**Summaries of the Proposed Recovery Strategies for the Gypsy-Cuckoo Bumble Bee, Blue Ash and Kentucky Coffee Tree**

**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 2007 (ESA) and the Accord for the Protection of Species at Risk in Canada.

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.

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.

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. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

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.

**Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*), Ontario Recovery Strategy Series 2017**

Declaration: The recovery strategy for the Gypsy Cuckoo Bumble Bee was developed 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.

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 and Forestry, Environment and Climate Change Canada, Canadian Wildlife Service, Ontario and Parks Canada Agency

Executive Summary

The Gypsy Cuckoo Bumble Bee is a medium-sized bumble bee with a distinctive white tail and black head. Females lack pollen baskets and have a strongly curved abdomen which distinguish them from non-cuckoo bumble bees. This species likely occurred throughout much of the province of Ontario, although the central and northern portions of the province are under-surveyed. It is an obligate social parasite, usurping nests of Rusty-patched Bumble Bees and Yellow-banded Bumble Bees to rear young. This species has declined throughout its expansive North American range including in Ontario. In Ontario, Gypsy Cuckoo Bumble Bee is designated as endangered under the Endangered Species Act, 2007.

The major threat to this species’ survival is the decline of its host species, which are at-risk of extinction. To recover this species, host populations must reverse their declines and stabilize.

The recovery goal for the Gypsy Cuckoo Bumble Bee is to ensure the species’ long-term survival in Ontario by achieving a self-sustaining population. This will be achieved through research, protection and management of host species’ populations as well as detected extant populations of the Gypsy Cuckoo Bumble Bee throughout the province. It will be critical to mitigate threats to these species, including pathogen spillover, habitat loss, degradation and fragmentation, pesticide use and climate change.

The protection and recovery objectives are to:

* Survey, protect and monitor Gypsy Cuckoo Bumble Bees throughout their Ontario range.
* Monitor and recover host species (Rusty-patched Bumble Bee and Yellow-banded Bumble Bee).
* Monitor, create and improve habitat in or near Pinery Provincial Park and other recently occupied sites in Ontario.
* Conduct research to address knowledge gaps for the Gypsy Cuckoo Bumble Bee.

It is recommended that the area prescribed as habitat in a habitat regulation under the Endangered Species Act be based on at least one of the following criteria being met.

* Documented Gypsy Cuckoo Bumble Bee occurrence (within past 20 years).
* Documented nests of host species (within past 20 years), within 10 km of historic Gypsy Cuckoo Bumble Bee occurrence.

If Gypsy Cuckoo Bumble Bees are found at any site, it is recommended that habitat be prescribed as a 2 kilometre radius around the area. A radius of 2 kilometres was chosen as host bumble bees can forage up to 2.5 kms from the nest. At sites where recent populations (within past 20 years) of host species occur within 10kms of historical Gypsy Cuckoo Bumble Bee occurrences, it is also recommended that habitat be prescribed as a 2 km radius around the area.

Species Description

The Gypsy Cuckoo Bumble Bee is one of six North American members of the bumble bee subgenus Psithyrus (i.e., cuckoo bumble bees) (Williams et al. 2014). Cuckoo bumble bees are obligate social parasites, where the female usurps the nest of another species and the workers of that nest rear their young. Cuckoo bumble bees do not have a worker caste; only males and queen-sized females exist.

Species Biology

Adult females of the Gypsy Cuckoo Bumble Bee and individual queens of both of its host species emerge from their overwintering sites in late April/May (Colla and Dumesh 2010). Female cuckoos enter an established nest of their host species and either kill or subdue the queen (Suhonen et al. 2015). The female cuckoo then lays eggs which are tended by the workers of the host colony. Female Gypsy Cuckoo Bumble Bees can be detected in flight, foraging or in nests from April until September (Colla and Dumesh 2010). Male Gypsy Cuckoo Bumble Bees are reared to the adult stage in the usurped colonies, then exit to locate mates. Adult males have been detected in flight or on flowers from June to October (Colla and Dumesh 2010). They do not overwinter but instead die before the winter. Young mated females select overwintering sites and emerge in the spring. It is unknown how individuals locate mates or host colonies.

Distribution, Abundance and Population Trends

The Gypsy Cuckoo Bumble Bee is a Holarctic species, occurring throughout Canada, the northern USA as well as much of Europe and Asia. In North America, it has suffered drastic declines throughout its Canadian and USA range (Cameron et al. 2011; Colla et al. 2012; Hatfield et al. 2016). The Gypsy Cuckoo Bumble Bee likely occurred through much of the province of Ontario although the central and northern portions of the province have been poorly surveyed. There are historic records (dating back to the late 1800s) from a variety of ecozones including the Mixedwood Plains, Boreal Shield and Hudson Bay Lowlands.

Southern Ontario has been extensively searched with only a single specimen located in the past 10 years (COSEWIC 2014, S. Colla, unpublished data). The specimen was located at Pinery Provincial Park which is also the last known Canadian site for the Rusty-patched Bumble Bee (COSEWIC 2010). Historical collections, up until the 1990s, indicate 1-2% of bumble bees in Ontario were this species (i.e., 1-2% relative abundance), indicating a significant decline in recent decades (COSEWIC 2014). A survey in southern Ontario conducted between 2004 and 2006 failed to locate the Gypsy Cuckoo Bumble Bee at historical sites of occurrence where it had been found to occur at 1% relative abundance during a similar survey in 1971-1973 (Colla and Packer 2008).



Habitat Needs

Given the expansive range of this species (Williams et al. 2014), many habitat types across ecozones are suitable. Currently, nothing is known about the mating and overwintering habitat requirements for the Gypsy Cuckoo Bumble Bee. Overwintering habitat for bumble bees in Ontario may include rotting logs, leaf litter and mulch (Macfarlane 1974), burrows in soil (Macfarlane 1974), and garden compost (Goulson 2010). Forage habitat includes the plant species mentioned below as well as other flowering plants which bloom early spring (e.g. Willow) to late autumn (e.g. Goldenrod). In addition to forage plants suitable for the Gypsy Cuckoo Bumble Bee, pollen and nectar sources for the host species are also required to build resources to rear the larvae and pupae in the colony to the adult stage. Gypsy Cuckoo Bumble Bees are not habitat specialists but have been mostly detected within or near wooded habitats (Colla and Dumesh 2010), likely because of host nest sites or early spring forage availability.

Limiting Factors

Bumble bees (including the Gypsy Cuckoo Bumble Bee) are among the most vulnerable of our native bee species to environmental stressors related to human population density and land use (Bartomeus et al. 2013). Due to lower dispersal ability and smaller population sizes than non-cuckoo bees, cuckoo bees may be more vulnerable to inbreeding and disease (Erler & Lattorff 2010). Thus, populations of this and other cuckoo bumble bee species are limited by nest densities of their host species. As a result, cuckoo species are more vulnerable to extinction than their host species (Suhonen et al. 2015).

Threats to Survival and Recovery: Decline of Hosts

The primary threat to this cuckoo species is the decline of its two-host species in Ontario; the Rusty-patched Bumble Bee and the Yellow-banded Bumble Bee. Despite being previously common, the Rustypatched Bumble Bee has only been detected a few times in the last decade and the Yellow-banded Bumble Bee at relatively few sites (reviewed in COSEWIC 2010; COSEWIC 2015). Stable populations of Yellow-banded and Rusty-patched Bumble Bees are required to sustain populations of the Gypsy Cuckoo Bumble Bee (Suhonen et al. 2015).

Pathogens and Parasites

Pathogen spillover from managed bees is cited to explain declines of the Rusty-patched and Yellow-banded Bumble Bees (e.g. Cameron et al. 2011; Szabo et al. 2012; Graystock et al. 2016).

Spillover occurs when managed populations introduce new pathogens to wild populations or amplify pathogens (spillback) which may have been naturally in lower abundances (Graystock et al. 2016). The mechanism for disease transfer is the use of shared floral resources (Durrer & Schmid-Hempel 1994). Inbreeding depression and low genetic diversity due to small population size can also result in increased disease levels among declining species (Cameron et al. 2011).

Pathogen spillover may impact the Gypsy Cuckoo Bumble Bee directly or by causing the decline of its host species (e.g. Cameron et al. 2011; Szabo et al. 2012).

Habitat loss, Fragmentation and Degradation

There are numerous types of habitat alteration which can have a negative impact on the Gypsy Cuckoo Bumble Bee and its hosts. Bumble bees require forage, nesting and overwintering habitat within accessible distances. Loss of any of these habitat components within a colonies range would negatively impact colony fitness. Fragmentation of these habitats, such as with roads, has been noted to negatively impact bumble bees (e.g., Bhattacharya et al. 2003). Overwintering habitat is not well understood for bumble bees in Ontario but may include rotting logs, leaf litter and mulch (Macfarlane 1974), burrows in soil (Macfarlane 1974), and garden compost (Goulson 2010).

Pesticide Use

Wild bumble bees can be exposed to pesticides while foraging on treated plants or if their nests are contaminated (by workers bringing in contaminated resources). In agricultural systems, insecticides (e.g. neonicotinoids) can negatively impact non-target organisms, like bees, while they forage on the crop or adjacent flowering plants or nests can be sprayed directly. Fungicides may also impact populations as studies show sub-lethal impacts on bee health and behaviour though studies have been mostly in the laboratory thus far. Given the growing number of studies on other bee species, it is likely extant populations of the Gypsy Cuckoo Bumble Bee and its hosts can be negatively impacted by exposure to a variety of pesticides and combinations of pesticides.

Climate Change

There is some indication that with climate change, many bumble bee species have declined more in southern portions of their ranges (Bartomeus et al. 2013; Kerr et al. 2015) while not expanding northward (Kerr et al. 2015). Climate change has been noted to alter the emergence date of wild bees as well as forage plant species (Bartomeus et al. 2011; Thomson 2010). Husband et al. (1980) suggests spring storms (i.e. snow, rain or hail) could be particularly dangerous for early-emerging bumble bees (such as the Gypsy Cuckoo Bumble Bee and its hosts). Spring storms could damage early food sources or kill newly emerged queens. Whether these contribute to the decline of the Gypsy Cuckoo Bumble Bee or its host species remains to be determined but evidence from other species suggest is it possible.

Knowledge Gaps

There are many knowledge gaps which exist for this and other native bumble bee species.

* The current distribution and abundance of this species is uncertain in central and northern Ontario where there have been few recent surveys.
* Ecological and habitat requirements for overwintering and mating are unknown for the Gypsy Cuckoo Bumble Bee and its host species.
* The minimum required host population size (Rusty-patched Bumble Bee and Yellow-banded Bumble Bee) to maintain a sustainable Gypsy Cuckoo Bumble Bee population is unknown.
* The extent of environmental stressors (e.g., pesticide use, forage loss, habitat fragmentation, disease and parasite dynamics, climate change and competition with invasive species), and possible synergies between these stressors, requires additional research.
* While there is evidence cuckoo bumble bees can be reared in captivity (Lhomme et al. 2013), the feasibility of conservation management tools such as translocation, captive breeding and co-reintroduction with hosts requires further research.

Recovery Actions Completed or Underway

Recovery actions for one host species, the Rusty-patched Bumble Bee, are currently underway as described in its Ontario recovery strategy (Colla and Taylor-Pindar 2011), draft Canadian recovery strategy (ECCC 2016), and Ontario government response statement (OMNR 2012). The citizen science program aids monitoring of bumble bees across North America, including the Gypsy Cuckoo Bumble Bee and its host species. It is a citizen science program that collects data and photos of bumble bees from volunteers across North America, to track and conserve bumble bees. All species are identified or verified by regional experts, making it an increasingly valuable data source for current and future analyses. Ontario released its Pollinator Health Action Plan in 2017. This includes objectives for wild pollinator monitoring and habitat availability. As part of Ontario’s Pollinator Health Strategy, the coating of corn and soybean seeds with neonicotinoid insecticides is being regulated. This should reduce the amount of neonicotinoids taken up by flowering plants in agricultural areas and their watersheds in future years.

Recovery Goal

The recovery goal for the Gypsy Cuckoo Bumble Bee is to ensure the species’ long-term survival in Ontario by achieving a self-sustaining population. This should be achieved by protecting and managing host species’ populations and by detecting extant populations of Gypsy Cuckoo Bumble Bee throughout the province. This should be accomplished by mitigating threats to these species, including pathogen spillover, habitat loss, fragmentation and degradation, pesticide use and climate change.

Protection and Recovery Objectives: Approaches to recovery

Objective 1: Survey, protect and monitor Gypsy Cuckoo Bumble Bees throughout their Ontario range.

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| **Relative Priority** | **Relative Timeframe** | **Recovery Theme** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Critical | Ongoing | Monitoring and Assessment Education and Outreach Stewardship | Develop and implement a standardized monitoring program to be conducted by qualified personnel and/or citizen scientists at Pinery Provincial Park, Presqu’ile Provincial Park, Dunks Bay and Oliphant Fen. | Knowledge Gap: Distribution and abundance of Gypsy Cuckoo Bumble Bee |
| Critical | Ongoing | Inventory, Monitoring and Assessment Research | Conduct an inventory program for the Gypsy Cuckoo Bumble Bee across the province, prioritizing under-sampled areas (i.e., central and northern Ontario), historical Gypsy Cuckoo Bumble Bee sites and areas with known extant host populations (i.e. Yellow-banded Bumble Bee) | Knowledge Gap: Distribution and abundance of Gypsy Cuckoo Bumble Bee |

Objective 2: Monitor and recover host species (Rusty-patched Bumble Bee and Yellowbanded Bumble Bee).

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| **Relative Priority** | **Relative Timeframe** | **Recovery Theme** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Critical | Ongoing | Protection | Protect (through stewardship) sites with extant populations of the Yellow-banded Bumble Bee or the Rusty-patched Bumble Bee from habitat loss and fragmentation. | Threats:  Decline of hosts, Pathogens and parasites, Habitat loss, fragmentation and degradation |

Objective 3: Monitor, create and improve habitat in or near Pinery Provincial Park and other recently occupied sites in Ontario.

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| **Relative Priority** | **Relative Timeframe** | **Recovery Theme** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Necessary | Ongoing | Management | Initiate or continue restoration efforts in habitat where the Gypsy Cuckoo Bumble Bee and its hosts have been found. Use historical plant records to determine resource requirements. Ensure blooming plants are present throughout colony cycle | Threats:  Habitat loss, fragmentation and degradation Decline of hosts |
| Necessary | Ongoing | Protection Management Education and Outreach Communication, Stewardship | Determine whether there are greenhouses or farmers using managed bumble bees or honey bees for commercial crop pollination or honey production within 10 km (i.e., honey bee foraging distance) of the site. Work with farmers to prevent escape of managed bumble bees.  Work with honeybee keepers and farmers to ensure adequate disease monitoring is occurring and minimize the possibility of managed bees foraging at occupied sites.  Restrict retail sale of products containing neonicotinoids, limiting sale to appropriate expert users | Threats: Pathogens and parasites Habitat loss and degradation Pesticide use |

Objective 4: Conduct research to address knowledge gaps for the Gypsy Cuckoo Bumble Bee.

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| **Relative Priority** | **Relative Timeframe** | **Recovery Theme** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Critical | Ongoing | Research | Carry out research on basic biology such as forage requirements/behaviour, response to restoration practices, overwintering requirements, mating behaviour, population dynamics, and nesting requirements. | Knowledge gaps: Overwintering and mating ecology and habitat Minimum population sizes required for Gypsy Cuckoo Bumble Bee and its hosts Dispersal ability and forage range Effectiveness of recovery actions |
| Critical | Ongoing | Research Management | Complete habitat assessments for sites with extant populations of the Gypsy Cuckoo Bumble Bee or its host species. | Threats: Habitat loss, fragmentation and degradation Knowledge gaps: Extent of environmental stressors Effectiveness of recovery actions |
| Critical | Ongoing | Research | Determine minimum viable population size and minimum required host abundance to maintain a sustainable Gypsy Cuckoo Bumble Bee population. | Knowledge gaps: Minimum population sizes required for Gypsy Cuckoo Bumble Bee and its hosts |
| Necessary | Ongoing | Research | Determine lethal and sub-lethal impacts of stressors and combinations of them, such as climate change, insecticides, honey bees and disease. | Threats: Habitat degradation Pathogens and parasites Climate Change Knowledge gaps: Extent of environmental stressors |
| Necessary | Ongoing | Research | Determine feasibility of captive breeding and release or translocation programs for the Gypsy Cuckoo Bumble Bee and its hosts. | Knowledge gaps: Feasibility of conservation management tools |

Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources and Forestry 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 author will be one of many sources considered by the Minister when developing the habitat regulation for this species.

It is recommended that the area prescribed as habitat in the habitat regulation be based on at least one of the following criteria being met.

* Documented Gypsy Cuckoo Bumble Bee occurrence (within past 20 years).
* Documented nests of host species (within past 20 years), within 10 km (estimated bumblebee dispersal distance, e.g. Kraus et al. 2009 (gene flow)) of historic Gypsy Cuckoo Bumble Bee occurrence.

If individual Gypsy Cuckoo Bumble Bees or host species’ nests are found at any site (as per criteria above), it is recommended that habitat be prescribed as a 2km radius around the site where the individual or host species’ nest was seen. The selected distance is based on the host species foraging range, indicating where nests are most likely to be found when an individual bee is sampled while foraging (i.e Gypsy Cuckoo Bumble Bee habitat).

Habitat can be, but is not limited to, natural or anthropogenic structures (e.g. buildings with nests) or landscapes, including farms, forests, grasslands, and urban gardens. At these sites, forage habitat (diverse floral resources), nesting habitat (e.g., rodent burrows containing host bumble bee species) and overwintering habitat (e.g., rotting logs and mulch) are critical to the species’ ecological requirements.

**Blue Ash (*Fraxinus quadrangulata),* Ontario Recovery Strategy Series 2017**

Declaration

The recovery strategy for the Blue Ash was developed 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. 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, Forestry Environment and Climate Change Canada – Canadian Wildlife Service, and Ontario Parks Canada Agency

Executive summary

Blue Ash (Fraxinus quadrangulata) is a medium-sized tree native to Ontario’s Carolinian Zone. In Ontario, Blue Ash is designated as threatened under the Endangered Species Act, 2007. It has been documented from a total of 56 sites in southwestern Ontario, including sites on Pelee and Middle Islands in Lake Erie. Although precise population estimates are not available, it has been estimated that the number of mature reproductive individuals in Ontario is less than 2500.

Blue Ash occurs in three main habitat types in Ontario: in moist deciduous forest, on stabilized dunes, and on limestone bedrock. Blue Ash is moderately shade tolerant, and will grow and even proliferate in open and semi-shaded conditions. It is the most drought-tolerant of native ashes.

Several threats to Blue Ash have been identified, although their impacts are not clear. The invasive Emerald Ash Borer (EAB, Agrilus planipennis) is now present throughout the Ontario range of Blue Ash. Although Blue Ash appears to exhibit greater resistance to EAB than other native ash species, it is possible that EAB may threaten Blue Ash over the long term. Causes of mortality or damage to trees include localized colonies of Double-crested Cormorants, habitat loss due to development, vegetation management, fire suppression and water management, and recreational pressure.

The recovery goal for Blue Ash in Ontario is to maintain or increase all current naturallyoccurring populations within its known Ontario range, and to ensure its persistence as a functional, reproductive forest tree. The following protection and recovery objectives are proposed.

* Evaluate threats to Blue Ash through regular monitoring.
* Mitigate documented threats with management and stewardship.
* Encourage in-situ and ex-situ conservation to augment populations and conserve genetics.
* Conduct research to fill knowledge gaps related to Blue Ash mortality and management in Ontario.

Species Description

Species description The Blue Ash is a medium-sized tree in the olive (Oleaceae) family, often growing up to 20 metres in height. The seeds are contained within keys, called samaras, which have a broad, twisted wing that extends along the body to the base (Waldron 2003; Voss and Reznicek 2012).

Species Biology

The information available on the biology of Blue Ash is relatively minimal, and in some cases conflicting. In Ontario, the flower clusters of Blue Ash appear in April and May, before the leaves emerge. The flowers are wind-pollinated, and good seed crops (“mast crops”) in ashes are generally produced every 3-4 years or more (Prasad et al. 2007, Sutherland et al. 2000).

The winged seeds of related ashes are dispersed in late fall primarily by gravity and wind (McEuen and Curran 2004 Prasad et al. 2007). Modelling of seed dispersal of Green Ash (Fraxinus pennsylvanica) in Germany showed mean dispersal distances of between 47 and 66 m.

In colder climates, seeds shed in winter may disperse through secondary transport on snow (Greene and Johnson 1997). During winter, Sutherland et al. (2000) estimate that ash samaras can be blown “100 metres or more” from the parent tree. Dispersal by water along floodplains may carry seeds even further. Landscape fragmentation increases the likelihood of long-distance dispersal of winged seeds by wind. Birds and small mammals also consume the seeds and can transport them varying distances (see COSEWIC 2014).

Blue Ash is moderately shade tolerant, and as the forest canopy closes, regeneration decreases (Ambrose and Aboud 1983, Strobl and Bland 2013). Like many other deciduous forest species, Blue Ash can proliferate following canopy thinning, showing increased vigour and regeneration (Ambrose and Aboud 1983).

Distribution, Abundance and Population Trends

Distribution, abundance and population trends Blue Ash is found in Ontario’s Carolinian Zone 2, occurring naturally at Point Pelee, Pelee Island and other Lake Erie Islands, and in valleys along the Thames and Sydenham Rivers. Blue Ash is also grown commercially and has been planted in many urban and natural areas in southern Ontario, especially in the City of Windsor (Waldron 2003, COSEWIC 2014).

Approximately 56 naturally-occurring sites are known in Ontario, although many of these have not been recently confirmed (COSEWIC 2014). In 2012-13, about half the known naturally-occurring sites were surveyed. These surveys resulted in a total count of 1806 trees (both mature and immature). Overall, the number of mature individuals in Ontario is estimated at less than 2,5003.



Trees greater than 10 cm in diameter at breast height were considered “mature individuals” for assessing abundance (COSEWIC 2014).

Habitat Needs

Blue Ash occurs in three main habitat types in Ontario. Most commonly, it is found in moist deciduous forest, especially along floodplains. Although Blue Ash can persist in a range of soil types, it grows best on well-drained, rich bottomland soils. The species is highly resistant to drought, which is especially evident at sites on Pelee Island.

Deciduous Floodplain Forests

The majority of Ontario sites occur on floodplains of the Sydenham and Thames River watersheds. In these areas, Blue Ash is usually found in rich bottomland deciduous forests with deep alluvial soils, usually silt to clay loams, but sometimes on heavy clay.

Stabilized sand dunes and savannas

Blue Ash is found at Point Pelee National Park and Fish Point (Pelee Island) on calcareous sands. It occurs on open shores, stabilized dunes, and in open woodlands and forests. Several non-native invasive species, including English Ivy (Hedera helix), Periwinkle (Vinca minor), and Garlic Mustard (Alliaria petiolata), are also common at some shaded sites in PPNP (Dougan and Associates 2007).

Alvars and Limestone Bedrock

On Pelee Island, Middle Island and Hen Island, Blue Ash grows on shallow soil over limestone bedrock. More open habitats are characterized as alvars or rock barrens; shaded sites may grade into forested vegetation types.

Threats to Survival and Recovery: Browsing by White-tailed Deer

Ash twigs and leaves are a favoured food of White-tailed Deer (Odocoileus virginanus) which are present in high numbers in many areas of southern Ontario (Waldron 2003). High browsing pressure can result in reduced plant diversity and shrub cover, local extirpation of native plants, and increased cover by exotic species (Hynes et al. 2002). It is also possible that browsing pressure on Blue Ash may increase as other ash species are reduced or extirpated by Emerald Ash Borer.

Even following deer exclusion, regeneration of the forest understory may take many years, and native species will recover only if seeds remain available in the soil (Pendergast et al. 2015).

Emerald Ash Borer

The Emerald Ash Borer, an invasive beetle native to Asia, has been present in Ontario since 2002 and has now been detected in most areas of southern Ontario (Haack et al. 2002; USDA 2016). Adult beetles lay eggs under ash bark; the larvae feed on the inner bark and can cause tree death within one to three years (Poland et al. 2015). Mortality of most ash trees is virtually complete within 3-6 years (Knight et al. 2013).

When compared to other native ashes, Blue Ash appears to show some resistance to EAB (Anulewicz et al. 2008, Tanis and McCullough 2012). The reasons for the observed resistance are unknown, but may be due to the presence of phenolic compounds, or structural differences in the inner bark (Tanis 2013). In recent surveys of Ontario Blue Ash sites, EAB was present at almost half of sites, but infestation on Blue Ash was found at only 3.7% of these sites.

While there are promising indications that Blue Ash harbours some resistance to EAB, there is still reason for concern. Some crown dieback is also occurring at sites within the St. Clair watershed (T. Payne, pers. comm. 2016). While these are isolated observations, it is possible that Blue Ash decline may be delayed, because Blue Ash is a less-preferred host of EAB. It has been speculated that damage and even mortality may increase once the more common species of ash are reduced or locally extirpated (COSEWIC 2014).

Double-crested Cormorants

High densities of colonial tree-nesting Double-crested Cormorants (Phalacrocorax auritus) are present on Middle Island and several other Lake Erie islands (Hebert et al. 2014).

Fire Suppression and Water Management

Blue Ash is probably susceptible to changes in natural systems. At some sites, recruitment may depend on the creation of openings in the forest canopy, allowing seedling establishment (Ambrose and Aboud 1983). Such gaps may be less frequently created than historically, because natural fire is often suppressed, and extreme flooding events are now controlled through management. Shoreline hardening, extensive tile drainage, and flood control structures may all have altered the local hydrology within existing habitats, potentially influencing recruitment.

Habitat Loss Due to Development

Incremental loss of Blue Ash habitat is ongoing in southwestern Ontario (J. Ambrose, pers.comm. 2016). Habitat loss is caused by forest clearance for a variety of reasons, including development, transportation, agricultural intensification, and landscaping.

Vegetation Management

In some areas, roadside brush and tree cutting have been observed where Blue Ash is present. In some cases, this may be due to misidentification. The effect on the Blue Ash population is local, but may be significant, especially on Pelee Island (J. Ambrose, pers. comm. 2016). It is likely that potentially healthy Blue Ash have been and continue to be removed for EAB control.

Other threats

Recreational vehicles (e.g., ATVs) and trampling probably have a local impact at some publicly accessible sites. Loss of genetic diversity is a risk arising from habitat fragmentation, but has not been studied in this species (Ambrose and Aboud 1983).

Approaches to Recovery

Objective 1: Evaluate threats to Blue Ash through regular monitoring.

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| **Relative Priority** | **Relative Timeframe** | **Recovery Theme(s)** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Critical | Long-term | Monitoring and Assessment Research | Regularly complete and analyze standardized health assessments of representative Blue Ash stands in Ontario   * develop and consistently use standardized survey method * analyze and publish results | Threats: Emerald Ash Borer  Browsing by White-tailed Deer  Knowledge gaps: Effects of EAB Severity of deer browsing |

Objective 2: Mitigate documented threats with management and stewardship.

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| **Relative Priority** | **Relative Timeframe** | **Recovery Theme(s)** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Necessary (possibly critical) | Ongoing | Management, Monitoring and Assessment, Communication | Where necessary, select and take effective measures to protect Blue Ash from deer browsing (e.g., fenced exclosures, reductions in local deer populations) | Threats: Browsing by White-tailed Deer |
| Necessary | Long-Term | Management | Continue control of DoubleCrested Cormorants on Middle Island, and elsewhere if necessary | Threats: Double-crested Cormorants |
| Necessary | Ongoing | Management, Stewardship | Communicate with municipalities and utilities to:   * identify Blue Ash on roadsides, hydro corridors and other managed lands * ensure protection of plants during regular vegetation management, and EAB management | Threats: Vegetation management |
| Necessary | Short-term | Protection, Management | Reduce or eliminate local ATV damage and trampling through signage, fencing, etc. | Threats: Trampling and ATV use |

Objective 3: Encourage in-situ and ex-situ conservation to augment populations and conserve genetics.

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| **Relative Priority** | **Relative Timeframe** | **Recovery Theme(s)** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Beneficial | Ongoing | Management | Use locally-sourced Blue Ash seed or seedlings in restoration plantings to augment existing populations within suitable habitat | Threats:  All |
| Beneficial | Ongoing | Research, Management | Identify EAB-infested but apparently healthy trees for use in future restoration efforts | Threats: Emerald Ash Borer |

Objective 4: Conduct research to fill knowledge gaps related to Blue Ash mortality and management in Ontario.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Relative Priority** | **Relative Timeframe** | **Recovery Theme(s)** | **Approach to Recovery** | **Threats or Knowledge Gaps Addressed** |
| Critical | Long-term | Monitoring and Assessment, Research | Study the effects of EAB on Blue Ash health, mortality, demographics and population viability in Ontario | Threats:  EAB  Knowledge gaps: Effects of EAB |
| Critical | Long-term | Management, Monitoring and Assessment, Research | Continue experimental release of parasitoid biological control within Blue Ash habitat across southern Ontario, and evaluate effects on Blue Ash infestation and mortality specifically | Threats: EAB Knowledge gaps: Effects of EAB Efficacy of biological control |

Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources and Forestry on the area that should be considered in developing a habitat regulation.

It is recommended that areas where natural populations of Blue Ash occur be prescribed within a habitat regulation.

Because most wind-dispersed seeds are likely deposited within 75 m of a parent tree, a contiguous ELC vegetation type polygon that is not within a regulated floodplain may be bounded by a distance of 75 m in any direction from a parent tree. However, Blue Ash trees within a regulated floodplain may be dispersed longer distances by water, and the maximum dispersal distance is not known. In these areas, the contiguous ELC vegetation type (with no maximum distance) is recommended for protection.

For trees close to a habitat edge, or trees where the ELC vegetation type cannot be ascertained (e.g. along fencerows and roadsides),

* To protect root zones of existing trees, a radial distance of at least 23 m around each tree is recommended for protection. This is based on the estimated root zone of the Blue Ash trees, of three times the maximum crown width (see rationale below).
* To protect seed dispersal zones and regeneration habitat, a secondary area around each Blue Ash tree should be protected for seed dispersal by gravity and wind of at least 75 m, to allow for possible seedling establishment (see rationale below). Potentially suitable habitat within this radius should receive protection, because although it may be unoccupied, research shows that there is still a reasonable likelihood that seeds may disperse into such areas, perhaps especially in more open areas where wind speeds are higher.

It is recommended that trees planted as horticultural specimens in landscaped areas be excluded from habitat regulation. The area surrounding restoration plantings should be considered as regulated habitat following the recommendations above, to contribute to the recovery of the species.

Regulation of Habitat of Individual Trees

Protection of individual trees is based on protecting the tree’s root zone. Findings have determined that most tree roots extend laterally rather than vertically, and that in unconfined soils they can spread up to three times the diameter of a tree crown (Jim 2003). Thus, protecting a diameter width of three times the diameter of a large tree crown is considered important to protect the tree’s root zone.

The crown diameter or spread of Blue Ash is estimated at 10 to 15 metres (Hightshoe 1987; some American sources suggest a spread of 18 meters (Missouri Botanical Gardens 2017). In a more northerly climate in Ontario, a reasonable estimate to capture the diameter of a large crown is likely 15 metres (based on scale drawings in Kershaw 2001 and Waldron 2003). Three times this diameter equals 45 m surrounding each tree, or a 22.5 m radial distance from the stem of each tree. Rounding up, a minimum 23 m radial distance from the stem of each Blue Ash is recommended for root protection.

Regulation of Habitat for Seed Dispersal and Regeneration

Blue Ash seeds are primarily wind-dispersed. Although the vast majority of seeds are deposited close to the parent tree, a smaller proportion of seeds will disperse longer distances, depending on the tree’s location, wind velocity, and wind direction

In studies of forest fragments in Michigan, McEuen et al. (2004) found that many species dominating the seed rain had few to no successful recruits. While recruitment is limited to a degree by the abundance of parent trees for dispersal, it is also influenced by seed predation, germination, and early seedling survival. Only a small fraction of most seeds will germinate and survive beyond the first year (Clark et al. 1998).

Accounting for water dispersal in regulation is more challenging, since research on this form of dispersal is lacking. However, it is unclear whether this environment could be considered comparable to that of Blue Ash in Ontario.

In summary, protecting Blue Ash habitat by ELC vegetation type is the recommended standard method of delineation, and is likely to protect existing trees and their habitat, and allow for dispersal and recruitment.

**Kentucky Coffee Tree (*Gymnocladus dioicus*), Ontario Recovery Strategy Series 2017**

Declaration

The recovery strategy for the Kentucky Coffee-tree was developed 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.

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.

Kentucky Coffee-tree (Gymnocladus dioicus) is a moderate-sized canopy tree of the legume family, and is the only member of its genus in North America. Male and female flowers are generally produced on separate trees and, when fertilized, form a hard, dark, bean-like pod, which remains on the tree through the winter. However, the species spreads primarily through root suckers (ramets) and sexual reproduction is relatively infrequent.

In Canada, Kentucky Coffee-tree is found only in southern Ontario. Of 33 known native populations, 23 are considered extant, with an estimated total population of fewer than 500 mature native trees. It is designated Threatened in Canada under the Species at Risk Act (SARA).

Threats identified to the Canadian population of Kentucky Coffee-tree include, but are not limited to: land development, Double-crested Cormorant (Phalocrocorax auritus) nesting colonies, alteration of the water regime, alteration of the fire regime, cutting/removal of Kentucky Coffee-trees, planting of non-native Kentucky Coffee-trees and invasive species. The species is also limited by: small, geographically-isolated populations, low rates of sexual reproduction and limited dispersal ability. Given that in Canada the species is found at the northern extent of its North American range and is uncommon, it will likely always be vulnerable to natural and human-influenced stressors

The population and distribution objectives for the Kentucky Coffee-tree in Canada are to: maintain the abundance and distribution of native extant populations occurring within natural settings (e.g., floodplain woodlands and woodland edges of marshes), augment extant native single-sex populations (i.e., populations that are not sexually-reproducing) occurring within natural settings to attempt to establish sexually-reproducing populations, if biologically and technically feasible, and maintain the remaining extant native populations that occur in landscaped or agricultural settings either in situ or through their incorporation into, or use in the establishment of, populations in natural settings.

Critical habitat for Kentucky Coffee-tree is partially identified in this recovery strategy, based on the best available data. Critical habitat for Kentucky Coffee-tree is located on both federal and non-federal land. As more information becomes available, additional critical habitat may be identified where sites meet the critical habitat criteria.

Recovery Feasibility Summary

Based on the following four criteria outlined in the draft SARA Policies (Government of Canada 2009), there are unknowns regarding the feasibility of recovery of Kentucky Coffee-tree. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

Twenty-three populations are believed to be extant in Canada and at least four of these have been confirmed as mixed-gender sexually-reproducing populations. Additional native stock is available from arboreta (e.g., University of Western Ontario) (Bowles pers. comm. 2010) and native plant nurseries, as well as potentially from populations in the northern United States, to supplement single-gender populations with opposite sex plants to improve rates of sexual reproduction. However, even when seeds are produced, natural seed dispersal is limited and germination is infrequent.

The species thrives in a variety of open and semi-open habitats in southwestern Ontario, and extensive areas of suitable habitat are currently unoccupied by the species. There are several habitat management techniques (e.g., thinning) available to create open canopy conditions amenable to seedling establishment.

The primary threats to the species (i.e., habitat loss to land development and cutting/removal of Kentucky Coffee-trees) can be mitigated through appropriate land use planning, site management and land securement. Several key populations currently occur on public lands managed for conservation purposes. It is unknown whether the impacts from Double-crested Cormorant (Phalocrocorax auritus) breeding colonies can be mitigated to the extent required to meet the population and distribution objectives.

Although enhancement of single-gender populations through reintroduction of individuals of the opposite sex can be used to improve rates of seed production and increase genetic diversity (within the seeds), there is little evidence of the successful germination of seeds in natural settings to establish the required sexually-reproducing populations to meet the population and distribution objective. However, the seeds germinate readily after scarification or soaking in an acid solution (Wiesehuegal 1935) and the species can easily be propagated from root shoots and cuttings (Ambrose 1984). Double-crested Cormorant control methods have been developed; however, their effectiveness in producing impacts at the population level is not well established.

Species Status Information

In Canada, Kentucky Coffee-tree is found only in the province of Ontario; the national and subnational conservation ranks are imperilled 5 (N2 and S2, respectively) (NatureServe 2011).

Kentucky Coffee-tree is listed as Threatened 6 on Schedule 1 of the federal Species at Risk Act (SARA). In Ontario, Kentucky Coffee-tree is listed as Threatened 7 under the provincial Endangered Species Act, 2007 (ESA).

Species Description

Kentucky Coffee-tree is a moderate-sized canopy tree of the legume family, and is the only member of its genus in North America. Mature trees grow 18 to 30 m tall (USDA 2007) and may live up to 100 years or more. The species has stout, widely-spaced branches and a narrow crown, with large, doubly-compound leaves that can reach one metre in length, the longest of any tree in Canada. Kentucky Coffee-tree has a short growing period relative to other deciduous trees (Kozlowski and Ward 1957), with the leaves developing late in the spring and falling in early autumn; it is therefore leafless for half the year or more. Greenish-white flowers in terminal clusters appear in May and June, and expand after the new leaves emerge, with male and female flowers generally produced on separate trees. Fertilized flowers form a hard, dark, bean-like pod 12 to 20 cm long containing 4 to 8 dark brown seeds, which remains on the tree through the winter (Farrar 1995; COSEWIC 2000; USDA 2007).

Kentucky Coffee-tree has evolved several characteristics that make it relatively well adapted to cope with a variety of natural and human-influenced stressors. These defences include toxic leaves and seeds (which are rarely consumed by herbivores, including livestock), hard coated seeds (which deter both invertebrate and vertebrate herbivores), a capacity to reproduce and expand populations both sexually and vegetatively, and an ability to thrive in a variety of open to semi-open moist and upland habitats.

Population and Distribution

In Canada, it occurs only in extreme southern Ontario, in Middlesex, Essex, Kent, and Lambton Counties (Figure 2). It has been introduced widely as an ornamental plant, from Texas to Quebec and in the states of northern New England. Introduced Canadian populations are not being considered in this recovery strategy because many do not contain the native genome or their genetic origin is uncertain, and many occur outside the native range of the species or in landscaped settings such as urban gardens; recovery actions target the native populations in Canada, which occur only in southwestern Ontario.



Since Kentucky Coffee-tree is a conspicuous species, it is unlikely that many new native populations will be found in the province (COSEWIC 2000). With that being said, there is some indication that suitable habitat still exists at historic locations that have not been visited for many years (pre-1991) and that populations at these locations may remain extant. Habitat loss within its Ontario range has been very extensive over the past two centuries due to clearing for agriculture and urban land uses (Jalava et al. 2009), suggesting that declines in populations may be considerably greater than existing data indicate.

Kentucky Coffee-tree is rare or uncommon throughout its Canadian range in southwestern Ontario, with an estimated total abundance of fewer than 500 genetically-distinct mature trees.

Kentucky Coffee-tree is frequently planted as an ornamental tree, often from non-native stock originating in the United States. There are also several Canadian occurrences where it is believed the trees originated from transplanted local stock or were propagated from local seed.

As a result, it can be difficult to ascertain whether trees are: native, planted from native stock, planted cultivars from the United States, or offspring of horticultural specimens that have spread into natural habitat.

Existing planted populations may be of some value to the recovery of the species (e.g., as sources of future seed stock) if they are known or suspected to be from Ontario stock. The information and objectives presented in this recovery strategy pertain to the 23-recognized native extant populations of Kentucky Coffee-tree in Canada.

Needs of the Kentucky Coffee-Tree

Kentucky Coffee-tree grows best on fertile loam soil with ample moisture, and tolerates alkaline soils and dry sandy soils. For sites around Lake Erie, Limbird et al. (1980) expand on the optimal set of conditions for this species to include shallow, coarse-textured sandy soils to gravelly soils, excessively well-drained and sloping sites and relatively infertile soils.

Kentucky Coffee-tree can thrive in a broad range of habitats; however, it is shade-intolerant and requires canopy openings for seedling establishment and success. In Ontario, the species typically grows in rich floodplain woodlands and woodland edges of marshes where open canopy conditions exist (COSEWIC 2000). At Walpole Island First Nation, the species is found at the woodland edges of prairie habitats (Bowles 2004) at former Anishnaabeg homesteads (Jacobs pers. comm. 2012).

To reproduce sexually and allow for genetic exchange, Kentucky Coffee-tree requires the presence of both male and female flowering plants in a population. At least four Ontario populations of Kentucky Coffee-tree contain both male and female trees and produce seeds (Craig pers. comm. 2007).

Kentucky Coffee-tree produces seeds with a hard, water-impermeable seed coat. The seeds require scarification 13 for germination to occur, yet no insect or rodent herbivores are known to have the ability to break the seed coat. This results in infrequent germination and probably accounts for the fact that the species is rare or uncommon throughout much of its extensive North American range (Yeiser 1983; Ball and Kisor 1985). It is estimated that less than 5% of seeds germinate naturally.

Kentucky Coffee-tree seeds are unable to germinate in shaded conditions. Ambrose (pers. comm. 2006) has observed that through vegetative growth, new stems produced in the understory can reach the canopy if partial canopy conditions exist; thus, with a pre-existing population, the species can spread vegetatively without a fully open canopy.

Because no native herbivores consume the toxic Kentucky Coffee-tree seeds, its dispersal ability is also greatly reduced. Evidence in Ontario supports this theory as individuals in downstream floodplains are suspected to have originated from the seed-producing trees in the upstream population (Ambrose 1983; Giroux pers. comm. 2011). However, confirmation of this would require genetic testing.

A correlation exists between current extant stands of Kentucky Coffee-tree and former Native American and Aboriginal settlements; thus, it is possible to infer that these cultures played a significant role in the perpetuation of the species and in shaping the tree’s current distribution (VanNatta 2009). It is hypothesized that many of the floodplain populations of Kentucky Coffeetree occurring in North America originated from abandoned human settlements of Native Americans, Aboriginal peoples and early European pioneers where the seeds were used as game pieces and as a coffee substitute (after roasting to detoxify) (Curtis 1959; McClain and Jackson 1980; Zaya and Howe 2009). Canadian occurrences are noted to follow known travel routes used historically by Aboriginal peoples, which may in part explain the species presence in floodplains, as streams were natural corridors of movement for Aboriginal peoples (Jacobs pers. comm. 2012; McClain and Jackson 1980). Other traditional uses include jewelry, music, and medicine (VanNatta 2009).

Biological Limiting Factors

Kentucky Coffee-tree populations in Canada are limited by low rates of sexual reproduction. Lack of both sexes in most Ontario populations, and subsequent lack of reproduction by seed, is the likely factor explaining the historically restricted distribution in Ontario, where populations spread only locally through clonal reproduction (Ambrose 1983). As a result, the species is typically distributed as widely separated single trees or in small groves, further limiting genetic exchange.

Severe habitat fragmentation due to development in southern Ontario, have resulted in geographically-isolated populations that are especially prone to loss of genetic diversity. This loss of genetic diversity in turn reduces plant fitness and increases the risk of extirpation by disease or other environmental stressors, human actions or stochastic events. Shade intolerance may also limit the ability of the Kentucky Coffee-tree to survive in areas undergoing natural succession, as seeds are unable to germinate in shaded conditions.

Threat Assessment

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Threat** | **Level of Concern** | **Extent** | **Occurrence** | **Frequency** | **Severity** | **Casual Certainty** |
| **Habitat Loss or Degradation** | | | | | | |
| Land Development | High | Widespread | Historic/Current | Continuous | High | High |
| Double-crested  Cormorant Nesting Colonies | High | Localized | Current | Seasonal | High | High |
| **Disturbance or Harm** | | | | | | |
| Cutting/Removal of Kentucky Coffee Trees | High | Widespread | Historic/Current | Continuous | High | High |
| **Changes in Ecological Dynamics or Natural Processes** | | | | | | |
| Alternation of the Water Regime (flood control) | Medium | Localized | Unknown | Continuous | Moderate | Medium |
| Alteration of the Fire Regime | Medium | Widespread | Current | Continuous | Moderate | Medium |
| **Exotic, Invasive or Introduced Species/Genome** | | | | | | |
| Planting of Non-native Kentucky Coffee-Trees | Medium | Widespread | Current | Continuous | Unknown | Low |
| Terrestrial Invasive Plants (e.g. Dog Strangling Vine) | Low/Medium | Widespread | Anticipated | Continuous | Unknown | Low |

Highlight [page 26]: Habitat Loss or Degradation Land Development Double-crested Cormorant Nesting Colonies High High Widespread Localized Historic / Current Current Continuous Seasonal High High High High

Highlight [page 26]: Disturbance or Harm Cutting / Removal of Kentucky Coffeetrees High Widespread Historic / Current Continuous High High

Highlight [page 26]: Changes in Ecological Dynamics or Natural Processes Alteration of the Water Regime (e.g., flood control) Alteration of the Fire Regime (e.g., fire suppression) Medium Low / Medium Localized Localized Unknown Current Continuous Continuous Moderate Moderate Medium Medium

Highlight [page 26]: Exotic, Invasive, or Introduced Species/Genome Planting of Nonnative Kentucky Coffee-trees Terrestrial Invasive Plants (e.g., Dogstrangling Vine) Medium Widespread Current Continuous Unknown Low Low / Medium Widespread Anticipated Continuous Unknown Low

Population and Distribution Objectives

Although all individual trees are protected under the Species at Risk Act (on federal lands) or Ontario Endangered Species Act, 2007 (on non-federal lands), the focus of recovery efforts is targeted to native, extant populations, primarily those in natural settings. Therefore, the population and distribution objectives for the Kentucky Coffee-tree in Canada are to:

* maintain extant native populations within natural settings at their current abundance and distribution
* augment extant single-sex native populations (i.e., populations that are not sexually reproducing) occurring within natural settings to attempt to establish sexually reproducing populations, if biologically and technically feasible, and
* maintain the remaining extant native populations that occur in landscaped or agricultural settings either in situ or through their incorporation into, or use in the establishment of, populations in natural settings.

One of the main limiting factors for Kentucky Coffee-tree is the lack of reproduction by seed. Augmenting single-sex populations, particularly with opposite-sex individuals (to achieve sexual reproduction) but also same-sex individuals (to improve abundance and ensure both sexes are represented), will lead to improved genetic diversity and increased seed production (including increased probability of successful germination of seeds) which in theory will allow the species to naturally colonize nearby suitable habitat and establish self-sustaining populations. Single-sex populations currently occurring within natural settings (e.g., floodplain woodlands and woodland edges of marshes) will be augmented with both opposite-sex and same-sex individuals as these populations contain the suitable habitat necessary to allow for expansion of the population once sexual reproduction is achieved.

Actions Already Completed or Currently Underway

The following actions relating to the recovery of Kentucky Coffee-tree in Ontario have been completed or are underway:

* Periodic surveys have been performed for various populations of Kentucky Coffee-tree in Ontario. Most recently, detailed surveys have been performed on East Sister Island by Ontario Parks and on Middle Island by Jalava et al. (2008).
* Of the 23 extant occurrences in Ontario, six occur in protected areas that receive targeted management actions: three occur on conservation authority lands; one occurs at Point Pelee National Park (Middle Island) where Double-crested Cormorant control measures are being undertaken; one population occurs on East Sister Island Provincial Nature Reserve; and one occurs within an Agreement Forest that is now owned by Southwest Middlesex municipality.
* A management plan has been developed for East Sister Island. Ontario Parks is preparing a background document that summarizes a number of studies to investigate the overall effects of cormorants on the island ecosystem (Dobbyn pers. comm. 2007, 2011). In 1997, the Ontario Ministry of Natural Resources (OMNR) completed a “Review of the Population Status and Management of Double-crested Cormorants in Ontario” in response to increasing cormorant populations, and public demand for information and management options (OMNR 1997). Since 1997, the scientific community, and provincial and federal agencies have increased the knowledge base with respect to cormorant biology, population dynamics, environmental impacts, and future management challenges. An updated document reports on this new knowledge, and expands on the information presented in the 1997 review document (OMNR 2006).
* Highlight [page 32]: 5. A cooperative restoration program involving Walpole Island First Nation and the Sherwood Fox Arboretum of the University of Western Ontario (UWO) has been established to restore or increase native populations at priority locations such as Walpole Island First Nation (Jacobs pers. comm. 2012). A single female tree close to a clone of male trees at Walpole Island First Nation is being monitored as part of the habitat restoration program (Bowles 2004; Bowles pers. comm. 2006, 2010; Jacobs pers. comm. 2012).
* The University of Guelph Arboretum has a living gene bank of many of the Ontario populations of Kentucky Coffee-tree collected in the mid 1980s (Ambrose pers. comm. 2007).
* Walpole Island First Nation is currently developing an ecosystem protection plan based on the community’s traditional ecological knowledge (TEK).
* Mitigation, in response to Kentucky Coffee-tree removal at a subdivision developed in Ancaster, Ontario, involved the establishment of mixed-gender population(s) in Essex through strategic planting and site restoration (Pickett pers. comm. 2011) in association with the aforementioned Essex Forests and Wetlands CAP.

Identification of the Species’ Critical Habitat

Critical habitat for Kentucky Coffee-tree in Canada is identified in this recovery strategy to the extent possible, based on available data. It is recognized that the critical habitat identified below is insufficient to achieve the population and distribution objectives for the species.

Sites where Kentucky Coffee-tree has been planted as part of a restoration program will not be considered for critical habitat identification until it can be determined that the plantings are successful. Determination of restoration success and viability, as measured through plant vigour and fitness, must precede identification of critical habitat at restoration sites at this time. Critical habitat may be identified at restoration sites following long-term monitoring to determine success, extent of suitable habitat and site occupancy.

Suitable Habitat

It is shade-intolerant, requiring canopy openings for seedling establishment. Root shoots appear to tolerate more shade than seedlings, often occurring under partial shade. Required conditions are often found in the deciduous floodplain woodlands and woodland edges of marshes where Kentucky Coffee-tree typically grows in Ontario.

Kentucky Coffee-tree appears to be associated more with site conditions (e.g., open canopy) than with specific species compositions. Deciduous woodland and woodland floodplain habitat as well as more open habitats such as tallgrass prairie and savannah, and moist habitats such as swamp, fen, bog and marsh are all considered suitable.

Site Occupancy Criterion

A site is considered occupied when a native Kentucky Coffee-tree has been observed between 1992 and 2011 in suitable habitat. If a field survey by a qualified individual (e.g., forester or biologist) determines that no living Kentucky Coffee-tree plants (e.g., ramets, saplings or trees) are extant at a site, the site is considered unoccupied.

A site is defined by a boundary drawn at a radial distance of 20 m around a known observation of a native extant Kentucky Coffee-tree. The 20m distance is applied to each observation, with spatially overlapping areas merged together to form larger sites.

A site must contain at least one living Kentucky Coffee-tree plant (which may include ramet, sapling or tree), and can include apparently dead individuals (based on visual observations), believed to be native in origin, and located in suitable habitat. Apparently dead, standing snags are included because ramets are often observed in the vicinity of individuals which otherwise appear to be dead. Any sites containing plants that are considered horticultural specimens, and those clearly planted in landscaped settings such as urban gardens, are not considered to be occupied for the purposes of identifying critical habitat.

Application of the Kentucky Coffee-tree Critical Habitat Criteria

Critical habitat for Kentucky Coffee-tree is identified in this recovery strategy as the suitable habitat (Section 7.1.1) within the site boundary as per the Site Occupancy Criterion (Section 7.1.2).

Application of the critical habitat criteria to available information identified 26 sites containing critical habitat across 12 populations in Canada (Table 3). Critical habitat for Kentucky Coffee-tree occurs within the 1 x 1 km standardized Universal Transverse Mercator (UTM) grid where the critical habitat criteria and methodology described in section 7.1 are met.

The UTM grid is a standardized national grid system that indicates the general geographical area containing critical habitat and can be used to highlight areas that contain critical habitat (e.g., by land-use planners, landowners, or during an environmental assessment). The 1 x 1 km UTM grid may represent the accuracy of the best available information (e.g., occurrence or suitable habitat/biophysical features) for certain locations (e.g., the location would require field verification to improve the accuracy).

Once adequate information is obtained (i.e., detailed location, extent of populations and suitable habitat), additional critical habitat will be identified and may be described within an area-based multi-species at risk action plan developed in collaboration with the Walpole Island First Nation.

Activities Likely to Result in the Destruction of Critical Habitat

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 (Government of Canada 2009).

Examples of activities that are likely to result in the destruction of critical habitat include but are not limited to the following:

* Activities that result in impermeable surface conditions (e.g., construction of roads or buildings) thereby altering the biophysical conditions required for the species to survive and/or reducing the available critical habitat to expand its populations
* Activities that cause rutting, soil compaction and erosion (e.g., use of heavy equipment and motorized vehicles), making soil conditions unsuitable for seedling and ramet establishment
* Activities that alter the water regime of floodplain and riverside populations (e.g., construction of dams, water diversion in upstream portions of the watershed) affecting changes to the natural hydro period. These changes could potentially result in permanent flooding, loss of intermittent/seasonal water fluctuations required to maintain open conditions in the floodplain or forest succession and eventual canopy-closure and thereby inhibit seedling and ramet establishment. In addition, changes to the water levels nearby seed-producing trees may affect natural seed dispersal and the conditions required for successful germination of seeds (i.e., immersion in water).

Measuring Progress

Every five years, success of recovery strategy implementation will be measured against the following performance indicators:

* The abundance of Kentucky Coffee-tree at extant native populations occurring within natural settings in Canada has not decreased;
* The distribution of extant native populations occurring within natural settings in Canada has not decreased
* If determined to be biologically and technically feasible, extant single-sex native populations (i.e., populations that are not sexually-reproducing), occurring within natural settings, have been augmented to establish sexually-reproducing populations
* Extant native populations in landscaped or agricultural settings have been maintained.

Statement on Action Plans

One or more action plans will be posted on the Species at Risk Public Registry for the Kentucky Coffee-tree by December 2021.