, Ambrose and Aboud 1987, Melzer et al. 2004, Tindall et al. 2004, Natural Heritage Resource Centre database, etc.) be prescribed as habitat within a habitat regulation under the ESA. It is recommended that trees planted for horticulture, landscaping or research be exempt from the habitat regulation but should be individually assessed for genetic conservation value.

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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME (population): American Chestnut
SCIENTIFIC NAME: *Castanea dentata*
SARO List Classification: Endangered
SARO List History: Endangered (2008), Endangered – Not Regulated (2005), Threatened (2004)
COSEWIC Assessment History: Endangered (2004), Threatened (1987)
SARA Schedule 1: Endangered (August 15, 2006)
CONSERVATION STATUS RANKINGS: GRANK: G4 NRANK: N3 SRANK: S2

The glossary provides definitions for technical terms, including the abbreviations above.

1.2 Species Description and Biology

Species Description

American Chestnut (*Castanea dentata*) is a member of the *Fagaceae* or Beech family. There are up to 14 described species of trees and shrubs in the genus *Castanea*. These species include Chinese Chestnut (*C. mollissima*), European Chestnut (C. sativa), Japanese Chestnut (*C. crenata*), Henry Chinquapin (*C. henryi*), Ozark Chinquapin (*C. ozarkensis*), Seguin Chestnut (*C. seguinii*) and Allegheny Chestnut (*C. pumila*). Only American Chestnut is native to Canada (Farrar 1995). However, Chinese Chestnut and hybrids and to a lesser extent, European Chestnut and Japanese Chestnut have been planted within the range of American Chestnut. Over the past two centuries, American Chestnut was initially considered as a range extension of European Chestnut, then as a variety of European Chestnut, and finally as a distinct North American species (Sudworth 1892).

American Chestnut is a large, deciduous canopy tree, that can grow up to 30 m tall and have a trunk up to 1.5 m in diameter, with smooth dark brown/olive bark that separates into broad flat-topped ridges with age. Leaves are yellowish-green, alternate and simple, 15 to 28 cm long and taper to both ends. Leaves have 15 to 20 veins running parallel on each side and each vein ends in a prominent tooth. American Chestnut is monoecious and self-incompatible with male flowers occurring in catkins and female flowers occurring singly or in small clusters at the base of some catkins. Trees flower in late May to early July and are insect-pollinated (Ambrose and Kevan 1990). One to

three nuts are enclosed in a spiny husk, five to eight centimetres across and are edible. Nuts usually mature by first autumn frost and are primarily dispersed by small mammals and birds that cache or bury them. American Chestnut has a faster rate of growth than other associated hardwood species and under good site conditions, mature trees can increase in diameter by up to 2.5 cm per year (Kuhlman 1978).

Species Biology

American Chestnut can begin to produce seed as early as eight years of age. The life-cycle of forest canopy trees such as American Chestnut has two critical phases: (1) establishing seedlings in the understory; and (2) attaining a favourable position in the canopy after a disturbance (Paillet, 1994). As it is shade tolerant, American Chestnut typically persists in the understory of relatively open oak-dominated forests but responds rapidly to openings that develop in the canopy. When a chestnut tree is cut or the above ground part dies from blight, the root collar typically survives and gives rise to new sprouts. However, the repeated harvesting or re-infection of stems can weaken and eventually kill the entire tree (Paillet 1994).

Ecology

Although American Chestnut still persists in some areas, it no longer persists in sufficient numbers to fulfill its former ecological role. Many organisms were directly or indirectly influenced by this tree. Most of the species that relied on American Chestnut for food were considered to be generalists including: deer, rodents, insects and bird species. It is thought that these species now browse other nuts such as acorns, walnuts, beech nuts and hickory nuts.

Information on the diversity of phytophagous (plant-eating) insects on *Castanea* species in North America is not available, particularly before the introduction of chestnut blight. However, chestnut stems and blight cankers were found to harbour a large, diverse insect fauna of at least 495 insect species (Russin et al. 1984), the majority of which were from the Coleoptera and Diptera families. The pandemic of chestnut blight on American Chestnut is thought to have resulted in the decline or extinction of several phytophagous insects (Opler 1979, cited in Harvell et al. 2002). The Lesser Chestnut Weevil (*Curculio sayi* Gyllenhal) and Larger Chestnut Weevil (*Curculio caryatrypes* Boheman) are both native to North America but since the decline of American Chestnut, have become less common (Bessin 2003). The Clearwing Chestnut Moth (*Synanthedon castanae* Busck) was previously thought to have become extinct in the northeastern United States but was rediscovered in Connecticut in 1989 (Anagnostakis et al. 1994). Recent introductions have also occurred. For example, the Chestnut Gall Wasp (*Dryocosmus kuriphilus* Yasumatsu) was first reported in the United States in 1974 and is known to feed on *Castanea* species (Rieske 2007).

American Chestnut also has indirect ecological effects on associated species. Smock and MacGregor (1988) discovered that chestnut leaves altered the consumption rates, growth, and fecundity of shredding macro-invertebrates in headwater streams in the United States. The authors concluded that headwater streams in areas affected by chestnut blight may have experienced subtle changes at the population, community and

ecosystem levels due to the demise of chestnut. Other organisms, including a diversity of fungi, bacteria and viruses, were possibly impacted by the decline of American Chestnut but there is little documentation of these possible changes.

Cultural and Economic Significance

American Chestnut had an important historical role in many rural economies. The nuts were used to fatten livestock and were stored as a winter food source. The nuts were also an important cash crop for many rural families and nuts were sent to major cities over the Christmas season to be roasted and sold by street vendors. One railroad station in West Virginia was reported to have shipped 70,300 kg of chestnuts in 1911 (Giddings 1912 as reported by Kuhlman 1978).

American Chestnut was also an excellent timber tree. Forest-grown trees grew straight and were often free of branches for 50 feet (15 m). The wood was straight-grained, easy to work and rot-resistant. The wood was used for telegraph poles, railroad ties, shingles, panelling, fencing, ship masts, coffins, fine furniture, musical instruments, pulp and plywood. Production of chestnut lumber reached a maximum in 1909 at 663.9 million board feet (Saucier 1973). The United States Forest Service's estimated value of chestnut timber cut in 1909 was $20 million (Detwiler 1912 as reported by Kuhlman 1978). In 1924, the volume of standing chestnut saw timber was estimated at 19.3 billion board feet in the United States.

Non-timber products derived from this species included tannins extracted from the bark and wood used for tanning leather. In the United States, chestnut was the primary source of tannin for the leather industry. In 1923, over 55 tons (50 tonnes) of tannins were extracted from chestnut wood and bark (Saucier 1973).

Indigenous peoples' use of chestnut ranged from various extractions from leaves, bark, wood and nuts to restore health, to the use of the nuts for food, including soups, puddings and bread (Moerman 2003).

American Chestnut, because of its size and canopy form, was popular in urban plantings as a shade tree. American Chestnut was, and still is, grown in plantations for commercial nut production. There is a small but growing nut industry in Ontario, comprising primarily Chinese and hybrid chestnuts.

1.3 Distribution, Abundance and Population Trends

Global Distribution and Status

Based on fossil evidence, chestnut species are estimated to have been endemic to North America for at least 17 to 20 million years. Records of chestnut pollen verify that it grew on Long Island 30,000 to 50,000 years ago. Chestnut pollen was also found in 2,000-year-old soil layers in Massachusetts (Anagnostakis and Hillman 1992).

American Chestnut, a dominant climax hardwood, comprised approximately 25 percent of the eastern deciduous forest in the United States before the introduction of chestnut blight. Its native range extended from southern New England to the southern Appalachian mountains and covered more than 80 million hectares of forest (Kuhlman 1978) (Figure 1).

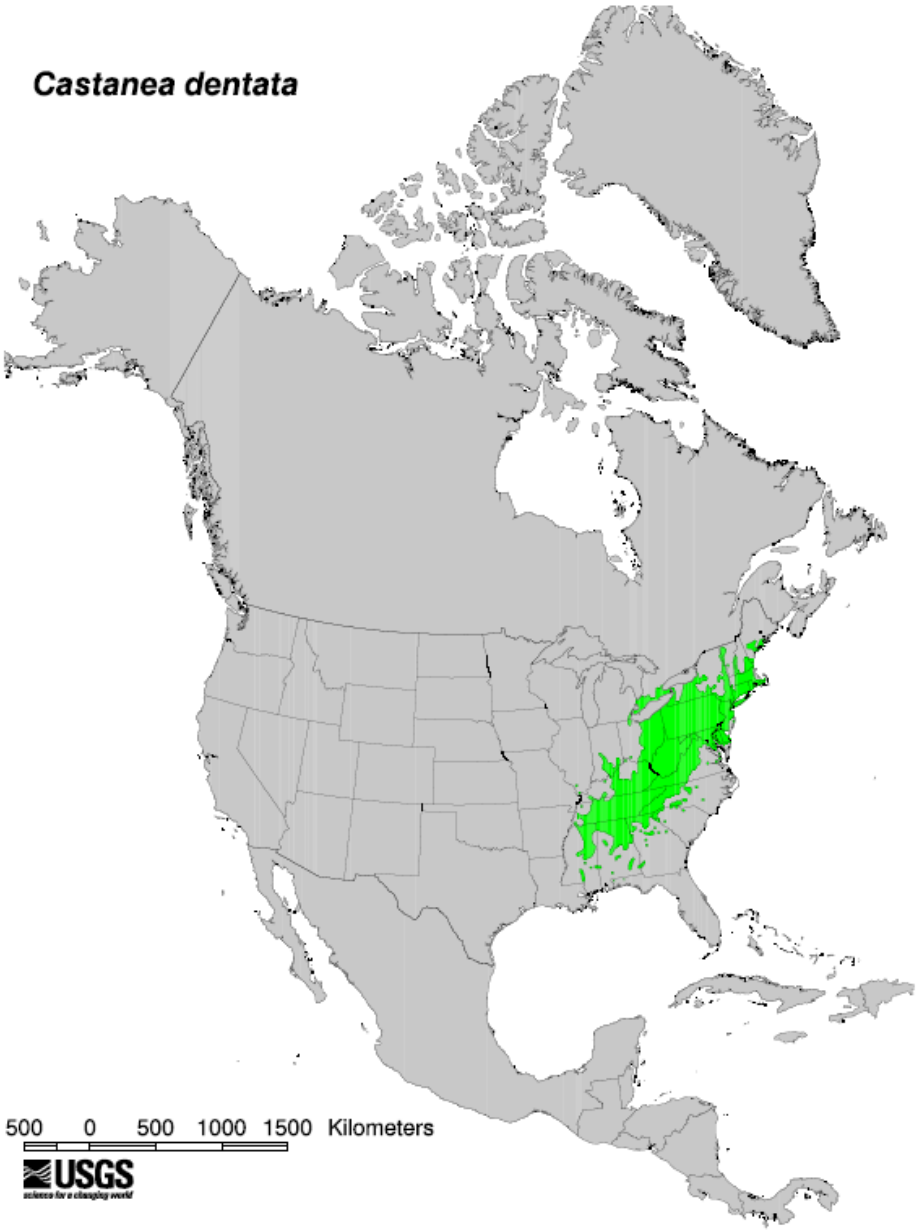

Figure 1. Natural range[1] of American Chestnut (Little 1977)

[1] Note: This range is the current and pre-blight range. The natural range of American Chestnut has not significantly changed since the arrival of chestnut blight; however, the number of trees within the natural range has declined.

The distribution of American Chestnut has been affected by four important events during the past several thousand years. These events include: (1) a post-glacial migration from south to north; (2) clearing of forests for farming; (3) commercial logging; and (4) introduction of chestnut blight to North America (Hill 1994). Following the most recent glacial retreat, this species migrated north. American Chestnut was considered a slowly dispersing species because evidence of it did not appear in New England until 2,000 years ago. Whereas Eastern White Pine (*Pinus strobus*), American Beech (*Fagus grandifolia*), crab apples and elms reached New England 9,000, 7,000 and 4,000 years ago, respectively. However, others believe that chestnut was present in New England in low numbers up to 4,500 years ago (Paillet 1994).

Clearing and logging reduced much of the eastern deciduous forest to only scattered remnants of virgin forest by the time *Cryphonectria parasitica*, the cause of chestnut blight, was introduced to North America in the early 1900s.

American Chestnut is considered 'apparently secure' with a global conservation status rank of G4. While young shoots of this species are widespread and abundant in the United States, it now seldom reaches reproductive maturity due to the presence of chestnut blight. Presumably there are millions of American Chestnut trees surviving as stumps that produce shoots, but large mature trees are extremely rare and are often isolated or cultivated far from the species' natural range (Table 1). The conservation status of American Chestnut in Canada and Ontario is ranked N3 (vulnerable) and S2 (imperilled), respectively (NatureServe, 2009).

Table 2. Conservation Status Rankings for American Chestnut (NatureServe, 2009)

Level	Conservation Status	Level	Conservation Status
Global	G4	**USA**	
Canada	N3	Michigan	S1S2
Ontario	S2	Mississippi	S1
USA	N4	Missouri	SNR
Alabama	SNR	New Hampshire	SNR
Connecticut	SNR	New Jersey	S4
Delaware	SH	New York	S5
District of Columbia	S1S2	North Carolina	S4
Florida	SX	Ohio	S3
Georgia	S3	Pennsylvania	S5
Illinois	SX	Rhode Island	SNR
Indiana	S3	South Carolina	SNR
Iowa	SNA	Tennessee	S2S3
Kentucky	S1?	Vermont	SNR
Maine	S4	Virginia	S4
Maryland	S2S3	West Virginia	S4
Massachusetts	SNR	Wisconsin	SNR

Canadian Distribution

American Chestnut naturally occurs below the 43rd parallel in Canada (Fox 1949). This region is generally referred to as the Carolinian zone of southern Ontario and represents the northwestern limits of the native range for American Chestnut in North America.

There appear to be no significant changes in the extent of the natural distribution of American Chestnut in southern Ontario from before the introduction of chestnut blight (Moss and Hosking 1983). American Chestnut occurs in 13 counties along Lake Erie from Windsor to Niagara Falls and north to London. During a survey conducted from 1994 to 1997, American Chestnut was identified at 135 sites in southwestern Ontario. Approximately 58 percent of the sites contained only one tree or regenerating clump. Over one-half of the sites reported in a 2001 to 2003 survey (Tindall et al. 2004) occurred in Elgin, Haldimand and Norfolk Counties. American Chestnut was also reported in Brant, Essex, Halton, Hamilton-Wentworth, Chatham-Kent, Lambton, Middlesex, Niagara, Waterloo and Wellington counties (Ambrose 2004, Tindall et al. 2004). Locations of known occurrence sites are shown on the following map of southern Ontario (Figure 2).

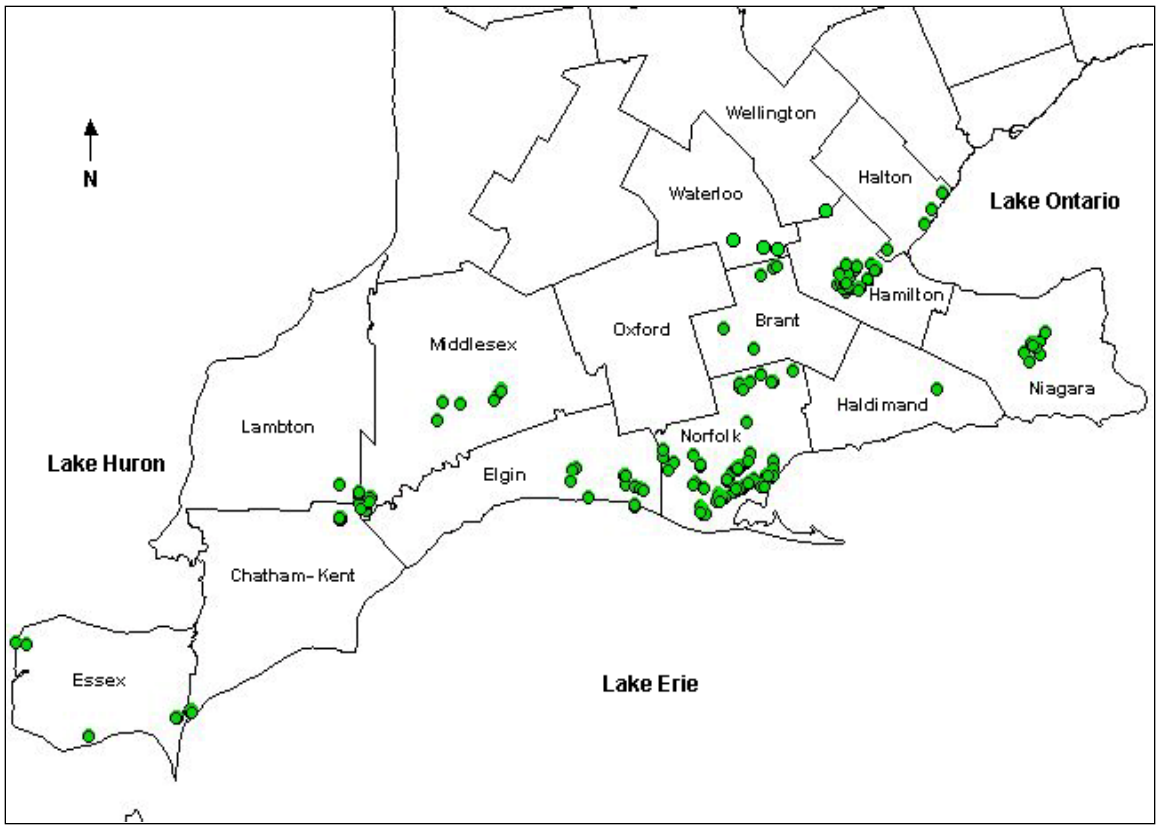

Figure 2. Known occurrence sites of American Chestnut in Ontario (Modified from Tindall et al. 2004)

Population Sizes and Trends

It is estimated that there were 1.5 to 2.0 million American Chestnut trees in southern Ontario prior to the introduction of chestnut blight in the 1920s (McKeen 1995, 1997).

The distribution of these populations was estimated to comprise 3.9 percent of the total area of distribution of American Chestnut in North America. The blight entered North America from Asia at New York City around 1904 (Gravatt and Gill 1930). By the mid-1940s, the Ontario populations of American Chestnut were devastated and declined dramatically. In 1947, sprouts that had regenerated from trees killed by blight were "common everywhere" but no living mature trees bearing nuts were found (Fox 1949).

There is little quantitative information on the decline of established populations of American Chestnut since the initial pandemics of chestnut blight. Surveys conducted in recent years are not comparable because of differences in methodologies, but a standardized survey protocol developed in consultation with the American Chestnut Recovery Team, was described by Tindall et al. (2004) and will enable such comparisons in the future. The most recent survey of American Chestnut populations in Ontario located 601 mature and immature individuals (Tindall et al. 2004). In this survey, blight symptoms occurred on 25 percent of all trees and in 48 of the 94 locations inspected. The number of cankers on infected trees averaged 5.7 (ranged from one to 40) and this was often associated with the presence of epicormic shoots. Individuals without blight had significantly smaller mean diameter at breast height (DBH; 12.0 cm) than trees with blight (16.9 cm) (Tindall et al. 2004). Mean height for trees without and with blight was 8.3 m and 9.0 m, respectively. Because Tindall et al. (2004) concentrated heavily on forested public lands and frequently did not sample all trees within any given location, this is likely only 30 to 70 percent of the estimated total population.

Ambrose and Aboud (1986) reported seedlings in 7 of 62 sites, whereas Tindall et al. (2004) found none within a 20 m radius of trees in 93 locations. Low recruitment is due, in part, to the fact that few regenerating sprouts survive until reproductive age. The survey by Tindall et al. (2004) found that nearly 50 percent of all trees examined had a DBH greater than 10 cm and 80 percent were less than 20 cm. Only 14 percent were reproductive (i.e., produced catkins or burrs) and no trees were observed with viable seeds (i.e., filled nuts). Low reproductive success in otherwise healthy trees may be related to the fact that these trees are often geographically isolated and therefore, rarely cross-pollinate.

In 1985, McKeen reported that 60 trees, ranging in DBH from 8 to 63 cm, were present within the original range. Other surveys by Ambrose and Aboud (1986) and Boland et al. (1997) reported 151 trees over 10 cm DBH, plus numerous uncounted smaller stump sprouts and 297 individuals, respectively. These surveys differed in objectives, search intensity and procedures and, hence, the values estimated from the three studies are not comparable and likely do not reflect a population trend. Derivation of a population estimate for the total number of chestnut stems in North America was precluded by missing data from the United States (McWilliams et al. 2005).

1.4 Habitat Needs

American Chestnut occurs in a variety of habitats but is most abundant on well-drained, acidic, sand and gravel soils. In Ontario, American Chestnut most often occurs in regions where the frost-free period ranges from 140 to 180 days, extreme temperatures range from lows of -27 to -29 degrees Celsius and highs of 40 to 41 degrees Celsius, precipitation ranges from 760 to 970 mm of rain plus 89 to 178 cm of snow, with soil pH ranges from four to six (Ambrose and Aboud 1986, Tindall et al. 2004), soil sand content ranges from 50 to 90 percent and elevation ranges from 90 to 290 m (Boland et al. 1997). Most individuals occur in forest or woodland ecosites in which the canopy cover exceeds 70 percent (Tindall et al. 2004). Habitats are most often dominated by oak [predominantly White Oak (*Quercus alba*) and Red Oak (*Q. rubra*)] or maple [predominantly Red Maple (*Acer rubrum)* and Sugar Maple (*A. saccharum*)], with regular occurrences of species such as: Eastern White Pine*,* Shagbark Hickory (*Carya ovata*)*,* Black Cherry (*Prunus serotina*)*,* Sassafras (*Sassafras albidum*)*,* White Ash (*Fraxinus americana*) and American Beech (Ambrose and Aboud 1986, Tindall et al. 2004). Under the Ecological Land Classification (ELC) system (Lee et al. 1998), American Chestnut was found predominantly in three community series: (1) mixed forest; (2) deciduous forest; and (3) treed cliffs (Tindall et al. 2004). The majority (97%) were located in forest or woodland habitats and 79 percent occurred in oak and (or) maple forest ecosites.

1.5 Limiting Factors

American Chestnut is a shade tolerant species that has a self-incompatible breeding system (prevents self fertilization) and therefore requires reproductively compatible trees within pollen dispersal range to produce viable seed (Ambrose and Kevan 1990). Due to chestnut blight, single chestnut trees are geographically isolated and thus availability of compatible trees for reproduction is likely a limiting factor.

Chestnut trees produce fruit with high nutritional value that provide an important food source for birds [e.g., Wild Turkey (*Meleagris gallopavo*) and jays] and for mammals (e.g., squirrels, deer and bears) (Hill 1994). Today, however, due to its low numbers, chestnut is relatively unimportant to wildlife. These wildlife species, however, can be viewed as seed predators which may limit seed dispersal when there are already extremely low numbers. American Chestnuts are long-lived organisms, which limits the rate of recovery to viable, reproductively mature populations. Conversely, the woody perennial life history also allows individual plants to persist as sprouts from surviving root systems well after the initial infection.

Although habitat availability is not a limiting factor for American Chestnut, dispersal to areas that do provide suitable habitat is limited. A large portion of the remaining Carolinian woodlands provide suitable habitat that could be enhanced through management to provide light and good microsites for the establishment and growth of

new American Chestnut trees. There are also ongoing programs of habitat restoration that will benefit American Chestnut and other Carolinian species.

1.6 Threats to Survival and Recovery

The following threats to survival and recovery of American Chestnut are listed in order of importance:

Chestnut Blight

Chestnut blight is the single greatest threat to American Chestnut in Canada. The blight was first noticed at the Bronx Zoo in 1904 on nursery stock, but it likely had multiple introductions at that time. The introduction of chestnut blight, caused by the fungus *C. parasitica* (Murrill) M.E. Barr, devastated the American Chestnut species throughout North America including Ontario. American Chestnut has persisted in southern Ontario by resprouting from the collars of surviving root systems but regenerated sprouts continue to become re-infected by the fungal pathogen. Some trees in southern Ontario are not currently showing blight symptoms. McKeen (1985) reported that 50 percent of trees had no obvious blight and Melzer and Boland (2004) found 41 percent of trees to be free of disease symptoms. In the most recent survey (Tindall et al. 2004), 325 of 459 trees assessed for blight (71%) had no obvious blight symptoms.

Chestnut blight will continue to threaten the remaining small and isolated populations of American Chestnut because it survives on sprouts and on alternative hosts. *Cryphonectria parasitica* has been observed to kill some alternative hosts but it usually exists on these hosts as a weak pathogen or saprophyte. Alternative hosts of *C. parasitica* in the Carolinian zone of southern Ontario include: White Oak, Red Oak, Black Oak (*Q. velutina*), Red Maple, Staghorn Sumac (*Rhus typhina*), Shagbark Hickory, Bur Oak (*Q. macrocarpa*), Chinquapin Oak (*Q. muhlenbergii*), Hop Hornbeam (*Ostrya virginiana*), Blue Beech (*Carpinus caroliniana*), Tulip Tree (*Liriodendron tulipifera*) and Sassafras (*Sassafras albidum*) (Mooij 1997). Locations for new plantings of American Chestnut for restoration or nut crops should be chosen carefully as they may act as a bridge to connect diseased populations of American Chestnut to isolated populations that have escaped disease.

Loss of Individuals

Loss of individuals due to clearing of forests for farming and development continues to be a threat to American Chestnut in Ontario. Several sprout clumps of chestnut occur along roadsides and are repeatedly cut back or sprayed with herbicide so they will not interfere with overhead wires. Several young trees/sprouts have been damaged or killed due to logging and others have been lost due to clearing of forests and fencerows for agriculture and urban development. While many rural land owners practice good forest management and stewardship, exceptions of poorly managed forests including unsustainable logging and even complete clearing to expand other economic activities, are having a negative impact.

Hybridization

Interbreeding between American Chestnut and three introduced chestnut species (Chinese Chestnut, Japanese Chestnut and European Chestnut) may threaten the persistence of American Chestnut in Ontario. This concern stems from the theoretical view that rare species that hybridize with a more abundant relative will by virtue of their small numbers, be assimilated into the more common genome and ultimately cease to exist as a genetically distinct taxon. Although this process has rarely been documented in other plants (Burgess and Husband 2006, Burgess et al. 2008), the potential for hybridization to affect American Chestnut may be significant. From controlled pollinations, it is clear that all four species of chestnut are inter-fertile and can produce viable hybrid offspring. In addition, Chinese Chestnut and to a lesser extent, European Chestnut and Japanese Chestnut are widely distributed and planted in southern Ontario as ornamentals and (or) for nut production. It is likely that these out-plantings are located within pollen-dispersal distance of American Chestnut populations in many locations throughout the native range.

Despite the apparent opportunities for hybridization, the actual measurable risks to American Chestnut may be quite low at this time. Cultivated trees of other *Castanea* species tend to be clustered together and restricted mostly to the margins (around homes or in nurseries) rather than the interior of American Chestnut habitat. The impact of hybridization would therefore be reduced because members of the same genus do not interact directly and American Chestnut remains in the majority within its own populations. The low occurrence of hybridization was confirmed by a recent genetic analysis of trees in southern Ontario (Gerrath 2006). Gerrath used Randomly Amplified Polymorphic DNA (RAPD) markers to genetically characterize known samples of each species. Then, by comparing these genotypes to those of wild species from the American Chestnut range, trees were screened for hybrid parentage. Sixty trees, many of which were selected as most likely to be hybrids, were sampled from the native range. Only one tree (2% of all trees sampled) was identified as a hybrid, with Japanese Chestnut as the most likely parent. Although many trees have not been assessed, these results indicate that hybridization may not be prevalent in natural populations at the current time and should be considered a low risk to Canadian populations of American Chestnut.

Despite the threat that non-indigenous *Castanea* species may pose in natural systems, it is the resistance traits that these species have evolved that may provide one of the best solutions for the recovery of American Chestnut in North America. Specifically, backcross breeding programs have been developed to incorporate the resistance component of closely related species of *Castanea* into the genome of American Chestnut. The details of this method are provided in section 2.3 of this recovery strategy.

Insect Pests

Of the insect pests that are known to feed on American Chestnut, little is known about their biology and impacts. They are, therefore, covered in the Knowledge Gaps section (Section 1.7).

1.7 Knowledge Gaps

There is sufficient literature on the biology and ecology of American Chestnut to initiate recovery. However, periodic assessment of the status of the species and additional information on the control of chestnut blight are necessary.

The effect of chestnut blight on American Chestnut is ongoing. It has increased the vulnerability of the remaining populations to potential secondary threats such as declines caused by unpredictable population dynamics or environmental disturbances and accumulation of deleterious mutations. Further study and analysis is required to determine which if any, secondary threats are affecting the species and the level and extent of threat they pose.

Hypovirulence associated with fungal viruses as a naturally-occurring biological control strategy has controlled chestnut blight well in some locations in Europe but has failed almost completely in eastern North America (Milgroom and Cortesi 2004). However, some localized results have appeared promising, particularly in Michigan and with the use of hypovirulent isolates from Europe. Research efforts are still underway in the USA to evaluate hypovirulence on a longer-term ecological scale and to identify crucial factors regulating the establishment of hypovirulence in chestnut forests.

The need to restore American Chestnut to sustainable population sizes requires the development of methods of increasing blight resistance by screening individuals in natural populations. Conservation and restoration efforts by the Canadian Chestnut Council and The American Chestnut Foundation involve selective breeding programs to enhance resistance of native American Chestnut at a faster rate than that occurring in natural populations. The various programs of ongoing research differ in specific strategy, but share the common feature of starting with an initial cross (F1) between American Chestnut and resistant individuals of Chinese Chestnut. Methods for the inoculation of trees, the identification of resistant parents and progeny and the characterization of resistance genes controlling genetic resistance are needed. This research will hopefully fill the gaps in knowledge associated with blight susceptibility and resistance in American Chestnut populations.

Although hybridization does not currently appear to be a serious threat, its role may change particularly if populations of American Chestnut continue to decline and plantings of introduced chestnut species increase. As a result it will be important to expand the screening for hybrids to other individuals in natural populations (specifically plants with uncharacteristic leaf morphology, growth architecture and reduced blight) and to monitor plant material used in out-plantings.

Another potential threat to the American Chestnut species in Ontario is the Oriental Chestnut Gall Wasp. This wasp was introduced to North America through Georgia during 1974. It is currently found in Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and Tennessee (Anon. 2009). Galls caused by these wasps suppress shoot elongation, reduce fruiting, and trees with severe

infestations often die. It is not known if the Oriental Chestnut Gall Wasp can survive the colder temperatures in the northern portions of the American Chestnut's native range.

The Chestnut Weevil *(Curculio elephas)* native to southern and central Europe, may also pose a threat to American Chestnut. Adult female weevils deposit eggs into developing nuts. After hatching, the larvae feed in the nut for several weeks. Infested nuts drop prematurely and larvae chew their way out of the nut after it has fallen. Although there are many introductions of this weevil into North America each year, it has not been observed in the wild (Venette et al. 2003). In commercial nut production, good sanitation, cultural practices and insecticides can effectively control weevils therefore the potential threat is expected to be low.

1.8 Recovery Actions Completed or Underway

Recent surveys of distribution in Ontario were documented by Ambrose and Aboud (1986), Boland et al. (1997) and Tindall et al. (2004). Details of chestnut reproductive biology were elucidated by Ambrose and Kevan (1990). Following the 1986 COSEWIC status report, several studies were conducted in Ontario on select chestnut blight strains that exhibited reduced virulence (Dunn and Boland 1993, McKeen 1995, Boland et al. 1997, Melzer et al. 1997 and Melzer and Boland 1999). These surveys and studies provided a framework from which to develop the recovery objectives outlined in the next section.

Several strategies may show promise for the management of chestnut blight. These strategies include sanitation measures (e.g. removal of dead twigs and stems that act as infection sites, and the removal of infested plant material that acts as sites for sporulation of the pathogen), fungicides, biological control and disease resistance. Diagnostic tests for resistance and early infection will be important for continuing research and management of nursery stock and out-plantings. See Appendix for a description of *C. parasitica* and symptoms of chestnut blight disease as well as steps that can be taken to prevent disease spread by humans.

<u>Assessment of the status of American Chestnut in Ontario</u>
To assess the population status of American Chestnut trees in southern Ontario, an extensive baseline survey of accessible, known or newly found populations was conducted between 2001 and 2003 using a standardized protocol (see Tindall et al. 2004). A total of 601 mature and immature individuals located in 94 sites across southern Ontario were inventoried, permanently labelled with metal tags, and georeferenced using GPS. The following data were generated from the inventory:

- diameter, height, and reproductive state of each tree;
- health condition of each tree (number and kinds of cankers and degree of tree dieback);
- habitat description, ecosystem type, other species present, canopy cover, slope and soil type, pH and texture of each site as per the ELC system protocol;

- using sanitary techniques, a very small amount of plant material in the form of leaf, bud and twig samples was collected to serve as herbarium specimens [and possibly for future gene bank (DNA) storage purposes]; and
- taxonomic status and possibility of hybridization, based on morphological, molecular and/or physiological characters.

This survey will be repeated at five to ten year intervals and the results used to assess and monitor the status of known and newly discovered populations within the species' native range in Ontario.

Activities of agencies currently engaged in recovery efforts

The Canadian Chestnut Council founded in 1988, has played an important leadership role in public awareness and in encouraging research on American Chestnut and chestnut blight. Members of the Canadian Chestnut Council have mapped many of the remaining sites of chestnut in southern Ontario and continue to monitor many of these sites. Volunteer members have pollinated and collected nuts from isolated, mature trees and have initiated plantings of chestnut seedlings. In addition the Canadian Chestnut Council initiated a disease resistance breeding program. It incorporates germplasm of American Chestnut from southern Ontario with known intra- and interspecific sources of disease resistance following a similar program of interspecific hybridization being used by The American Chestnut Foundation.

The American Chestnut Foundation was founded in 1983. The mission of the American Chestnut Foundation is to restore American Chestnut as an integral part of the eastern forest ecosystem. It maintains an extensive breeding program for developing resistance to chestnut blight. The goal of this program is to introduce resistance from Chinese Chestnut into American Chestnut while preserving as completely as possible the genome of the American Chestnut. Resistance in Chinese Chestnut appears to be controlled by two or three incompletely dominant genes. Therefore, the goal of this breeding program is to develop chestnuts that are homozygous for both resistance genes. Resistant Chinese Chestnuts are backcrossed to American Chestnuts at least four times resulting in crosses with a genome that is at least 15/16ths (94%) of American Chestnut origin. Progeny are tested for resistance by inoculation with virulent isolates of *C. parasitica* after each backcross. Final selections are intercrossed to produce the first nuts for restoration outplanting. Because the American Chestnut Foundation expects that natural selection has created populations adapted to regional conditions, it has used germplasm of American Chestnut from across the range of American Chestnut. The American Chestnut Foundation maintains breeding programs in Connecticut and Pennsylvania as well as on their main breeding farm in Virginia. The American Chestnut Foundation hopes to have its first resistant line(s) ready for planting in 2010 to 2015.

The Ontario Soil and Crop Improvement Association (OSCIA) initiated a two year project in 1998 to promote interest in the farming community in chestnut recovery and to identify farmers with suitable sites who are willing to set aside up to one acre of land to be planted with American Chestnut seedlings. In 1998 to 1999, the OSCIA coordinated

the establishment of 24 demonstration sites with a total of approximately 1,300 American Chestnuts planted in southern Ontario. Ten of the 24 sites are located outside the native range of American Chestnut.

Ongoing research into the potential of using hypovirulence as a biological control strategy is being conducted by Dr. C. McKeen, the Canadian Chestnut Council and Dr. G.J. Boland, University of Guelph. Naturally-occurring healing-type cankers have been observed in southern Ontario and putatively hypovirulent isolates have been recovered from these cankers and their hypovirulence has been confirmed in laboratory tests. Hypovirulent isolates of *C. parasitica* from Ontario were released at several locations, including an experimental site at Skunk's Misery in Middlesex and Lambton counties. Hypovirulent isolates compatible with virulent isolates at the site were inoculated around the perimeter of cankers. Expansion of treated cankers was measured in comparison with untreated cankers 15 months after inoculation. For the first one to two years after treatment, statistical differences were detected between treated and untreated cankers and after 15 months, hypovirulent isolates were recovered from 82 percent of the treated cankers. However, visual observations three to five years after inoculation were not as encouraging and many of the treated trees had died from blight. Observations will be continued at this site to see if there are any long-term effects from these treatments.

2.0 RECOVERY

2.1 Recovery Goal

To restore American Chestnut populations in Ontario to a self-sustaining state whereby natural recruitment results in the maintenance or increase of current population size throughout the species' native range.

2.2 Protection and Recovery Objectives

Table 3. Protection and recovery objectives

No.	Protection or Recovery Objective
1	Survey suitable habitat and/or formerly occupied habitat for American Chestnut and protect and monitor known populations within the species' native range in Ontario.
2	Promote protection and public awareness of American Chestnut.
3	Develop and evaluate management measures to control threats.
4	Secure Ontario sources of germplasm originating from blight-free trees.

2.3 Approaches to Recovery

Table 3. Approaches to recovery of the American Chestnut in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
1. Survey suitable habitat and/or formerly occupied habitat for American Chestnut and protect and monitor known populations within the species' native range in Ontario.				
Critical	Short-term	Inventory, Monitoring and Assessment, Research	**1.1** Survey and monitor status of known and newly discovered populations within the species' native range in Ontario: – develop survey protocol; – conduct detailed site habitat surveys and health assessment of all trees labelled during the 2001 to 2003 inventory; – collect new reports of American Chestnut between surveys; – monitor tree health every five to 10 years; – conduct population viability analysis; – screen for naturally-occurring hybrids.	• Status of species • Chestnut blight • Loss and degradation of habitat
Necessary	On-going	Inventory, Protection	**1.2** Monitor and maintain planted populations located within the species' native range in Ontario as potential sources of blight-free native germplasm: – locate and evaluate status of all planted populations; – identify two sites to maintain as a potential source of blight-free germplasm for future outplanting; – stock each site with individuals representative of variability found in southern Ontario; – use information on existing plantations to direct locations of future American Chestnut plantations thereby reducing potential impacts on natural populations	• Chestnut blight

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
2. Promote protection and public awareness of American Chestnut				
Necessary	Short-term	Communications, Stewardship, Protection	**2.1** Promote protection of known populations of American Chestnut to land management authorities, private landowners and recovery teams	• Loss and degradation of habitat
Beneficial	Long-term	Education and Outreach, Stewardship	**2.2** Promote public awareness of American Chestnut	• Loss and degradation of habitat
3. Develop and evaluate management measures to control threats				
Critical	Short-term	Research	**3.1** Investigate the effectiveness of various chestnut blight control measures in an experimental setting	• Chestnut blight
Critical	On-going	Management Monitoring	**3.2** Identify, manage and monitor at least 15 American Chestnut populations of those inventoried within the species' native range in Ontario: – select 15 populations from those inventoried under approach 1.1 based on their recovery potential; – test a variety of selected management measures and develop guidelines for controlling chestnut blight; – monitor managed populations for all threats to species using protocol from 1.1.	• Chestnut blight • Insect pests • Hybridization

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Critical	Long-term	Research	**3.3** Develop techniques to decrease species' vulnerability to chestnut blight – test effects of spreading hypovirulent strains of chestnut blight; – conduct an intraspecific breeding program for blight resistance in American Chestnut; – conduct an interspecific breeding program for blight resistance in hybrid chestnut trees.	• Chestnut blight
Beneficial	Long-term	Management	**3.4** Restrict inter-jurisdictional movement of all *Castanea* species in Canada	• Chestnut blight
4. Secure Ontario sources of germplasm originating from blight-free trees				
Beneficial	Short-term	Protection	**4.1** Locate and inventory blight-free American Chestnut stands planted in Ontario outside the species' native range.	• Chestnut blight
Beneficial	Long-term	Research	**4.2** Monitor and protect at least two blight-free stands planted outside the species' native range in Ontario	• Chestnut blight

Supporting Narrative

The approaches described in Table 3 primarily address chestnut blight, the most important threat to the species. The recommendations focus primarily on the need to develop and evaluate blight control methods. If the blight is controlled, the small immature stump-sprout saplings which currently account for a large portion of extant populations may grow to maturity, increasing numbers of fruit-bearing individuals to levels where healthy breeding and seed production can occur.

Until blight can be controlled, the greatest promise for recovery of the species lies in developing and deploying a blight-resistant locally-adapted American Chestnut genotype. As outlined in section 1.6, natural hybridization is considered a potential threat to the recovery of American Chestnut. However since chestnut blight is still the primary cause of endangerment for this species, controlled breeding with close relatives that exhibit a higher degree of resistance such as Chinese and Japanese Chestnut, may be needed to accelerate the evolution of resistance. This research is being pursued by the Canadian Chestnut Council breeding program. The intent of this program involves introducing the disease resistance of Chinese Chestnut into Ontario genotypes of American Chestnut through an initial hybrid cross, backcrossing the hybrids with Ontario genotypes over multiple generations to reduce the Chinese Chestnut genetic contribution to the target level of less than six percent and then selecting crosses that perform well in disease resistance screening tests. It is anticipated that blight-resistant trees that meet these genetic criteria and are phenotypically indistinguishable from naturally occurring genotypes could be produced within 15 years. In addition, naturally occurring individuals with lower blight susceptibility are also being assessed (intraspecific resistance). These efforts would be followed by diligent out-planting efforts to get the resistant genotype established in the network of priority populations. However, there is no information on the durability of resistance as trees mature.

Utilizing this method for recovery comes at the cost of introducing genes from interspecific crosses with other *Castanea* species and thus may cause some ambiguity between hybrids developed specifically for the recovery strategy versus those that occur naturally (Jacobs 2007). As indicated in section 1.6, hybridization that occurs naturally is a potential threat to American Chestnut as the genetic component of offspring that are produced is likely to be 50 percent or less American Chestnut. In contrast, the genetic component of hybrids that are produced using the rigorous methods of backcrossing for the recovery strategy will be close to 94 percent or more American Chestnut (Hebard 2005). Therefore, to avoid any ambiguity, reintroduction programs that involve backcrossed American Chestnut should clearly articulate how they differ from naturally occurring hybrids that are a potential threat.

Over time, it is anticipated that selection will favour genotypes with a combination of resistance and local adaptation. Ultimately, the survival of American Chestnut which is affected so severely by blight, may depend on this infusion of genetic variation.

Other efforts include maintaining existing populations in the wild, utilizing management techniques for controlling the blight, maintaining in-situ and ex-situ germplasm through protection and planting. Finally, species recovery efforts continue to benefit from a volunteer network assisting in pollen transfer, seed collection, seed production, tree planting and maintenance.

Approach 1.1

Existing information on the occurrence of surviving individuals and populations of American Chestnut is either incomplete or scattered among various agencies and individuals. A more detailed, standardized and frequent approach to collecting observations on American Chestnut would contribute to a sample and information database. This could possibly be maintained by the Ontario Ministry of Natural Resources or the Canadian Chestnut Council, and would provide more accurate information on the current status of this species and provide a framework for continued recovery efforts.

It is recommended that a protocol be developed for surveying all American Chestnut populations in Ontario every five to ten years, to:

- record number and size of individuals and their state of health;
- record habitat observations (associated species and forest canopy density);
- determine reproductive status of individuals and populations (fruiting and recruitment);
- examine individuals for presence/severity of blight or other threats to health;
- examine individuals for hypovirulent/healing cankers;
- sample chestnut blight populations for culture collection; and
- expand screening for naturally-occurring hybrids

These data will permit estimation of survival and recruitment rates of American Chestnut and the percentage of individuals with chestnut blight, thereby providing a measure of population viability. New observations and reports of American Chestnut will be collected between surveys and added to the survey records.

Approach 1.2

Recovery action of American Chestnut must involve careful consideration of collections and plantings of cultivated American Chestnut trees throughout the native Canadian range. Historically, American Chestnut or cultivars have been planted for the purposes of commercial nut production, landscaping and conservation. Unfortunately, these plantings have been established with little thought about their impact on naturally occurring populations of American Chestnut. There has been little coordination or regulation as to how and where planting should occur. As a result, there is a risk that out-plantings are not true American Chestnut or are not from the best suited local seed sources and that they will serve as conduits for the movement of *C. parasitica* among populations. At the same time, there is a need for planted trees of known composition to serve as a germplasm reserve for future restoration efforts and for research purposes. The following actions are recommended.

- Identify existing planted populations of chestnut, American or otherwise, planted within the native range of American Chestnut and determine the genetic parentage (species, hybrid) and geographical source where possible.
- Collate and distribute information on existing plantings to the lead recovery agency (Ontario Ministry of Natural Resources) as well as major conservation interests. This document would be used for identifying potential locations for research, for developing a management plan for existing planted populations with the intent of reducing interactions with native populations and for directing and reducing the potential impacts of future planted populations.
- Identify potential locations/sponsors to maintain at least two planted populations of native American Chestnut within the native range. The locations should be located in different parts of the geographic range – such as the southwest and the northeast part of the range – and should be isolated from natural populations by at least 50 kilometres. This distance is recommended as a precautionary approach to avoid blight transference among the natural and planted populations. These planted populations can be used for a variety of purposes including: (1) germplasm reserve for future out-plantings in natural populations and (2) research on genetic variability in native populations, natural blight resistance and blight management. Planted populations used as germplasm reserves should be completely or nearly blight-free.
- Stock the designated planted populations with approximately 40 trees, representing populations from throughout the native range in Canada. These trees should be disease-free and should be characterized genetically to confirm their American Chestnut heritage.

Monitor the state of all planted populations (i.e., incidence of blight; tree age/size and health) with regular updates from owners (using survey methods under approach 1.1).

Approach 2.1

Planning agencies within each municipality in which American Chestnut occurs should be made aware of all known sites within their jurisdiction to be included in their natural heritage mapping. Existing habitats need better protection by land management agencies and private land owners.

Land management authorities

Many of the known sites of surviving American Chestnut are on crown and public lands. However, accurate information is often not communicated directly to agencies and individuals involved with land planning and management. Improved communication can contribute directly to improved management of surviving populations of American Chestnut. It is recommended that planning agencies, conservation authorities, forestry consultants and municipal by-law officers be notified of the status of American Chestnut in Ontario and to work cooperatively with them to protect known populations and their habitats within their jurisdictions. Information and status of regional populations should be made available to these agencies once the inventory is complete.

Private landowners
Some of the known healthy American Chestnut populations are on private land. Consideration should be given to the stewardship or securing of such sites to ensure the protection of these trees. It is recommended that private landowners be contacted to encourage stewardship opportunities. Alternate methods for securing sites could be explored for other lands (such as those where land owners do not reside on the land or are not interested in stewardship). Communication with agencies such as the Nature Conservancy of Canada, local land trusts, and regional stewardship networks is recommended to bring about the securing of land through such mechanisms as landowner stewardship, conservation easements or acquisition. It is important to strive for open dialogue with land owners and assume willingness for good land management and stewardship. However, no action should be taken without their concurrence. Researchers and recovery workers should remember to obtain landowner permission before venturing onto any property.

Recovery Teams
Maintaining communication with ecosystem-based recovery teams such as Carolinian Woodlands and watershed-based recovery teams in southern Ontario is recommended.

Approach 2.2
Public awareness of the current status and potential recovery of American Chestnut has been, and will continue to be, an important component of the recovery of this species. It is through such promotion that new sites of chestnut are located, seeds are collected and distributed and much of the enthusiasm and support surrounding this species is generated.

Awareness of the status of American Chestnut by the general public can be increased through communication with farm, forestry, naturalist, and planning organizations. The communication should be periodic highlights of recent findings and improving status of individual sites, landowner stewardship and their actions/activities that have promoted the recovery of this species and opportunities for new participants. It should also include practical information for landowners, such as identifying native chestnuts, chestnut blight cankers and healing cankers.

This outreach can be accomplished using various means including:
- flyers;
- website
- newspaper/magazine articles and news releases;
- booths at community events; and
- community meetings.

Approach 3.1
Several methods are professed for the effective short-term control of chestnut blight but little information is available to substantiate these claims. In addition, recent developments in fungicide technology and biological control may present new opportunities for managing this disease and pathogen. A comparative assessment of

such practices may identify effective methods and/or products that can be used for future application in recovery efforts as well as by commercial chestnut growers.

It is recommended that the most effective combination of management practices be determined based on existing information and experiment results. Experiments designed to test the following management practices should be conducted in plantings, orchards or natural populations not identified in approach 3.2. Management practices to control chestnut blight might include:

- fungicide treatment of expanding cankers and assessment of canker development and pathogen sporulation;
- mud pack treatment of expanding cankers and assessment of canker development and pathogen sporulation;
- removal of dead uninfected branches that provide infection sites for the pathogen; and
- removal of dead branches, suckers and trees that provide pathogen sporulation sites.

Approach 3.2

Existing populations of American Chestnut are largely fragmented and isolated. This presents an opportunity to manage individual sites more intensively through cultural practices, artificial pollination of trees and out-planting of seedlings. It is recommended that the 15 populations with the highest potential for recovery be identified from those inventoried under approach 1.1, based on some or all of the following criteria:

- size of population – larger populations preferred (over half of the known sites consist of only one individual);
- reproductive status of individuals – reproducing populations preferred;
- ownership – publicly owned land or secured private land is preferred to ensure long-term access and protection;
- blight – sites with, and without blight; and with healed or hypovirulent cankers;
- size of habitat – larger habitats with room for population expansion preferred;
- habitat characteristics – some site characteristics such as soil type have been reported to be conducive to the development of healing cankers;
- geographic location – select populations from across the native range of American Chestnut in southern Ontario; and,
- genetic composition - populations with sufficient spatial separation from known sites of other *Casanea* spp. or hybrids.

Once the 15 populations have been selected, management measures may be initiated in 10 of the 15 populations. The remaining five populations could initially be unmanaged and serve as experimental controls. The management measures could include: (1) removing dead, sporulating chestnut tissue from the site to reduce inoculum; (2) suppressing canker development using selected treatments; (3) encouraging recruitment of new individuals through pollination; (4) transplanting uninfected individuals from other sites; and (5) thinning or other microhabitat management to improve survival and growth of seedlings. Specific strategies would be based on survey results (see approach 1.1), current research literature and results of

experimental investigation of the effectiveness of various chestnut blight control measures (see approach 2.1). The results will be summarized as guidelines to managing sites where chestnut blight is present. As much as possible, recruitment should be encouraged from within each site. Additional sites can be added to the management strategy as deemed necessary.

Finally, the protocol from approach 1.1 should be applied to monitoring of tree health, insect pests and hybridization of these 15 populations every five to 10 years to produce a population health status report.

Approach 3.3

Long-term management strategies to control chestnut blight are critical for the recovery of this species. Currently, there are three techniques with the potential to achieve this goal: (1) spread of hypovirulent strains of chestnut blight; (2) identification of natural resistance in surviving stands of American Chestnut; and (3) breeding for resistance in American Chestnut through hybridization with other *Castanea* species.

Approaches to the following areas of research are not presented in detail because they are continually evolving and approaches will change as new information is obtained.

Hypovirulence

The purpose of this technique is to promote the development and spread of hypovirulent strains of chestnut blight amongst existing populations of American Chestnut. Following survey results (see approach 1.1), three or more populations with healing cankers and/or hypovirulent isolates of chestnut blight could be selected to conduct research on the effectiveness of this technique in controlling chestnut blight. The goal for these sites would focus on increasing recruitment of American Chestnut to provide susceptible hosts for the continued growth and possible spread of hypovirulent isolates of chestnut blight. Recruitment of American Chestnut could be increased where possible, through cross-pollination among individuals within a site. Alternatively pollen, seed or seedlings can be imported from other sites with similar characteristics. As much as possible, recruitment should be encouraged from within each site and seedlings should be protected from herbivores. No other blight control measures should be used in these populations so that virulent and hypovirulent isolates can continue to interact on living and dead chestnut tissues.

Other locations in southern Ontario should be monitored for the presence of naturally occurring hypovirulent blight strains. Emphasis should be placed on identifying hypovirulent isolates that are associated with healing and healed cankers and are prevalent or spreading within the native range of American Chestnut. Continuing research will identify additional factors associated with the spread and efficacy of hypovirulent strains of *C. parasitica.*

Intraspecific breeding for disease resistance

Using species and disease severity information collected from native populations of American Chestnut under approach 1.1 and possibly from populations established

outside the species' native range (see approach 3.1), individuals with putative resistance to chestnut blight should be identified for outplanting and/or inclusion in breeding programs.

Where feasible, it is recommended that nurseries of putatively resistant American Chestnut be established and the degree of resistance of these trees to chestnut blight be assessed. Resistant individuals could then be cross-pollinated, to assess the progeny's degree of blight resistance. Intraspecific breeding may identify individuals of American Chestnut with measurable levels of disease resistance. To date, no significant resistance to chestnut blight has been identified in surviving populations of American Chestnut but differences in susceptibility have been reported.

Interspecific breeding for disease resistance
This technique involves the identification of highly resistant individuals in other *Castanea* species, such as Chinese Chestnut for use in an on-going backcross breeding program with a representative selection of locally adapted American Chestnut.

It is recommended that efforts be continued to establish nurseries of potentially resistant hybrid *Castanea* species and assess the degree of resistance to chestnut blight, as well as backcrossing resistant individuals to American Chestnut and assessing resulting progeny for blight resistance. Backcrossing should continue for five or more generations, until the genetic background is at least 94 percent American Chestnut. Such interspecific breeding aims to yield individuals: (1) whose genetic composition is predominantly American Chestnut; (2) have high levels of resistance to chestnut blight; and (3) are adapted to local environmental conditions.

Approach 3.4
To ensure that known sites of American Chestnut outside of the native range of chestnut blight remain free of disease, it is important to prevent the introduction of blight into these regions through the movement of nursery stock of *Castanea* species. Thus, it is recommended that inter-provincial and international trade of *Castanea* species be restricted to prevent the introduction and/or spread of chestnut blight from infested/infected seed and/or seedlings of *Castanea* species.

To that end, a proposal in accordance with the Plant Protection Regulations of the *Plant Protection Act* should be developed and submitted to the Canadian Food Inspection Agency of Agriculture and Agri-Food Canada regarding the monitoring of nurseries and certification of disease-free stock or restriction of shipments if this cannot be done with certainty. This proposal should also address the introduction of chestnut blight on *Castanea* species from Ontario to other provinces of Canada or countries where American Chestnut is known to occur.

Approach 4.1:
In a parallel approach to collecting more detailed information and samples from individual sites within the native range of American Chestnut (see approaches 1.1 and 1.2), it is recommended that American Chestnut populations in Canada - but outside of

the Ontario native range - also be inventoried. Much of this work would be conducted in collaboration with local organizations and individuals. These populations can serve as ex-situ sources of germplasm for possible transplant into the species native range.

This approach first involves locating populations of American Chestnut occurring outside their native range. Landowners should be contacted before entering sites and offered the opportunity to participate if interested. Collecting information on the origin of plantings is especially important. Once these populations have been located they should be inventoried using the survey protocol outlined in Tindall et al (2004) and summarized in this recovery strategy in section 1.8.

Approach 4.2
Sites of American Chestnut located outside of the native range of southern Ontario represent an important source of germplasm of this species that is located outside of the known distribution of chestnut blight. It is recommended that at least two populations each having a minimum of 40 trees, be selected by 2015. These trees should have origins representative of American Chestnut's native geographic range in Ontario. Suitable planted populations should be established if they do not currently exist. These plantings should be maintained as an important source of disease-free germplasm for potential future out-plantings. Existing individuals of American Chestnut outside of the native range may also be useful as a source of germplasm if the parentage can be confirmed. Every effort should be taken to keep these planted populations blight-free.

2.4 Performance Measures

Table 4. Performance measures for evaluating the achievement of recovery of the American Chestnut in Ontario

Recovery Objectives	Performance Measures	Target date
1. Survey suitable habitat and/or formerly occupied habitat for American Chestnut and protect and monitor known populations within the species' native range in Ontario.	• Standardized survey protocol developed • All known sites surveyed to assess tree health and habitat characteristics • Inventoried populations remain extant and showing recruitment (compared to previous surveys) • Planted populations are identified and surveyed Recruitment and importance for long-term survival estimated • Two planted populations of at least 40 individuals representing the native range in Ontario remain blight-free	2015
2. Promote protection and public awareness of American Chestnut	• Partners in protection have been identified and contacted • Outreach materials have been produced and distributed	2015

Recovery Objectives	Performance Measures	Target date
3. Develop and evaluate management measures to control threats	• Testing of management measures have been completed, and most successful measures for controlling chestnut blight identified • Guidelines for managing sites where chestnut blight is present developed • Population health status report produced for 15 selected study populations • All threats were monitored • Methods to decrease species vulnerability to blight developed (hypovirulence techniques developed and evaluated, intra- and inter-specific breeding programs established) • Potential threats from hybridization, secondary threats and insect pests were evaluated	2015
	• Long-term chestnut blight control measures have been developed	2025
4. Secure Ontario sources of germplasm originating from blight-free trees.	• Populations outside the species' native range have been located and assessed • At least two of these planted populations, each with a minimum of 40 trees, have been selected and monitored	2015
	• Movement of chestnut species has been restricted (by legislation or other means)	2015

2.5 Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the recovery team will be one of many sources considered by the Minister when developing the habitat regulation for this species.

The area to be prescribed as habitat in a habitat regulation for American Chestnut should include all areas in the counties of Essex, Chatham-Kent, Lambton, Elgin, Middlesex, Norfolk, Brant, Haldimand, Niagara, Hamilton-Wentworth, Waterloo, Wellington and Halton where 1) one or more individuals of the species occur or 2) one or more individuals were previously documented in written reports or surveys (e.g., Ambrose and Aboud 1987, Melzer et al. 2004, Tindall et al. 2004, Natural Heritage Resource Centre database). Research at occupied sites has been conducted by the recovery team to identify which Ecological Land Classification (ELC) ecosites (as defined by Lee et al. 1998) support American Chestnut. With this knowledge, it is recommended that the area prescribed as habitat is restricted to only the contiguous ELC ecosite polygons where there are extant or historic occurrences of American Chestnut. If an individual is close to the polygon edge, a minimum distance of 30 m from the stem of the tree (or sprouting stump) is recommended for inclusion in the area

prescribed as habitat in the habitat regulation. This is a precautionary measure to ensure that a minimum distance is met for any ground disturbance that could affect mature trees.

The following ELC ecosite and vegetation classifications were recorded in a status assessment of accessible, known or newly found American Chestnut populations that was undertaken by the University of Guelph between 2001 and 2003 using a standardized protocol (Tindall et al. 2004):

- Treed Cliff (CLT)

- Deciduous Forest (FOD)
  - Dry-fresh Oak Deciduous Forest Ecosite (FOD1)
  - Dry-fresh Red Oak Deciduous Forest Type (FOD1-1)
  - Dry-fresh White Oak Deciduous Forest type (FOD1-2)
  - Dry-fresh Oak-Maple-Hickory Deciduous Forest Ecosite (FOD2)
  - Dry-fresh-Red Maple Deciduous Forest type (FOD2-1)
  - Dry-fresh Oak-Red Maple Deciduous Forest Type (FOD2-2)
  - Dry-fresh Poplar Deciduous Forest type (FOD3-1)
  - Dry-fresh Deciduous Forest Ecosite (FOD4)
  - Dry-fresh White Ash Deciduous Forest Type (FOD4-2)
  - Dry-fresh Sugar Maple Deciduous Forest Ecosite (FOD5)
  - Dry-fresh Sugar Maple Deciduous Forest Type (FOD5-1)
  - Dry-fresh Sugar Maple-Beech Deciduous Forest type (FOD5-2)
  - Dry-fresh Sugar Maple-Oak Deciduous Forest Ecosite (FOD5-3)
  - Fresh-moist Sugar Maple Deciduous Forest Ecosite (FOD6)
  - Dry-fresh Sugar Maple-White Ash Deciduous Forest Type (FOD5-8)
  - Dry-fresh Sugar Maple-Red Maple Deciduous Forest Type (FOD5-9)
  - Fresh-moist Lowland Deciduous Forest Ecosite (FOD7)
  - Fresh-moist Sassafras Deciduous Forest Type (FOD8-2)
  - Fresh-moist Oak-Maple-Hickory Deciduous Forest Ecosite (FOD9)

- Mixed Forest (FOM)
  - Dry-Oak-Pine Mixed Forest Ecosite (FOM1)
  - Dry-fresh White Pine-Maple-Oak Mixed Forest Ecosite (FOM2)
  - Dry-fresh Hardwood-Hemlock Mixed Forest type (FOM3-1)

- Coniferous Forest (FOC)
  - Dry-fresh Pine Coniferous Forest Ecosite (FOC1)

Prescribing habitat based on the vegetation community will help to preserve the ecological function of the area and the ecological conditions required for the persistence of American Chestnut.

Since the greatest threat to the species is the chestnut blight, isolated planted individuals may be important for maintaining and recovering the species. It is

recommended that emphasis be placed on all American Chestnut individuals in natural populations. Trees planted for horticulture, landscaping or research should be exempt from the habitat regulation but can be individually assessed for possible genetic conservation value.

If future scientific studies indicate that additional areas of habitat are necessary to achieve the recovery goals for this species, the habitat regulation should be updated accordingly.

GLOSSARY

Anastomosis: Fusion of two cells or hyphae in contact that reabsorb their walls and fuse into one.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

Conidium: Asexual, non-motile spores of a fungus; they are also called mitospores due to the way they are generated through the cellular process of mitosis.

Conservation status rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

1 = critically imperilled
2 = imperilled
3 = vulnerable
4 = apparently secure
5 = secure
H = possibly extinct or extirpated
NA = a conservation status rank is not applicable because the species is not a suitable target for conservation activities
NR = rank not yet assessed
X = presumed extinct or extirpated

Demographic stochasticity: Fluctuations in population growth rates due to random variation in survival and reproduction among individuals.

Endangered Species Act, 2007 (ESA): The provincial legislation that provides protection to species at risk in Ontario.

Environmental stochasticity: Variation in population growth due to fluctuations in environment over time.

Epicormic shoots: Stems that emerge from dormant buds along the trunk of a tree

Ex situ: Not situated in the original, natural or existing place or position.

Extant: In existence; still existing; not destroyed or lost.

GRANK: See “Conservation status rank”

Germplasm: The sum of all genetic material that an individual can transfer to successive generations.

Hypha: A long, branching filamentous cell of a fungus that is the main mode of vegetative growth in fungi.

Hypovirulence: Having less virulent characteristics.

In situ: Situated in the original, natural or existing place or position.

Isolate: A strain or an individual selected from a population of a micro-organism, often maintained in pure culture in laboratory conditions.

Monoecious: Individuals with male and female flowers on the same plant but borne separately.

Mutation accumulation: Rise in frequency of deleterious mutations in small populations due to chance

Mycelium: The entire mass of hyphae that constitutes the vegetative body or thallus of a fungus

NRANK: See “Conservation status rank”

Phytophagous: Feeds on plants

SRANK: See “Conservation status rank”

Self-incompatible: Self-pollinations do not yield seed owing to a physiological rejection.

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This act establishes Schedule 1 as the legal list of wildlife species at risk to which the SARA provisions apply. Schedules 2 and 3 contain lists of species that at the time the act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

Thallus: The vegetative body of a fungus.

Virulent: The degree or measure of pathogenicity of a microbe; the relative ability of a microbe to cause disease

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APPENDIX 1. CHESTNUT BLIGHT

Description of *Cryphonectria parasitica* and Symptoms of Chestnut Blight

The chestnut blight fungus, *Cryphonectria parasitica*, has orange mycelium[2], fruiting bodies, and spores. Symptoms of chestnut blight include bark cankers, wilting of distal foliage (furthest away from the main trunk), and formation of epicormic shoots below cankers. On young trees, cankers are sunken and orange, and are most easily seen if the bark is wet. Cankers are not easily seen on trees with mature bark and can most easily be located by the epicormic shoots that form below the cankers. The fungus kills chestnut trees when cankers on the trunk girdle the tree and interrupt the vascular flow between roots and crown.

The asexual spores of *C. parasitica*, termed conidia, are wet spores and are dispersed by rain, insects, birds, and mammals. Conidia can survive freezing, drying and flooding. In the drip zone of infected trees there can be up to several million viable conidia per gram of soil. Conidia in soil are replenished with each rainfall. Numbers of conidia gradually decrease between periods of rain and conidia survive up to four months of desiccation in soil. These results suggest that there are always viable conidia present in soil under infected trees (Heald and Gardner 1914).

The sexual spores of *C. parasitica*, termed ascospores, are dry spores and are predominantly wind dispersed. Ascospores are released during periods of rain and for up to several hours after rain has ended. Ascospores released during rain are predominately washed to the ground but those released after rain are wind dispersed. In one study, 23 to 50 ascospores per square inch were counted from water traps exposed for 5 days 300 to 400 feet (91-122 m) from the nearest ascospore source (Heald et al. 1915). Infections by ascospores and conidia[3] occur at wounds or branch scars.

Insect Transmission

Many insects have been implicated in the transmission of chestnut blight through non-specific transferral of conidia between trees. One post-epidemic study confirmed that chestnut stems and blight cankers harboured a large, diverse insect fauna (Russin et al. 1984). The majority of 495 captured insect species were from the *Coleoptera* and *Diptera* families, and *C. parasitica* was isolated from 69 insect species (mostly *Coleoptera*) representing four orders. To date we have not found any evidence that American Chestnut had a strong connection to any individual pollinator species and that no pollinator was solely dependent on chestnut flowers.

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[2] The entire mass of hyphae that constitutes the vegetative body or thallus of a fungus
Hypha: a long, branching filamentous cell of a fungus, and is the main mode of vegetative growth in fungi
Thallus: the vegetative body of a fungus

[3] Asexual, non-motile spores of a fungus; they are also called mitospores due to the way they are generated through the cellular process of mitosis

Precautions to Prevent Disease Spread by Humans

Extreme care must be taken not to move chestnut blight between populations of American Chestnut. All surfaces in the drip zone of the tree are potentially covered with spores of the pathogen, especially the trunk and forest floor. Vehicles should be parked at least 20 metres from the nearest chestnut tree. When approaching a tree, prior to entering the drip zone, shoe/boot covers should be placed over footwear. Disposable gloves should be worn if any contact is made with any surface in the drip zone of the tree. Care should be taken not to allow clothing to contact surfaces, especially if other trees will be visited before the clothing is laundered. Disposable coveralls may be necessary. Just outside of the drip zone, equipment that has touched surfaces must be disinfected with 0.5% sodium hypochlorite. Gloves and shoe covers should be removed and placed in a plastic bag for disposal. Gloves and shoe covers should only be used once.

Disease Management Strategies

Several strategies have shown promise for the management of chestnut blight. These strategies include sanitation measures, fungicides, biological control, and disease resistance.

Sanitation measures include the removal of dead twigs and stems that act as infection sites, and the removal of infested plant material that acts as sites for sporulation of the pathogen. In Europe, these measures are primarily practiced in chestnut orchards grown for nut production (Milgroom and Cortesi 2004). They are considered to reduce the amount of inoculum of the pathogen but, alone, has a relatively small effect on disease progress and is most effective when used within an integrated management program.

In North America, little sanitation of infected plant material is practiced in natural forests. Previous attempts at using such practices met with relatively limited success, particularly during the height of the pandemic when inoculum of the pathogen was abundant within populations of chestnut. However, the surviving populations of chestnut and chestnut blight have become fragmented and isolated, and many sites no longer appear to contain the pathogen. Therefore, cultural practices that reduce the number of infection sites on susceptible trees or reduce populations of the pathogen may prove more effective now.

Thinning around sprouting chestnuts may promote vigorous growth and reduce their susceptibility to blight infection (Griffin 2000). A recent survey in Ontario also showed a reduced amount of blight infection where the canopy was more open (Tindall et al. 2004). In contrast, removal of the overstory resulted in an increase of disease from 5 percent to 100 percent within five years (Paillet 1994). When thinning around American Chestnut, great care must be taken not to cause wounding because the blight pathogen is a wound pathogen. In sites where alternative hosts are present, thinning of such species within a 20 to 40 metre radius should be considered, particularly if any symptoms of blight are present.

The application of selected fungicides for management of blight cankers has met with limited success. Difficulties in selecting fungicides and formulations that can penetrate to the site of infection in the vascular cambium of woody tissues, and the development of resistance to selected fungicides, appear to be the primary limiting factors to efficacy. Emphasis in previous studies was placed on slowing canker development and/or eliminating the pathogen from infected tissues. Recent developments in fungicide chemistry and formulations may have identified new opportunities for management of plant diseases associated with woody cankers. In addition, the use of fungicides for suppressing sporulation by the pathogen on the surface of diseased tissues has not been examined. Such an epidemiological approach to the management of chestnut blight could contribute to a reduction in the populations of the pathogen over time. Fungicides are regulated compounds in Canada and, if available for use, would be most suitable for protecting individual trees considered to be of high-value, such as orchard trees being used for nut production, grafted trees, etc., and would primarily be effective for relatively brief periods of time. Application of fungicides is not practical in forest settings.

Hypovirulent isolates (i.e., isolates with reduced virulence[4] due to the presence of a fungal virus) of chestnut blight have shown considerable success in Europe for biological control. Hypovirulence in isolates of the chestnut blight pathogen not only cause a marked reduction in virulence, or the ability to cause disease, but the specific fungal viruses that interfere with virulence can be transmitted to virulent isolates through physical contact or anastomosis[5] between isolates. In Europe, where chestnut populations were also devastated by the blight, naturally occurring hypovirulent isolates were found that produced superficial cankers that eventually healed instead of killing the tree. Natural and assisted transmission of hypovirulence through the *C. parasitica* population in Europe has resulted in extensive regeneration of populations of chestnut in the forests there.

Hypovirulence has not been as effective in North America as in Europe, despite the presence of hypovirulent isolates in various regions of the United States and Canada. Several of these isolates have been studied extensively in the United States but there is little evidence that they have successfully reduced the severity of chestnut blight (Milgroom and Cortesi 2004). In Ontario, promising hypovirulent isolates of *C. parasitica* were characterized from several locations, and assessment of these isolates for biological control efficacy was initiated. Results from field inoculations to date have not been encouraging but additional study and intervention into processes affecting the spread and distribution of hypovirulence may identify factors restricting the efficacy of this approach in North America.

Critical analyses of using hypovirulence for biological control of chestnut blight have concluded that effective control has been observed in Europe and in Michigan but that almost all other attempts in North America have failed, particularly at the population level

[4] The relative ability of a pathogen to cause disease
[5] Fusion of two cells or hyphae in contact that reabsorb their walls and fuse into one

(Milgroom and Cortesi 2004). Medium or large-scale experiments have been completed in West Virginia, Connecticut, Virginia and Wisconsin where up to hundreds of trees and thousands of cankers were inoculated with hypovirulent isolates, with little evidence of effective biological control of blight. Various characteristics of the fungal viruses, the pathogen, and the trees are thought to determine the success or failure of hypovirulence (Milgroom and Cortesi 2004). Knowledge of these factors, such as tree, site, and climate characteristics, and their influence on the epidemiological aspects of blight are often poorly understood (Griffin 1989, Griffin et al. 1991, Brewer 1995).

Hypovirulent isolates have been found in various locations in North America, but the only region where hypovirulence has been effective is in Michigan where it occurs naturally and in some places trees are remarkably healthy (Milgroom and Cortesi 2004). Populations of chestnut and blight in Michigan are similar to those in Ontario, where one hypovirulence-associated virus, CHV-3, has been associated with healing cankers and infected isolates of the pathogen (Melzer and Boland 1999). However, the role of hypovirulence in Ontario is less clear than in Michigan.

Other strategies for the biological control of chestnut blight have also been evaluated. The use of mud packs directly on cankers is thought to be effective because of the activity of micro-organisms in the soil that affect growth and development of the pathogen in the canker. These micro-organisms may offer an opportunity for alternative approaches to biological control.

There is considerable interest in the potential for identifying or breeding American Chestnut that is resistant to chestnut blight. Evolutionary theory suggests that some resistant trees may be present in an otherwise susceptible population of a species, and that these resistant trees may survive in remnant populations following pandemic diseases. Naturally-occurring resistant trees would be an important discovery for the recovery of this species, and differences in susceptibility have been observed among some individuals (Griffin 2000). Unfortunately, it can be difficult to distinguish between resistant trees and trees that have simply escaped disease and there have been no confirmed examples of American Chestnut that are resistant to chestnut blight. The relatively high proportion of trees in southern Ontario that do not have symptoms of chestnut blight is encouraging.

There is also considerable interest in breeding resistant American Chestnut trees through interspecific hybridization with Chinese and Japanese Chestnuts, followed by recurrent back-crossing to the American species and selection of resistant individuals. It is anticipated that this procedure will result in progeny that are highly resistant to chestnut blight and are at least 94 percent American Chestnut in other characteristics. While this is expected to produce blight resistant trees for planting, there is no information on the durability of resistance as trees mature. The American Chestnut Foundation has a large and established program in breeding for disease resistance in chestnut and outplanted seeds from their breeding program to test for blight resistance in three national forests in 2008. Breeding programs are also established at several universities and government research stations in the United States. The Canadian Chestnut Council has initiated a

disease resistance breeding program in southern Ontario that hopes to build on the efforts of the American Chestnut Foundation and other institutions and to incorporate germplasm that is adapted to this region with disease resistant American Chestnut breeding material. In addition to this traditional approach to breeding resistant chestnut, scientists in the United States are evaluating the potential for genetic engineering of American Chestnut with disease resistance genes from other organisms.

Part 3 – *American Chestnut – Ontario Government Response Statement*, prepared by the Ontario Ministry of Natural Resources

Ministry of Natural Resources

Natural. Valued. Protected.

American Chestnut

Ontario Government Response Statement

PROTECTING AND RECOVERING SPECIES AT RISK IN ONTARIO

Species at risk recovery is a key part of protecting Ontario's biodiversity. Biodiversity – the variety of living organisms on Earth – provides us with clean air and water, food, fibre, medicine and other resources that we need to survive.

The *Endangered Species Act, 2007* (ESA) is the Government of Ontario's legislative commitment to protecting and recovering species at risk and their habitats. As soon as a species is listed as extirpated, endangered or threatened under the ESA, it is automatically protected from harm or harassment. Also, immediately upon listing, the habitats of endangered and threatened species are protected from damage or destruction.

Under the ESA, the Ministry of Natural Resources (the Ministry) must ensure that a recovery strategy is prepared for each species that is listed as endangered or threatened. A recovery strategy provides science-based advice to government on what is required to achieve recovery of a species.

GOVERNMENT RESPONSE STATEMENTS

Within nine months after a recovery strategy is prepared, the ESA requires the Ministry to publish a statement summarizing the government's intended actions and priorities in response to the recovery strategy. The recovery strategy for American Chestnut (Castanea dentata) was published on June 15, 2012 (http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/STDPROD_075644.html).

The response statement is the government's policy response to the scientific advice provided in the recovery strategy. All recommendations provided in the recovery strategy were considered and this response statement identifies those that are considered to be appropriate and necessary for the protection and recovery of the species. In addition to the strategy, the response statement is based on input from stakeholders, other jurisdictions, Aboriginal communities and members of the public. It reflects the best available traditional, local and scientific knowledge at this time and may be adapted if new information becomes available. In implementing the actions in the response statement, the ESA allows the Ministry to determine what is feasible, taking into account social and economic factors.

American Chestnut is a large, deciduous canopy tree that can grow up to 30 metres tall and have a trunk up to 1.5 metres in diameter with smooth dark brown/olive bark that separates into broad flat-topped ridges as it ages. Trees flower in late May to early July and are wind and insect-pollinated.

Ontario

MOVING FORWARD TO PROTECT AND RECOVER AMERICAN CHESTNUT

American Chestnut is listed as an endangered species under the ESA. The ESA prohibits harm or harassment of the species without authorization. Such authorization would require that conditions established by the Ministry be met. The American Chestnut's habitat will be protected from damage or destruction under the Act by June 30, 2013.

American Chestnut was a dominant forest tree species in northeastern North America until the early 1900s when populations were devastated by a fungal pathogen that causes chestnut blight. Chestnut blight continues to be the greatest threat to American Chestnut in Ontario, as well as loss and degradation of habitat. In southwestern Ontario, American Chestnut populations have been reduced to less than one percent of the original 1.5 to 2 million trees. The species' native range in Ontario accounts for less than five percent of its native range in North America, which extends from southern New England to the southern Appalachian mountains. Historically, American Chestnut held significant economic and cultural importance in North America for indigenous and for non-indigenous peoples.

American Chestnut populations in Ontario are gravely threatened by chestnut blight, with many trees surviving only as stumps with coppice shoots[1], while large mature trees are considered extremely rare. The Ontario population is unlikely to become self-sustaining without effective measures to control or halt the impact of chestnut blight. At this time, however, there remains a significant amount of uncertainty around the feasibility and effectiveness of blight control measures and appropriate methods of intervention. To date, recovery actions targeted at weakening the blight virus on affected trees and finding disease-resistant American Chestnuts have not been found to be effective in Ontario. The recovery action with the greater potential to establish blight resistance in American Chestnut in a reasonable time appears to be the production of a modified American Chestnut with genes from blight-resistant or blight-tolerant Chestnut species (e.g., Chinese Chestnut). At this time recovery efforts will focus on the continued support of research into various blight control measures, as well as on ensuring the persistence of the existing American Chestnuts in Ontario by supporting the conservation and enhancement of their genetic diversity, promoting blight tolerance, and preventing the spread of the disease.

The government's goal for the recovery of American Chestnut is to retain the current population level and distribution in Ontario while increasing genetic diversity and reproductive success, and where possible, explore the feasibility of implementing blight control measures to restore the species to a self-sustaining state.

As research into blight control measures, such as inter-breeding, progresses over the next five years, the government's goal for the recovery of American Chestnut may be re-evaluated as the potential feasibility and policy options of implementing blight control measures evolve.

Protecting and recovering species at risk is a shared responsibility. No single agency or organization has the knowledge, authority or financial resources to protect and recover all of Ontario's species at risk. Successful recovery requires inter-governmental co-operation and the involvement of many individuals, organizations and communities.

In developing the government response statement, the Ministry considered what actions are feasible for the government to lead directly and what actions are feasible for the government to support its conservation partners to undertake.

1. Coppice shoots are shoots that sprout from buds that lay beneath the bark of a trunk after higher parts of the plant are damaged.

GOVERNMENT-LED ACTIONS

To help protect and recover American Chestnut, the government will directly undertake the following actions

- Undertake and consult on an evaluation of when and how intervention, such as inter-breeding to create blight resistant American Chestnuts, is appropriate for the purposes of recovery. Although in some cases these types of actions may be the only viable method of recovery, the role of species at risk that have been genetically modified raises policy questions that require further investigation and analysis.
- Educate other agencies and authorities involved in planning and environmental assessment processes on the protection requirements under the ESA.
- Encourage the submission of American Chestnut data to the Ministry's central repository at the Natural Heritage Information Centre.
- Undertake communications and outreach to increase public awareness of species at risk in Ontario.
- Protect American Chestnut and its habitat through the ESA. Apply and implement habitat protection provisions of the Act by June 30, 2013.
- Support conservation, agency, municipal, industry partners and Aboriginal communities to undertake activities to protect and recover the American Chestnut. Support will be provided through funding, agreements, permits (including conditions) and advisory services.
- Establish and communicate annual priority actions for government support in order to encourage collaboration and reduce duplication of efforts.

GOVERNMENT-SUPPORTED ACTIONS

The government endorses the following actions as being necessary for the protection and recovery of the American Chestnut. Actions identified as "high" will be given priority consideration for funding or for authorizations under the ESA. The government will focus its support on these high-priority actions over the next five years.

Focus Area: **Inventory and Monitoring**
Objective: Survey and monitor known American Chestnut populations and habitat in Ontario.

Actions:

1. **(HIGH)** Develop and implement a standardized survey monitoring program for naturally-occurring populations of American Chestnut to:
   - detect undiscovered occurrences;
   - regularly complete population surveys and health assessments of American Chestnut occurrences; and
   - assess habitat conditions at occupied sites.

2. Identify and assess planted populations of American Chestnut across Ontario to:
   - determine the genetic parentage (i.e., which one or more species of chestnut the tree is derived from) and geographical source of the trees, where possible;
   - act as potential sources of genetically-resistant trees for future restoration efforts and research purposes; and
   - reduce the risk of spreading blight from planted chestnut trees to naturally-occurring American Chestnuts.

Focus Area: **Threat Management**
Objective: Develop and evaluate management measures to control the threat of chestnut blight.

Actions:

3. **(HIGH)** Conserve and enhance genetic diversity of American Chestnuts through the establishment of quarantined plantations (e.g., from seed or clones) and facilitated propagation (e.g., cross pollination) in naturally-occurring populations.
4. **(HIGH)** Investigate the effectiveness of producing a modified American Chestnut with genes from blight-resistant or blight-tolerant Chestnut species (e.g., Chinese Chestnut).
5. Investigate the effectiveness of breeding American Chestnut with other American Chestnuts for blight resistance.
6. Investigate the effectiveness of inoculating the species with a viral infection to weaken the blight fungus and decrease the species' vulnerability to the disease.

Focus Area: **Awareness**
Objective: Increase public awareness about chestnut blight and the need to protect American Chestnuts.

Actions:

7. Promote awareness among land management authorities, private landowners, conservation partners, and Aboriginal communities of the need to increase protection of American Chestnut, reduce the movement of all chestnut species, and limit the spread of blight.

The planting or moving of American Chestnuts without appropriate precautions may introduce chestnut blight into populations that may not yet have been exposed, thus increasing the risks to the species' survival and recovery.

IMPLEMENTING ACTIONS

Financial support for the implementation of actions may be available through the Species at Risk Stewardship Fund, Species at Risk Research Fund for Ontario, Species at Risk Farm Incentive Program or Community Fisheries and Wildlife Involvement Program. Conservation partners are encouraged to discuss project proposals related to the actions in this response statement with the Ministry. The Ministry can also advise if any authorizations under the ESA or other legislation may be required to undertake the project.

Implementation of the actions may be subject to changing priorities across the multitude of species at risk, available resources and the capacity of partners to undertake recovery activities. Where appropriate, the implementation of actions for multiple species will be co-ordinated across government response statements.

REVIEWING PROGRESS

The ESA requires the Ministry to conduct a review of progress towards protecting and recovering a species not later than five years from the publication of this response statement. The review will help identify if adjustments are needed to achieve the protection and recovery of the American Chestnut.

ACKNOWLEDGEMENT

We would like to thank all those who participated in the development of the "Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario" for their dedication to protecting and recovering species at risk.

For additional information:
Visit the species at risk website at
ontario.ca/speciesatrisk
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