Recovery Strategy for the Red Mulberry (*Morus rubra*) in Canada

Red Mulberry

2011

Parks Canada Parcs Canada

Canada

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« Programme de rétablissement du mûrier rouge (*Morus rubra*) au Canada»

RECOMMENDATION AND APPROVAL STATEMENT

The Parks Canada Agency led the development of this federal recovery strategy, working together with the other competent minister(s) for this species under the Species at Risk Act. The Chief Executive Officer, upon recommendation of the relevant Park Superintendent(s) and Field Unit Superintendent(s), hereby approves this document indicating that Species at Risk Act requirements related to recovery strategy development (sections 37-42) have been fulfilled in accordance with the Act.
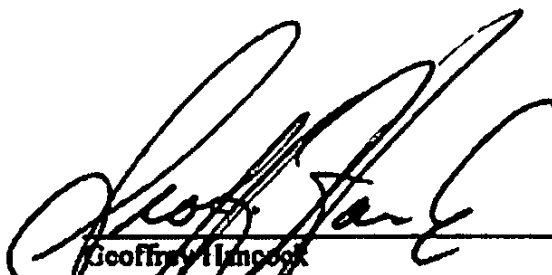
Recommended by:

Marian Stranak
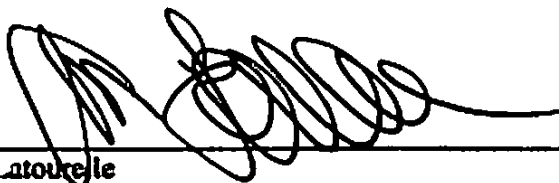*Superintendent, Point Pelee National Park of Canada, Parks Canada Agency*

Recommended by:

Geoffrey Hancock
Field Unit Superintendent, Southwestern Ontario Field Unit, Parks Canada Agency

Approved by:

Alan Latourelle
Chief Executive Officer, Parks Canada Agency

All competent ministers have approved posting of this recovery strategy on the Species at Risk Public Registry.

DECLARATION

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. The *Species at Risk Act* (S.C. 2002, c.29) (*SARA*) requires that federal competent ministers prepare recovery strategies for listed Extirpated, Endangered and Threatened species.

The Minister of the Environment presents this document as the recovery strategy for the Red Mulberry as required under *SARA*. It has been prepared in cooperation with the jurisdictions responsible for the species, as described in the Preface. The Minister invites other jurisdictions and organizations that may be involved in recovering the species to use this recovery strategy as advice to guide their actions.

The objective and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide further details regarding measures to be taken to support protection and recovery of 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 actions identified in this strategy. In the spirit of the *Accord for the Protection of Species at Risk*, all Canadians are invited to join in supporting and implementing this strategy for the benefit of the species and of Canadian society as a whole. The Minister of the Environment will report on progress within five years.

ACKNOWLEDGMENTS

PREFACE

This recovery strategy addresses the recovery of Red Mulberry across its native range in Canada, (i.e. the Carolinian Life Zone of southern Ontario).

The Minister of the Environment is the "competent minister", on behalf of both Parks Canada Agency and Environment Canada, for this species under *SARA*. Parks Canada Agency adapted this recovery strategy, in cooperation with Environment Canada, from a more detailed draft document prepared by the OMNR, which itself was based on a document originally developed by the Red Mulberry Recovery Team. The Royal Botanical Gardens; Hamilton, Niagara Peninsula, and Halton Conservation Authorities; Niagara Parks Commission; Ontario Forest Research Institute; Nature Conservancy of Canada; academia; and private consultants all provided valuable contributions. All responsible jurisdictions reviewed the strategy.

EXECUTIVE SUMMARY

Red Mulberry (*Morus rubra*) is an understory tree of moist, eastern North American forests, woodlands, and talus communities. In Canada, it has been confirmed as extant in 21 locations in two broad regions within the Carolinian Life Zone of southern Ontario: 1) Essex County and the Municipality of Chatham-Kent and 2) Niagara, including the cities of Hamilton and Burlington. Only 10 sites have five or more individuals. This species' range is contracting and its numbers are declining. In 2000, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Red Mulberry as Endangered because of its small and declining number of mature individuals (under 250) and its fragmented population.

Red Mulberry is threatened with extirpation by the non-native and more aggressive White Mulberry (*Morus alba)*, with which it freely hybridizes. Other significant threats include habitat loss and fragmentation, disease, which is often facilitated by various stress factors, and the impacts of nesting Double-crested Cormorants. Threats posed by other exotic species and grazing by White-tailed Deer and snails are of lesser concern.

The recovery of Red Mulberry is believed to be technically and biologically feasible. The population and distribution objectives for Red Mulberry are to maintain all currently existing populations of the species across its Canadian (Ontario) range and to prevent further decline in the number of individuals across the species' range. These objectives will be revisited once new information becomes available, particularly as genetic work confirms the total number and location of pure Red Mulberry trees in Canada. The Red Mulberry Recovery Team has been actively working to protect and recover this species since 1998. Recovery will be achieved through critical habitat protection, habitat restoration, population enhancement, protection and restoration of genetic integrity, management of the impacts of nesting Double-crested Cormorants and grazing species, community support and stewardship, monitoring, and enhancing knowledge and understanding of the species.

Knowledge of the existing Red Mulberry populations, their demography, population dynamics, pollination distances, habitat requirements, stress factors and disease needs to be updated. Efforts need to be made to locate previously undocumented trees and/or populations. Genetic testing of trees for hybrids and *Morus murrayana* and monitoring the results of White Mulberry removal and Red Mulberry enhancement activities, and the changing nature of the resulting populations is also necessary. A population viability analysis is needed, as is an understanding of the factors that will increase the success of Red Mulberry establishment.

This strategy identifies critical habitat range wide on public and private lands to the extent possible with the information that is currently available. The approach includes protection of a tree root zone area plus intervening forest, woodland, and talus habitats between trees 999 m or less apart. Biophysical attributes of critical habitat are defined and examples of activities likely to result in the destruction of critical habitat and their effects are outlined. A schedule of studies lists additional work necessary to complete critical habitat identification in Canada. Progress toward recovery will be assessed in five years according to the performance measures identified. One or more action plans related to this recovery strategy will be completed by March 2018.

RECOVERY FEASIBILITY

Recovery of Red Mulberry in Canada is considered biologically and technically feasible. The species meets all four criteria presented in the draft Government of Canada *Species at Risk Act Policies* (2009), as described below, although some caveats exist.

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.**
Within the native Canadian populations of Red Mulberry, it is believed that approximately 322 pure strain individuals exist, many of which are capable of reproduction now or in the near future. However, confirmation of the genetic purity of individuals identified based on morphology is required and further analysis of all individuals is needed to determine if any are actually *Morus murrayana*, a newly discovered mulberry species in North America. This work may reduce the known Red Mulberry population size in Canada. Red Mulberry trees can be propagated and cultivated from seeds or summer cuttings and can be established as seedlings within existing habitats to improve abundance.

2) **Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.**
Native Red Mulberry is confined to the Carolinian Life Zone of Canada (located within Ontario), occurring in moist, forested habitats. There is currently believed to be sufficient suitable habitat to support the long-term survival of Red Mulberry populations. Sustaining and restoring Carolinian woodlands is important for the re-colonization of Red Mulberry in currently unoccupied areas. Large-scale stewardship projects are currently taking place in Carolinian Canada through projects such as the Big Picture Network.

3) **The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.**
Each core population is located completely or almost entirely on conservation lands, providing additional protection to that already afforded by legislation. It is believed that the major threats to Red Mulberry can be mitigated, at least to some extent, through management techniques and protection. However, while local efforts may be able to reduce White Mulberry numbers within and/or adjacent to Red Mulberry populations, elimination of White Mulberry in southern Ontario is not possible or feasible. Similarly, while the impacts of nesting Double-crested Cormorants may be managed, they will not be eliminated. As such, the long term viability of the Middle Island and East Sister Island Red Mulberry populations cannot be guaranteed. Lastly, it may not be possible to influence some factors like drought and low soil fertility that stress Red Mulberry trees or to prevent stressed individuals from being invaded by secondary pathogens that may lead to their decline and death. Given that 11 populations consist of only one or two individuals each, such threats may lead to loss of the smaller, non-core Red Mulberry populations.

4) **Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.**
Recovery techniques such as habitat restoration and population enhancement, White and hybrid Mulberry removal, and Red Mulberry augmentation exist and can be implemented to support the achievement of the Red Mulberry population and distribution objectives.

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1.   COSEWIC SPECIES ASSESSMENT INFORMATION

Date of Assessment:	May 2000
Common Name (population):	Red Mulberry
Scientific Name:	*Morus rubra*
COSEWIC Status:	Endangered
Reason for Designation:	Few small declining disjunct populations remain within a geographically restricted area. They are threatened by hybridization with an alien species, a blight disease, and habitat degradation.
Canadian Occurrence:	Ontario
COSEWIC Status History:	Designated Threatened in April 1987. Status re-examined and uplisted to Endangered in April 1999. Status re-examined and confirmed Endangered in May 2000. May 2000 assessment based on new quantitative criteria applied to information from the existing April 1999 status report.

2.   SPECIES STATUS INFORMATION

Red Mulberry is listed as Endangered on Schedule 1 of Canada's *Species at Risk Act* (*SARA 2002*) and is similarly listed on the *Species at Risk in Ontario List* under Ontario's *Endangered Species Act, 2007*. It reaches the northern edge of its global range in southern Ontario. The Canadian distribution represents a small portion of the entire breeding range in North America and is estimated to be less than 1% of the global distribution (Ambrose *et al.* 1998). Red Mulberry is considered imperiled in Ontario (S2) and Canada (N2), but occurs as an exotic species in British Columbia. It is at risk of extirpation (Michigan, Vermont, and Massachusetts), or possibly extirpated (Minnesota) in a few other range-edge states, although it is considered secure in the United States (N5), particularly within the central portion of its range, and around the globe (G5) (NatureServe 2010). Additional detail is available on the NatureServe website at: http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=137019&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=137019&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=137019&selectedIndexes=144144&selectedIndexes=148110.

3.   DESCRIPTION OF THE SPECIES AND ITS NEEDS

3.1   Species Description

Red Mulberry is a dioecious[1], although sometimes monoecious[2] understory tree that typically reaches a height of 6 to 18 m (Ambrose 1987). The flowers are wind-pollinated, yellowish to reddish-green catkins[3] that bloom in early spring (Ambrose 1987). Red Mulberry trees produce a moderate quantity of deep, red-coloured fruit that mature yearly in mid to late July (Ambrose 1987). The large, heart-shaped leaves are serrate[4], long tipped, rough, and hairy and may have one to three lobes. Red Mulberry can be difficult to distinguish from White Mulberry (*M. alba*) and their hybrids (Ambrose 1987, 1999). Field guides that are representative of Red Mulberry before the introduction of White Mulberry in North America include: Peattie (1950), Braun (1961), Harlow and Harrar (1969) and Tomlinson (1980).

3.2   Species Needs

Across its North American range, the best site conditions for Red Mulberry are found in moist, sheltered coves near streams (Martin *et al.* 1961). In Canada, the species is native to the Carolinian Life Zone in Ontario. There, it occurs in fresh (damp) to moist, well-drained, forested habitats, including floodplains, bottomlands, the slopes and ravines along the southern portion of the Niagara escarpment and in swales[5] on some western Lake Erie sand spits (Ambrose 1999). It occurs on sandy soils in the Essex-Chatham-Kent area and on limestone-based, loamy soils on the Niagara Peninsula (Ambrose 1999). While moderately shade tolerant, forest openings of exposed mineral soil, free of competition, appear to promote better recruitment (Ambrose 1999). Seedlings are sensitive to the heat of summer (Ambrose 1987).

As a wind pollinated species, groupings of trees within the pollen dispersal range are important to ensure the production of sufficient, viable seeds for colonization of new sites. Birds, and possibly small mammals, are important dispersal agents of Red Mulberry fruit (Ambrose 1987).

4.   THREATS

Populations of Red Mulberry in Canada face four significant threats listed in order of importance: hybridization; habitat loss and fragmentation, impacts from nesting Double-crested Cormorants, and disease and the stress factors that make trees susceptible. Threats posed by other exotic species and grazing by White-tailed Deer and snails are of lesser concern.Table 1 classifies each threat.

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[1]   Dioecious plants have male and female flowers on separate plants.
[2]   Monoecious plants have male and female flowers on the same plant.
[3]   A catkin is a slender, often drooping, cylindrical flower cluster whose petals are absent or difficult to see.
[4]   Serrate refers to teeth on a leaf that are notched like a saw and point forward.
[5]   A swale is a long, narrow, shallow depression, often running parallel to a shoreline, which typically remains moister than bordering ridges of higher land.

Table 1:   Threat classification.

Threat	Extent	Causal Certainty	Occurrence	Frequency	Severity	Overall Level of Concern
Hybridization	Widespread	High	Current	Continuous	High	High
Habitat Loss and Fragmentation	Widespread	High	Current	Continuous	High	High
Nesting Double-crested Cormorants	Localized	High	Current	Continuous	High	High
Disease & Causative Stress Factors	Widespread	High	Current	Continuous	Medium	Medium
Other Exotic Species	Widespread	Low	Current	Continuous	Unknown	Low
Herbivory	Unknown	Low	Unknown	Unknown	Unknown	Low

4.1   Hybridization

Hybridization with White Mulberry is the most significant, population level threat to Red Mulberry in Canada. White Mulberry was introduced from eastern Asia for the silkworm industry. It has naturalized across eastern North America and freely crossbreeds with Red Mulberry (Farrar 1995, Waldron 2003). Almost all Red Mulberry populations in Canada occur in communities mixed with White Mulberry; with hybrids between the two species common (Ambrose 1999). Burgess (2004a, Burgess *et al.* 2005) found that 53.7 % of the Red Mulberry trees in six of the core populations (five or more individuals less than 1 km away from at least one other individual) in southern Ontario were hybrids. Of those hybrids, approximately 67% were genetically more similar to White Mulberry than Red. Based on an analysis of the pollen pool in two different locations, Red Mulberry pollen production per tree is similar to that of hybrid and White Mulberry trees. However, because White and hybrid Mulberry trees are more common than their native counterpart, only 8% of the total mulberry pollen rain comes from the native Red Mulberry (Burgess *et al.* 2008b). Selective removal of White and hybrid mulberry trees in a 50 m diameter around reproductive, female Red Mulberry trees resulted in a 14% increase in pure Red Mulberry seed produced by those individuals (Burgess *et al.* 2008b). This shows that Red Mulberry is experiencing a strong mating disadvantage associated with its low abundance. The reduction in Red Mulberry offspring was found to be largely attributable to crossbreeding with hybrid trees.

From observations at Fish Point Provincial Nature Reserve, on Pelee Island, where frequent tree blow-downs have occurred, it appears that White and hybrid Mulberry trees establish naturally at a high rate while Red Mulberry seedlings are rarely encountered (K. S. Burgess pers. comm.). Transplant experiments show that seedling and juvenile survival and fitness were much higher for White Mulberry and their hybrids than Red Mulberry in all environments and that no habitat differentiation occurred between Red, White, and hybrid Mulberry trees that could shelter Red Mulberry from the effects of hybridization (Burgess and Husband 2006). In addition, offspring from female White Mulberry trees were more likely to survive than those from female Red Mulberry trees (Burgess and Husband 2004).

The large number of White Mulberry trees and hybrids across the landscape, and the genetic makeup of the hybrids, suggest that the Red Mulberry is being genetically assimilated by White Mulberry. Given the negative effect that hybridization has on mating and establishment in Red

Mulberry (Burgess 2004a), it is likely that, without recovery action, hybridization may result in the extirpation of pure Red Mulberry in Canada. Furthermore, habitat disturbance promotes hybridization with rare taxa (Wolf *et al.* 2001).

4.2   Habitat Loss and Fragmentation

Loss of suitable habitat poses a threat to Red Mulberry of only slightly lesser magnitude to that of hybridization. Land clearing for agriculture, industry, urban development, and utility and transportation corridors has greatly reduced the amount of natural wooded habitat in Carolinian Life Zone of southwestern Ontario. In some areas within the historical range of Red Mulberry, less than 3% forest cover remains, much of which is highly fragmented (Larson *et al.* 1999). The historical range of Red Mulberry in Canada once extended through eastern Toronto to Whitby, but these sites have disappeared (Figure 2), likely due to land clearing and habitat degradation (Ambrose 1987). Two populations in the Niagara Region have been lost to construction in the last 20 years (G. Meyers pers. comm. 1985), and others were likely impacted by valley infilling and development adjacent to what are now small populations. In addition, natural events, like the June 6, 2010 Harrow to Leamington tornado that passed near one of the Essex County woodlands containing a small Red Mulberry population, have the potential to eliminate populations. The resultant increased distances between populations, particularly the smaller ones, enhances their susceptibility to natural randomly occurring events and/or anthropogenic impacts that could lead to extirpations of additional species' occurrences. Beyond clear cutting, other high intensity forestry practices (high grading or diameter limit cuts) can damage vegetation, cause soil compaction which may result in reduced Red Mulberry establishment, cause soil disturbance which may promote increased establishment of exotic plants and increase evaporation resulting in decreased soil moisture levels thereby increasing drought-related stress on individual trees.

4.3   Nesting Double-crested Cormorants

Ontario's Double-crested Cormorant (*Phalocrocorax auritus*) population has increased dramatically over the past 30 years. Large colonies of nesting cormorants are threatening the long-term persistence of Red Mulberry populations and their habitat on Middle Island (10 trees in 2002/3 [North-South Environmental Inc. 2004]) and East Sister Island (five trees [S. Dobbyn unpub. data 2009, NHIC unpub. data 2010]) in the western basin of Lake Erie. Research has shown that cormorants impact trees in their breeding locations by physically breaking branches, stripping foliage for nesting material (Korfanty *et al.* 1999) and through the deposition of excrement on trees, leaves, and soil. The latter can affect photosynthesis as well as soil chemistry (Hobara *et al.* 2001, Hebert *et al.* 2005).

Since 2000, an average of 4 897 nests have been recorded on Middle Island, while an average of 4 752 have been recorded on East Sister Island during the same period (Parks Canada unpub. data). Double-crested Cormorant population estimates for the islands, 24 485 and 23 760 respectively, are based on an average of 2.5 adults (includes non-breeding individuals loafing around each island) and 2.5 chicks per nest (Hatch and Weseloh 1999; T. Dobbie pers. comm. 2010). On Middle Island, cormorant nests have been found in Red Mulberry trees as well as in adjacent trees, with all but one Red Mulberry tree being negatively impacted. One Middle Island tree appears to be dead and another nearly so (T. Dobbie pers. comm. 2010). This population, in

particular, is threatened with extirpation. On East Sister Island, the population may be less impacted as three of five trees are in areas of low to moderate cormorant nesting while another, in an area of more extreme impacts, appears to be faring well due to its location in a patch of lower trees and shrubs not yet used for nesting by cormorants (S. Dobbyn pers. comm. 2010).

4.4   Disease and Causative Stress Factors

Red Mulberry is known to suffer from twig blight, twig dieback, cankers, and root rot (Ambrose *et al.* 1998). Health assessments of four populations of Red Mulberry indicate that some populations are in very poor health, suffering population-level declines described as a "gradual, general deterioration" (McLaughlin and Greifenhagen 2002; Spisani *et al.* 2004). The former study concluded that no single pathogen was responsible for the disease symptoms. Rather, several opportunistic, canker-causing pathogens and two opportunistic root disease pathogens affected the diseased trees. These pathogens are not known to infect healthy tissues, but can successfully cause damage to stressed and weakened hosts. Probable factors causing such stress include drought, low soil fertility and/or poor or suppressed canopy position. The Fish Point Provincial Nature Reserve and Point Pelee National Park populations were not found to be as healthy as the one at Rondeau Provincial Park due to a lower water table and less developed Red Mulberry tree canopies as a result of competition with neighbouring trees. The Royal Botanical Gardens population was found to have a broad range of health conditions based on more fertile and moist soils, but often suppressed canopy position (McLaughlin and Greifenhagen 2002).

Other research indicates that the species is highly sensitive to air pollution, with high levels likely making the species more susceptible to disease (Little 1995). In West Virginia, ozone damage to Red Mulberry leaves is believed to increase susceptibility to an opportunistic twig canker disease (*Nectria cinnabarina*) leading to the death of whole trees (O. Loucks pers. comm. 1996). Areas of reduced air quality may also be impacting populations through nitrogen enrichment, which has been identified to have a serious impact on natural grasslands (Wedin 1992). Similarly, soil enrichment from agricultural pollution may negatively impact soil microbes, which could make Red Mulberry habitats and populations more susceptible to White Mulberry colonization and hybridization. Studies of mycorrhizal[6] functioning on other species have established a negative impact of nitrogen deposition, causing mycorrhizae to become more parasitic[7] on plants rather than having the usual mutualistic[8] relationships (Allen 1991). Given that many of these stress factors can, and do, occur together, they may have cumulative stress effects on Red Mulberry, increasing susceptibility to attack by opportunistic pathogens, leading to reductions in population size and potential extirpations.

4.5   Other Threats

The following are either unconfirmed threats or threats considered to be of low concern relative to the four primary threats listed above.

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[6]   Mycorrhizal refers to a close, and mutually beneficial, association between a fungus and the roots of a tree in which the fungus is wrapped tightly around the tree rootlets or actually penetrates the cells of the tree roots.

[7]   A parasitic animal or plant lives in or on another plant or animal, obtaining the nourishment it needs from this individual without benefitting or harming the other plant or animal.

[8]   Mutualistic relationships refer to the way in which two different species interact in a way that benefits both.

4.5.1 Other Exotic Species

Other invasive species, beyond White Mulberry, may negatively impact Red Mulberry or/and its habitat. Several introduced insect species are increasing their distribution across southern Ontario. Emerald Ash Borer (*Agrilus planipennis*) and Asian Long-horned Beetle (*Anoplophora glabripennis*) are two insects of high concern due to their invasive nature and ability to infest and kill healthy trees. The Emerald Ash Borer primarily targets ash species while the Asian Long-horned Beetle attacks a variety of tree species. The expansion of either or both insect ranges could alter forest composition and Red Mulberry habitat, with unknown impacts to Red Mulberry. Invasive plant species, such as European and Glossy Buckthorn (*Rhamnus cathartica* and *R. frangula*), Norway Maple (*Acer platanoides*), Tree of Heaven (*Ailanthus altissima*), European Alder (*Alnus glutinosa*), Garlic Mustard (*Alliaria petiolata*), and Dog-strangling Vine (*Vincetoxicum nigrum*), may pose a threat to mature Red Mulberry trees or their seedlings by aggressively competing for light, producing chemicals toxic to other plants or inhibiting mycorrhizal activity (Vaughn and Berhow 1999).

4.5.2 Herbivory

The fruit of Red Mulberry is an attractive food source of birds and small mammals, which, if eaten and dispersed before it is fully mature, may result in lower regeneration success (Johnson and Lyon 1976). High populations of gastropods can hinder seedling growth. Grazing by eight species of native snails and slugs was observed at Point Pelee National Park (T. Pearce pers. comm. 1992) to effectively eliminate seedlings (Ambrose 1991). Gastropod impacts at other sites are unknown. In areas of high deer populations, browsing of Red Mulberry has been observed and is a further hindrance to the establishment of new seedlings (Ambrose 1993, Thompson 2002b).

5. POPULATION AND DISTRIBUTION

5.1 Population and Distribution Context

In 2000, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Red Mulberry as Endangered because of its small and declining number of mature individuals (under 250) and its fragmented population (COSEWIC 2010).

Red Mulberry reaches the northern edge of its range in southern Ontario where it is confined to the Carolinian Life Zone (Figure 1). While its range is somewhat diminished, there are no records to indicate that it was ever common or widespread here (Ambrose 1987).
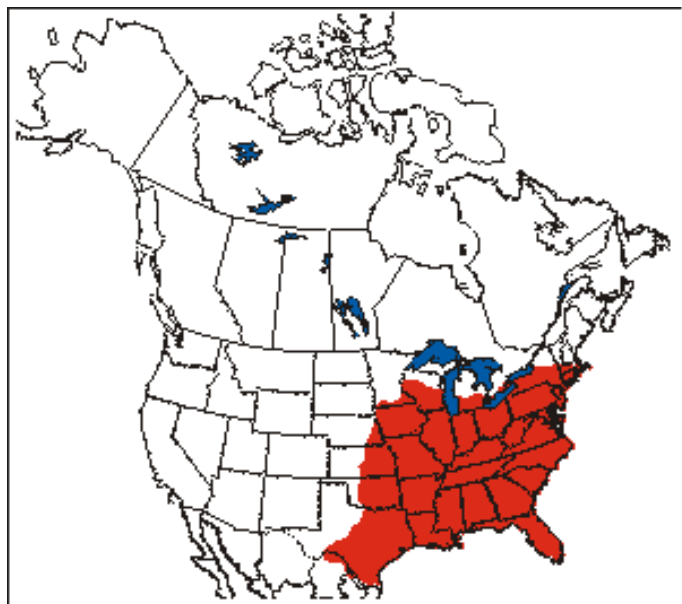

Figure 1: North American Red Mulberry distribution (Argus and White 1987). 6

COSEWIC last assessed the species in 2000 based on 10 known locations, including six core populations of five or more trees, in two broad regions: 1) Essex County and the Municipality of Chatham-Kent, including Point Pelee National Park and Pelee, Middle, and East Sister Islands, adjacent to western Lake Erie and 2) Niagara, including the cities of Hamilton and Burlington. Occupation of these two areas may correspond to different historical migration paths from the central part of the range in the United States. The forest habitats in these two regions are quite different; Red Mulberry in Niagara occurs along the moist, calcareous[9] Niagara Escarpment, while habitat along the Lake Erie shore is more open and sandy. These disparate ecological conditions appear to have given rise to genetic differentiation and local adaptation within Red Mulberry (K. S. Burgess pers. comm.).

Twenty-one extant populations (separated by at least 1 km) have now been confirmed (Table 2 and Figure 2). Of those, 10 are core populations of five or more trees (Thompson 2002b, Burgess *et al.* 2008a, Natural Heritage Information Centre [NHIC] unpub. data 2010). Of those 10, all are completely or almost entirely located on public or conservation lands. However, the impacts of nesting Double-crested Cormorants on the vegetation of Middle and East Sister Islands, in the western basin of Lake Erie, raise questions as to the long-term viability of these two populations. The remaining 11 populations, having only one or two trees each, may not be viable unless recovery work is undertaken to elevate their population size and minimize threats.

Overall, recruitment is low at all sites (K. S. Burgess pers. comm.). Red Mulberry seedlings are rarely encountered at Fish Point Provincial Nature Reserve (K. S. Burgess pers. comm.) and have only been infrequently observed in more stable forest communities, such as at Ball's Falls over the past 15 years. Although first year seedlings have been observed germinating at the edge of a gravel path under large fruiting trees at Point Pelee National Park, they did not survive for more than two years (Ambrose 1987). Numerous pollination experiments suggest that inbreeding depression in Red Mulberry is minimal (Burgess 2004a), although direct comparisons with Red Mulberry crosses within larger extant populations across the species range have not been made.

The largest population in the Niagara/Hamilton/Burlington region consists of approximately 155 trees of all age classes. The largest population in the Essex/Chatham-Kent region consists of approximately 55 trees of all ages. The total number of Red Mulberry trees, of all age classes, across the Canadian landscape is approximately 322 (Janas *et al.* 2001; Burgess *et al.* 2008a; Essex Region Conservation Authority unpub. data 2008; Parks Canada Agency unpub. data 2008; Ontario Parks unpub. data 2008, 2009; Niagara Peninsula Conservation Authority unpub. data 2009; Royal Botanical Gardens unpub. data 2009; NHIC unpub. data 2010; and G. Waldron, pers. comm. 2010). Apparent increases in overall population size in recent years are due to the location of older, previously undiscovered trees, rather than recovery of the population.

The Canadian distribution of Red Mulberry shows decline when compared to historical records (Figure 2). A total of 36 occurrences have been recorded for Red Mulberry. However, five of these are now considered extirpated and another 10 historic (not observed in the past 20 years). The northern limits of the Red Mulberry range once extended to Whitby, but have since contracted south to the Burlington area (Ambrose 1987). At Point Pelee National Park, the loss of three genetically pure trees has been documented since the late 1990s (Burgess *et al.* 2008a).

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[9]   Calcareous refers to a calcium or calcium carbonate-based substrate.

At some other sites, only hybrid forms can now be located; indicating that Red Mulberry likely occurred there in the past, but has been swamped by hybridization with the exotic White Mulberry (Ambrose 1999). The recorded loss of occurrences, as well as individual trees within occurrences, combined with minimal observed recruitment, indicates a decline is continuing.

Table 2:   Location and landownership of Red Mulberry trees in Canada.

Critical Habitat Parcel #	Location	Landowner(s)
Core Populations (5 or more trees under 1 km away from at least one other individual)		
228_1	Clappison Escarpment Woods, Hamilton	Conservation Halton
228_2	Waterdown Escarpment Woods, Burlington	Conservation Halton and private
228_3	Borer's Creek Conservation Area/Rock Chapel Escarpment/Berry Tract, Hamilton	Hamilton Conservation Authority, Royal Botanical Gardens, and private
228_4	Niagara Glen/Niagara Parkway, Niagara Falls	Niagara Parks Commission and Hydro One
228_8	Ball's Falls Conservation Area, Vineland	Niagara Peninsula Conservation Authority
228_9	Rondeau Provincial Park – North, Morpeth	Ontario Parks
228_12 228_13	Point Pelee National Park – South, Leamington (although historically one population, loss of a single, centrally located tree now places extant trees over 1 km apart. Critical habitat for this population is therefore mapped in two pieces)	Parks Canada Agency
228_15	Fish Point Provincial Nature Reserve, Pelee Island, western Lake Erie basin	Ontario Parks
228_16	Middle Island, Point Pelee National Park, western Lake Erie basin	Parks Canada Agency
228_17	East Sister Island Provincial Nature Reserve, western Lake Erie basin	Ontario Parks
Non-Core Populations (4 or fewer trees under 1 km away from at least one other tree)		
228_5	St. David's	Private
228_6	Leawood Court, St. Catharines	Private
228_7	Pendale Plaza, St. Catharines	Brock University
228-10	Rondeau Provincial Park – South, Morpeth	Ontario Parks
228_11	Point Pelee National Park – North, Leamington	Parks Canada Agency
228_14	Stone Road Alvar, Pelee Island	Essex Region Conservation Authority
228_18	Lot 6, Concession 3 East, Kingsville	Private
228_19	For the Birds, Colchester	Private
228_20	Big Creek Study Site #40, Amherstburg	Private
228_21	Canard River Kentucky Coffee-tree Woods Environmentally Sensitive Area, McGregor	Private
228_22	LaSalle Candidate Natural Heritage Site CA5, LaSalle	Town of LaSalle and private

Figure 2: Canadian distribution of Red Mulberry (updated from Thompson 2002b).

5.2   Population and Distribution Objectives

The goal of this recovery strategy is to ensure persistence of Red Mulberry in Canada by conserving and restoring functioning metapopulations[10] to long-term stability in the two broad regions of its occurrence.

The population and distribution objectives for Red Mulberry are:
1. to maintain all currently existing populations of the species across its Canadian (Ontario) range and
2. to prevent further decline in the number of individuals across the species' range.

These objectives will be revisited and potentially revised once new information becomes available. In particular, genetic work to confirm the total number and location of pure Red Mulberry trees in some of the largest populations in Canada may necessitate changes to the objectives. Recent research in the United States has identified a distinct species, *Morus murrayana*, in western Kentucky and the surrounding states, that has been previously identified as Red Mulberry (Galla *et al.* 2009). Further genetic research is required across the native Canadian population to determine if one or both native species of mulberry are present and to ascertain associated population size(s).

The impacts of nesting Double-crested Cormorants on the Middle Island and East Sister Island populations are severe enough that retention of these two populations cannot be guaranteed. In addition, while attempts need to be made to retain the 11 populations consisting of one or two trees each, given the extremely small size of these populations, the fact each tree bears either male or female flowers, and the potential for extirpation through natural events, long term maintenance of these populations remains uncertain, even if threats are reduced. For instance, the June 6, 2010 tornado that touched down from Harrow to Leamington passed very near one of the Essex County woodlands containing a Red Mulberry population of two trees. Other woodlands along the direct path of the tornado were devastated.

It should be noted that the second objective is not specifically to maintain the number of mature individuals. This is because: (1) the current population estimates are uncertain, given the possible occurrences of hybrids and of a new species; (2) a number of mature individuals are dying and their loss cannot likely be prevented; and (3) the only way to maintain populations is to facilitate regeneration or plant young (non-mature) trees.

The expectation under the objectives, and the best possible scenario, is that in future evaluations Red Mulberry will remain in the "Very Small Total Population" category of COSEWIC, but not fall in the "Small and Declining Number of Mature Individuals" category.

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[10]   A metapopulation is made up of a group of populations of the same species that are separated from one another, but that still experience exchange in individuals.

6.   BROAD STRATEGIES AND APPROACHES TO RECOVERY

6.1   Actions Already Completed or Currently Underway

Many Red Mulberry recovery actions have been undertaken since 1998. Included are surveys in the vicinity of extant and historic records and in some areas of suitable habitat, population censuses and heath assessments, Ecological Land Classification (ELC) [11] according to Lee *et al.* (1998), Conservation Land Tax Incentive Program (CLTIP) (MNR 1998) mapping and landowner contact, prior to regulation of the species under the *Endangered Species Act, 1971* (Husband and Burgess 1999, 2000, O'Hara 2000, Janas *et al.* 2001, Thuring and Smith 2001, Spisani *et al.* 2004).

Extensive research has been conducted on hybridization between Red and White Mulberry, its impacts, and management activities to address this threat, as well as comparative studies between both species and their hybrids (see Section 4.1) (Burgess 2000, 2003, 2004a, b, Burgess and Husband 2001, 2002a, b, 2004, 2006, Husband and Burgess 1999, 2000, 2001; Burgess *et al.* 2005, 2008b, Husband *et al.* 2000, 2001, Janas *et al.* 2001). This has led to additional knowledge regarding Red Mulberry demography and population dynamics. A pathology study (see Section 4.4) was also completed (McLaughlin and Greifenhagen 2002). Some work has also been done to test for differences in habitat characteristics between the two regions of occupancy and to compare seedlings from the different regions in a common environment (Beavers 1998).

Management activities to date include White/hybrid Mulberry removals conducted as part of an adaptive management study (Rodger 1997, Burgess *et al.* 2008b) and reductions in the size of the hyperabundant Double-crested Cormorant population on Middle Island to address impacts on plant species at risk, including Red Mulberry, according to the Conservation Plan developed to restore ecological integrity to the island (Parks Canada 2008). Ontario Parks' *East Sister Island Park Management Plan* has identified nesting Double-crested Cormorants impacts as an issue. A background document, which summarizes a number of studies to investigate the overall effects of cormorants on the island ecosystem, is now in preparation (S. Dobbyn pers. comm. 2010).

The Carolinian Woodlands Recovery Team is leading an ecosystem approach to recovery of the overall ecosystem in which Red Mulberry is found. At the broader landscape level, a gap analysis (Carolinian Canada's Big Picture Project) is informing restoration efforts to buffer and amalgamate forest fragments in the natural landscape to improve habitat quality by creating larger forest interior habitats.

6.2   Strategic Direction for Recovery

Broad strategies to recover Red Mulberry have been developed within this wider ecosystem context, with a focus on addressing threats and gathering the information needed to refine and attain the population and distribution objectives to support the recovery of Red Mulberry (see Table 3).

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[11]   ELC is a land and resource classification system that describes and delineates ecosystem units based on ecological factors including vegetation, soil and geologic conditions (Lee *et al.* 1998).

Table 3:   Recovery planning table.

Priority	Threat(s) addressed	Broad strategies to address threat(s)	Recommended approaches
High	All	Habitat restoration and population enhancement.	• Identify appropriate habitat and populations for restoration and population enhancement initiatives. • Develop and implement habitat restoration plans and population enhancement procedures.
High	Hybridization	Protect and restore genetic integrity.	• Develop and implement White Mulberry control procedures. • Develop techniques to enhance pure strain establishment and survival. • Determine current genetic composition of all populations, including variation within and between populations and metapopulations, and determine the presence/absence of *M. murrayana*.
High	Nesting Cormorants	Manage the impacts of nesting Double-crested Cormorants and communicate the need for such management.	• Implement the Middle Island Conservation Plan (Parks Canada 2008). • Determine the overall impact(s) of cormorants on East Sister Island and implement measures to address them.
High	All	Community support, stewardship, and Traditional Ecological Knowledge.	• Develop and implement best management practices to reduce or mitigate threats. • Develop and deliver outreach initiatives that increase awareness of Red Mulberry, understanding of threats to it, and foster voluntary stewardship actions. • Encourage the gathering and transfer of Traditional Ecological Knowledge from Knowledge Holders to others.
Medium	Habitat Loss & Fragmentation, Hybridization, Other Exotics	Critical habitat protection.	• Develop and implement critical habitat protection measures.
Medium	All	Monitoring.	• Conduct targeted searches in sites to update population status information as necessary, as well as at historical sites and in potential habitat. • Develop and implement a long-term monitoring program to detect changes in abundance, distribution, demography, health and threats.
Low	All	Enhance knowledge and understanding of the species.	• Fill knowledge gaps identified in Section 8 (Additional Information Requirements).
Low	All	Site-based management.	• Develop site-specific or multi-site plans to direct Red Mulberry recovery for core populations.
Low	Herbivory	Manage the impacts of grazing species.	• Develop and implement management actions to address the impacts of grazing species (White-tailed Deer and snails).

Recovery and conservation initiatives outlined in this strategy should be coordinated with other recovery teams (e.g. Carolinian Woodland Recovery Team), conservation groups (e.g. local Ontario Stewardship councils and conservation authorities) and restoration initiatives wherever possible. First Nation communities have maintained local ecosystems for generations through the use of community Traditional Ecological Knowledge. It is important to gather and share Traditional Ecological Knowledge from Knowledge Holders to others as a means for species and ecosystem protection and recovery. Traditional Ecological Knowledge and Science can, together, better inform assessment, monitoring, and recovery of the ecosystems that support specific species at risk.

7.   CRITICAL HABITAT IDENTIFICATION

Critical habitat is defined in section 2(1) of *SARA* as "*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*". This recovery strategy identifies critical habitat range-wide for native Red Mulberry in Canada, to the extent possible at this time based upon the best available information.

Geographical locations of known Red Mulberry trees were obtained from OMNR's NHIC (Figures 6, 7, 9-13, 16, and 19-22) and Ontario Parks (Figures 14 and 19), Parks Canada Agency (Figures 15 and 18), Royal Botanical Gardens (Figure 8), Niagara Peninsula Conservation Authority (Figure 13), Janas *et al.* (2001; Figure 17), Essex Region Conservation Authority (Figure 24), and Gerry Waldron, M.Sc., Consulting Ecologist (Figure 23). Additional map components were provided by OMNR's Land Information Ontario (Figures 6-24), the North American Atlas (Figures 6-24), Conservation Halton (Figures 6-7), Parks Canada Agency (Figures 15 and 18), Hamilton Region Conservation Authority (Figure 8), Royal Botanical Gardens (Figure 8), and Niagara Peninsula Conservation Authority (Figure 13).

This data was collected by regional, provincial, and federal agencies and their contractors, as well as by non-government organizations and individuals over the course of many years. The majority of trees were located during extensive searches in Hamilton, the Regional Municipality of Niagara and Essex County from 2000 to 2001, as part of the Conservation Land Tax Incentive Program for Endangered species in Ontario (Janas *et al.* 2001, Thompson 2002a). Targeted surveys at various locations were also completed from 2002 to 2004 and in 2007. Where possible, local experts were consulted regarding the continued existence of individual trees, knowledge regarding their genetic purity, accuracy of the data, and missing information.

Critical habitat has been identified for individuals that have been confirmed as pure-strain Red Mulberry trees through genetic testing or that were identified as Red Mulberry (as opposed to hybrid or White Mulberry) trees through morphological evaluation by species experts. Critical habitat has not been identified for trees that have been documented as hybrids through the techniques noted above, or for Red Mulberries that are known to have been planted or transplanted, or that have unverified origins. Records that are older than 20 years (pre 1990),

with no verification through follow-up surveys, were deemed historical and were also not considered during critical habitat identification.

Critical habitat is based on UTM (Universal Transverse Mercator coordinate system) locations of individual trees, obtained using a GPS (geographic positioning system) unit. Coordinates, obtained using this technology, are expected to be accurate to approximately 10 m or better. Records obtained by Paul O'Hara from the Clappison Escarpment Woods, Waterdown Escarpment Woods, and Borer's Creek Conservation Area/Rock Chapel Escarpment/Berry Tract populations have been excluded from consideration in critical habitat identification at this time, as data points have been determined to have an accuracy no better than 80- 100 m (N. Finney pers. comm. 2010).

Critical habitat is identified as a circle with a radius of 15 m surrounding the trunk of each live, individual, naturally occurring Red Mulberry tree, encompassing a critical habitat area of 707 m^2 around each tree (see Figure 3). This is based on a critical root zone definition, used as a zone of protection for trees, of up to 36 times the diameter at breast height (dbh – i.e. the diameter of a tree 1.3 m above ground level) of a tree (Johnson 1997). Given that the maximum-recorded dbh for Red Mulberry in Canada is 40 cm (Farrar 1995), the maximum critical root zone is then calculated to be 15 m (40 cm x 36 = 14.4 m rounded up to the nearest metre). This is supported by a 12.7 m rooting radius reported for a mature White Mulberry tree (dbh not provided) (Stone and Kalisz 1990), which occurs in the same genus as Red Mulberry. To be precautious, the larger of the two values has been applied in the identification of critical habitat.

Figure 3:   Conceptual illustration of critical habitat (15 m radius tree root zone) around a single Red Mulberry tree.

For locations where more than one Red Mulberry tree occurs, critical habitat also includes all Forest[12], Woodland[13], and Talus[14] ELC community classes[15] that fall within a shape, identified as the area within which critical habitat is found on the critical habitat maps, that encompasses the tree root zone of all Red Mulberry trees that are within 999 m or less of another Red Mulberry tree (see Figure 4A). On Middle Island, critical habitat also includes the Cultural Meadow/Cultural Thicket ELC community series, as this community is in the process of regenerating from former anthropogenic uses and is expected to succeed to woodland and eventually forest. The area within which critical habitat is found is represented by a minimum

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[12]   Forests have a tree cover greater than 60%.
[13]   Woodlands have a tree cover greater than 35% and less than or equal to 60%.
[14]   Talus are slopes of rock rubble at the base of cliffs where coarse, rocky debris makes up more than 50% of the substrate surface and there is an average substrate depth of less than 15 cm.
[15]   A Community Class is an organizational level with the ELC system of classification that groups plant communities based on similar, generalized ecological patterns and processes.

convex polygon[16] around all Red Mulberry tree root zones falling within 999 m or less of another Red Mulberry tree at that location (see Figure 4B). One kilometre is considered the minimum separation distance needed to place trees into two separate populations rather than a single one (NatureServe 2010). As such, the 999 m value has been selected to ensure protection of all suitable habitats between trees within a Red Mulberry population.

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[16] A minimum convex polygon is the smallest shape, drawn with straight line segments, which will surround all straight line segments that can be drawn between any two points (in this case, Red Mulberry trees with their 15 m tree root zone). As an analogy, picture an elastic stretched around a group of pegs on a peg board.

Figure 4: **Conceptual illustration of A) the area within which critical habitat is found for locations that have two or more Red Mulberry trees separated by 999 m or less and B) a distance greater than 999 m between Red Mulberry trees resulting in separate polygons related to critical habitat for each population.**

Across the species' range, the biophysical attributes of Red Mulberry critical habitat include moist, but well-drained, areas that have tree cover greater than 35% (Forest and Woodland ELC community classes). This includes:
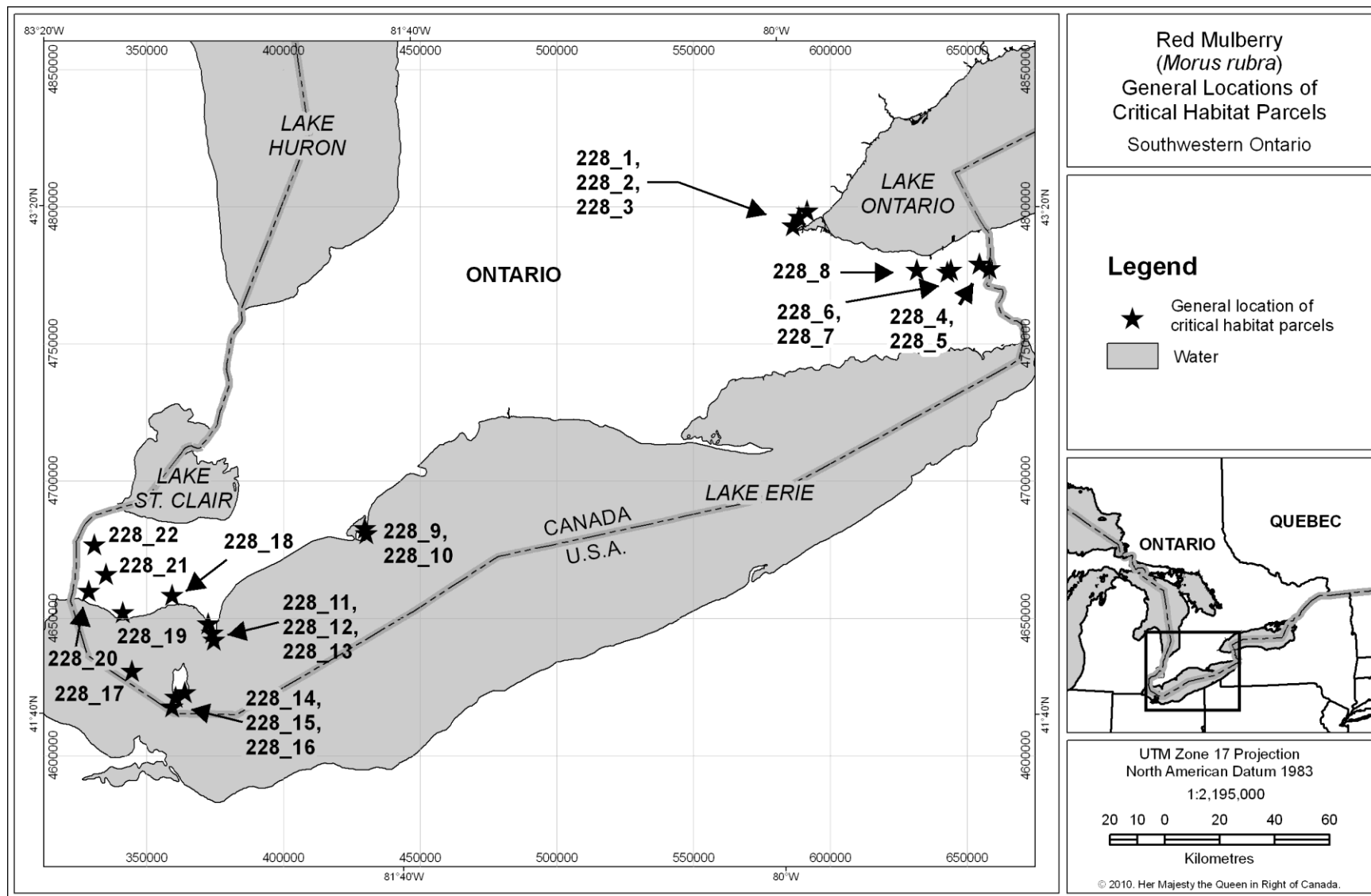
- floodplains and river valleys,
- areas where additional light penetrates the tree canopy (e.g. forest gaps and edges),
- Essex County, including Point Pelee National Park, Pelee, Middle, and East Sister Islands and the Municipality of Chatham-Kent: moist swales in sandy soils,
- Niagara Escarpment and Peninsula: limestone-based, loamy soils, plus the Talus ELC community class in areas, especially along benches (flat areas) in the escarpment, where moisture levels remain high.

General locations of Red Mulberry critical habitat are shown in Figure 5. Site-specific critical habitat maps for 22 critical habitat parcels are provided in Appendix B. Where a Red Mulberry tree exists within 999 m of another Red Mulberry tree, the area within which critical habitat is found has been mapped. Only the areas within this boundary that meet the biophysical description of critical habitat outlined in this section are critical habitat.

Existing anthropogenic features are excluded from critical habitat as they are not suitable habitats for the long-term persistence of this species. These features include, but are not limited to existing infrastructure (e.g. roads, trails, and parking lots), existing cultivated areas (e.g. agricultural fields), and unnatural vegetation types (e.g. grassed areas and septic beds). In addition, all White Mulberry trees and hybrid mulberry trees are excluded from critical habitat as optimal habitat for Red Mulberry should be free from these trees.

Figure 5: **General locations of critical habitat for Red Mulberry in Canada.**

7.1   Activities Likely to Result in the Destruction of Critical Habitat

Examples of activities, in or near critical habitat, likely to destroy critical habitat include, but are not limited to those outlined in Table 4 below.

Table 4:   Examples of activities likely to result in the destruction of critical habitat.

Effect of an Activity that May Destroy Critical Habitat	Examples of Activities likely to Destroy Critical Habitat
Loss or fragmentation of critical habitat.	Anthropogenic development within critical habitat (e.g. agricultural activities such as land clearing and/or tilling of the soil, industrial or residential development, or infrastructure developments such as new road, pipeline, water main, and wind power construction) or high intensity logging within critical habitat (clearing paths or other areas for log removal and/or stockpiling).
Damage to canopy or understory vegetation, increased evaporation leading to drying of the soil or soil compaction (which may result in reduced establishment of Red Mulberry recruits).	Logging - removal of trees within critical habitat using practices that do not conform to low impact logging standards (e.g. Forest Stewardship Council 2004). Examples of logging activities that are likely to destroy critical habitat include clear-cutting, high-grading, and diameter limit cuts.
Alteration of drainage patterns, ground water flow and soil moisture levels within critical habitat.	Property drainage (e.g. for agriculture or residential or industrial development) in or adjacent to critical habitat.
Alteration of forest vegetation resulting in increased hybridization with White Mulberry or hybrid mulberry trees and reduced production of pure Red Mulberry seed.	Intentional planting of White Mulberry plants within critical habitat.
Increased shading, or alteration of forest canopy or understory vegetation, leading to competition with Red Mulberry seedlings or saplings.	Intentional planting of non-native species within critical habitat.
Disturbance of soil (which may result in increased establishment of exotic plants) and/or destruction of vegetation.	Vandalism or off-road vehicle use within critical habitat.

7.2   Schedule of Studies to Identify Critical Habitat

Additional work required to refine the population and distribution objectives and determine if critical habitat identification requires modification to support these objectives for recovery is outlined in Table 5.

Table 5:   Schedule of studies for the identification of critical habitat.

Description of Research Activity	Expected Results	Estimated Timeline From Final Recovery Strategy Posting
Confirm status of Red Mulberry populations and individual trees where necessary.	Update information on Red Mulberry population sizes and the presence/ absence of individual trees.	3 years
Search suitable habitat (Niagara Escarpment, Brock University lands, Essex County, historic sites etc.) for Red Mulberry trees that have not previously been located.	Improve knowledge of current distribution and abundance.	4 years
Complete ELC surveys of extant populations of Red Mulberry.	Vegetation communities are identified in areas surrounding existing trees, ground-truthed and mapped to the extent possible for all extant sites contributing to critical habitat definitions.	4 years
Confirm the genetic purity of trees identified as Red Mulberry.	Confirm the genetic purity of trees previously identified using morphological characteristics and separate true Red Mulberry trees from *M. murrayana* in order to confirm which individual trees require critical habitat protection.	5 years
Complete critical habitat modeling and/or identification and delineation.	Refine the population and distribution objectives based upon the above information if necessary. Identify optimal Red Mulberry habitat and modify critical habitat required to support the population and distribution objectives for the Canadian Red Mulberry population if necessary.	6 years

8.   ADDITIONAL INFORMATION REQUIREMENTS

Information gaps still exist and need to be filled in order to meet the population and distribution objectives set out in this recovery strategy. These gaps include:

- **Census Surveys and Population Information:** Searches need to continue for as yet undocumented trees, recording new distribution, abundance, demography, health, genetic variation, habitat, threats, and trends. Updates are needed for many known populations.
- **Habitat Requirements:** The habitat of Red Mulberry needs to be fully characterized, including a comparison of habitats in the two regions of its occurrence.
- **Hybridization Research:** An expansion of the screening of trees for hybrid status is needed. In addition, it is imperative that White Mulberry removal and Red Mulberry enhancement trials, past, present and future, be monitored to evaluate the effect on Red Mulberry recruitment and community response to tree removal so that adaptive management can take place.

- **Disease and Causative Stress Factors**: Whether the attack of opportunistic pathogens is as a result of stress from drought, low soil fertility, and/or poor canopy position and the severity of those threat(s) needs to be confirmed.
- **Pollination:** Pollination distances for Red, White, and hybrid Mulberry need to be determined to inform hybrid and White Mulberry management.
- **Population Viability Analysis:** Information (sex, fecundity, seed predation, germination, seed dispersal, survivorship, recruitment, dispersal) needs to be gathered to complete a population viability analysis[17].
- **Transplantation:** Factors that will increase the success of Red Mulberry establishment (e.g. seeds sown in the field vs. the use of older transplants) need to be determined.

9.   MEASURING PROGRESS

Performance measures for evaluating the success in achieving the Red Mulberry population and distribution objectives in five years are as follows:

- Ten core populations and 11 non-core populations of Red Mulberry can be found distributed in two metapopulations (Essex County/Municipality of Chatham-Kent, including Point Pelee National Park and Pelee, Middle, and East Sister Islands, and Hamilton/Burlington/Niagara).
- The genetic composition and purity of trees across the Canadian range is known such that the population and distribution objectives can be revised if necessary (e.g. should trees formerly identified as Red Mulberry be determined to be hybrids or *M. murrayana*).
- The number of individual Red Mulberry trees of all age classes (approximately 322) has not declined, unless genetic studies determined that trees formerly believed to be Red Mulberry are in fact *M. murrayana* or hybrids with White Mulberry. Should genetic research determine that there are fewer pure Red Mulberry trees in Canada than previously thought, the target number of trees to be maintained will be lowered based on the findings.
- Habitat suitability has been maintained (Woodland, Forest, and Talus ELC community classes still exist) in areas of critical habitat.

10.   STATEMENT ON ACTION PLANS

One or more action plans related to this recovery strategy will be completed by March 2018.

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[17]   In a population viability analysis, demographic information (age or size specific survival and reproductive probabilities) are collected and incorporated into models or simulations with the intent of projecting future populations and estimating the likelihood of extinction or persistence.

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APPENDIX A: 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* (Government of Canada 2004). 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.

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 upon 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.

The majority of the broad strategies presented in this recovery strategy will have positive impacts on other species occupying the Carolinian forest, as well as the forests themselves. Many Red Mulberry populations occur in areas where there are other species at risk (e.g. Blue Ash [*Fraxinus quadrangulata*] and Butternut [*Juglans cinerea*]). Fragmentation is one of the main threats to Carolinian woodlands. Efforts to protect habitat, increase connectivity among habitat patches, and maintain and restore ecological integrity within the Carolinian Life Zone will inevitably benefit species at risk, as well as many common species found in association with Red Mulberry. Where White or hybrid Mulberry removal occurs or branch removal occurs near heavily shaded Red Mulberry trees, these activities will open the forest canopy, increasing light penetration to the benefit of shade intolerant, native plant species like Blue Ash. Such activities will need to be carefully monitored and managed to prevent a flush of other introduced/invasive species in these areas. Efforts to reduce invasive species will positively benefit other native species that are competing for space and resources. Increases in Red Mulberry abundance due to enhanced seedling recruitment will serve as a food source for birds, and, to a lesser extent, small and mid-sized mammals that feed on and later disperse its fruit.
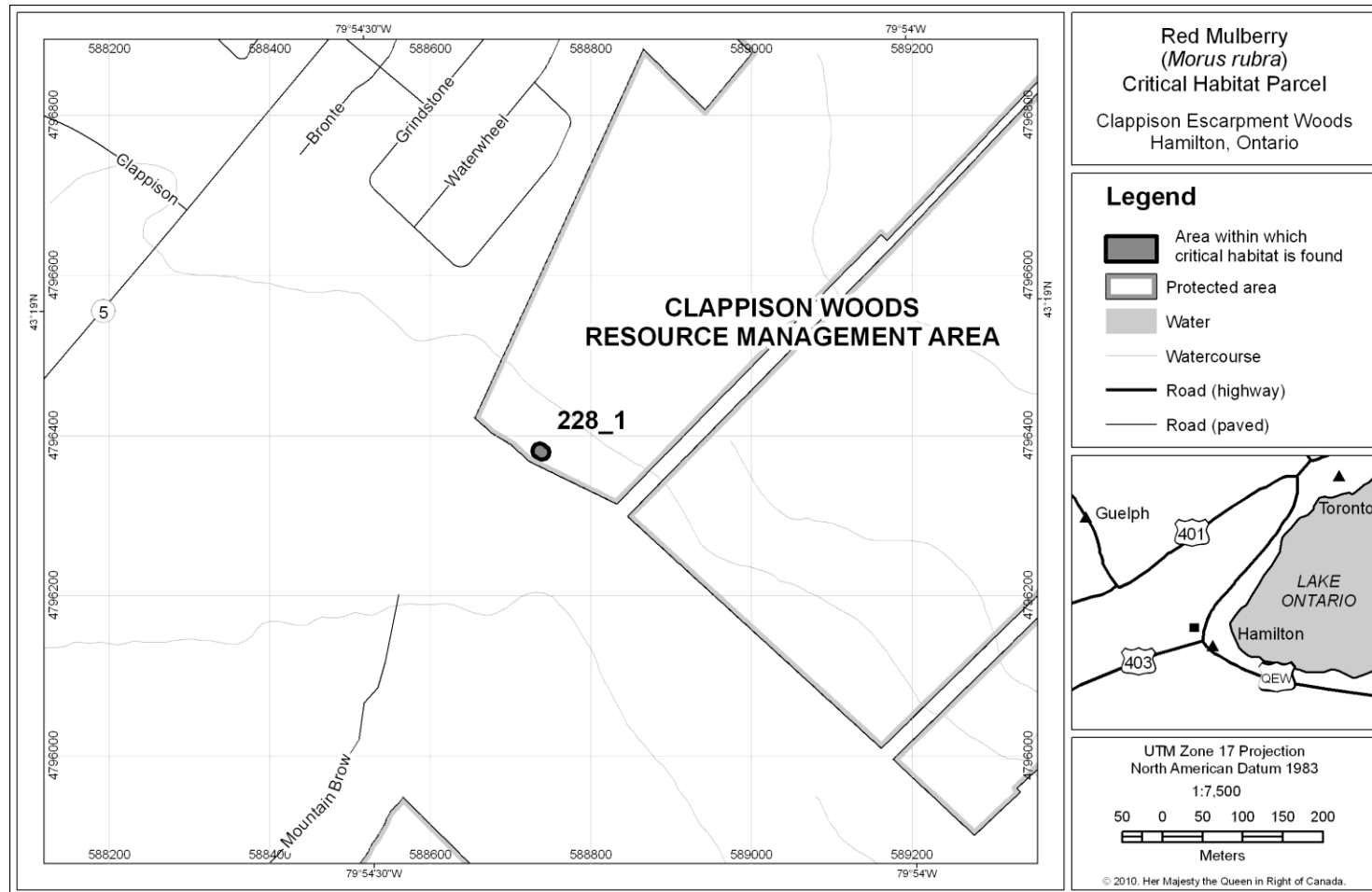
Some of the strategies could, however, have a negative impact on other species occupying Carolinian forest habitat. Herbicide use to prevent White or hybrid Mulberry from resprouting could impact soil, ground and surface water quality, and damage surrounding vegetation if not carefully applied. To limit these impacts, herbicides should be directly applied through stem injections or through careful painting or wicking of the cut or girdled stems. Herbicide application on Parks Canada lands will need to comply with Integrated Pest Management Directive 2.4.1 (Parks Canada 1998). Where cutting of White or hybrid Mulberry trees occur, careful attention will need to be given to sensitive vegetation and fauna in the vicinity to ensure minimal damage occurs to other species, communities and ecological processes. Removal of larger White and/or hybrid Mulberry trees could potentially disturb nesting activities, damage nests or injure rare or migratory birds, small mammals (including the Southern Flying Squirrel) and other wildlife species utilizing them as habitat. Removal programs will need to take place during the fall to avoid the breeding bird season (May to August) to mitigate potential impacts to birds as well as on herbaceous plants and the understory. Trees are also most sensitive to

herbicides during this time period and so this will increase the effectiveness of herbicide treatments. Careful field surveys prior to removal will be needed to determine if other species, including species at risk, will be impacted so that appropriate mitigation measures can be implemented. In addition, areas where trees are to be but down, as well as any access routes to be used for access or tree removal activities, will need to be scouted ahead of time to make sure that other species at risk are not being trampled or harmed. To the extent possible, the number of routes in and out of the areas to be targeted will be minimized. Gaps in the forest created through removals may promote the growth of invasive species. Soil disturbance should therefore be kept to a minimum. Native species recruitment in these gaps should be promoted through plantings, as well as immediate removal of colonizing invasive species, or other means. Depending on the density of White Mulberry removals, understory shade tolerant species may be negatively affected (Parks Canada 2006). In some locations, where White Mulberry occupies a significant proportion of the forest, removal may decrease food and habitat availability for some birds and small animals; however the increased presence of Red Mulberry through enhanced seedling recruitment could alleviate some of these effects. Removal programs targeting White Mulberry and hybrids should involve follow-up monitoring to determine the success of the techniques implemented, in addition to the impacts on other species, vegetation communities and ecological processes and changes in the rate of Red Mulberry hybridization. Removal of competing branches next to heavily shaded trees will also be monitored. In both cases, this will allow for adaptive management and continual adjustment and improvement of recovery efforts. As Red Mulberry is found within the Carolinian Life Zone, an area with a high number of protected and rare species, all monitoring and research activities should take care to minimize or avoid trampling and disturbance to those species.

Invasive species and vegetation removals at Point Pelee National Park may require screening level environmental assessments under the *Canadian Environmental Assessment Act (1992, c. 37) (CEAA)* to address project specific concerns. Control of insects, disease, and invasive vegetation in provincial parks are included under *A Class Environmental Assessment for Provincial Parks and Conservation Reserves (OMNR 2005)*.
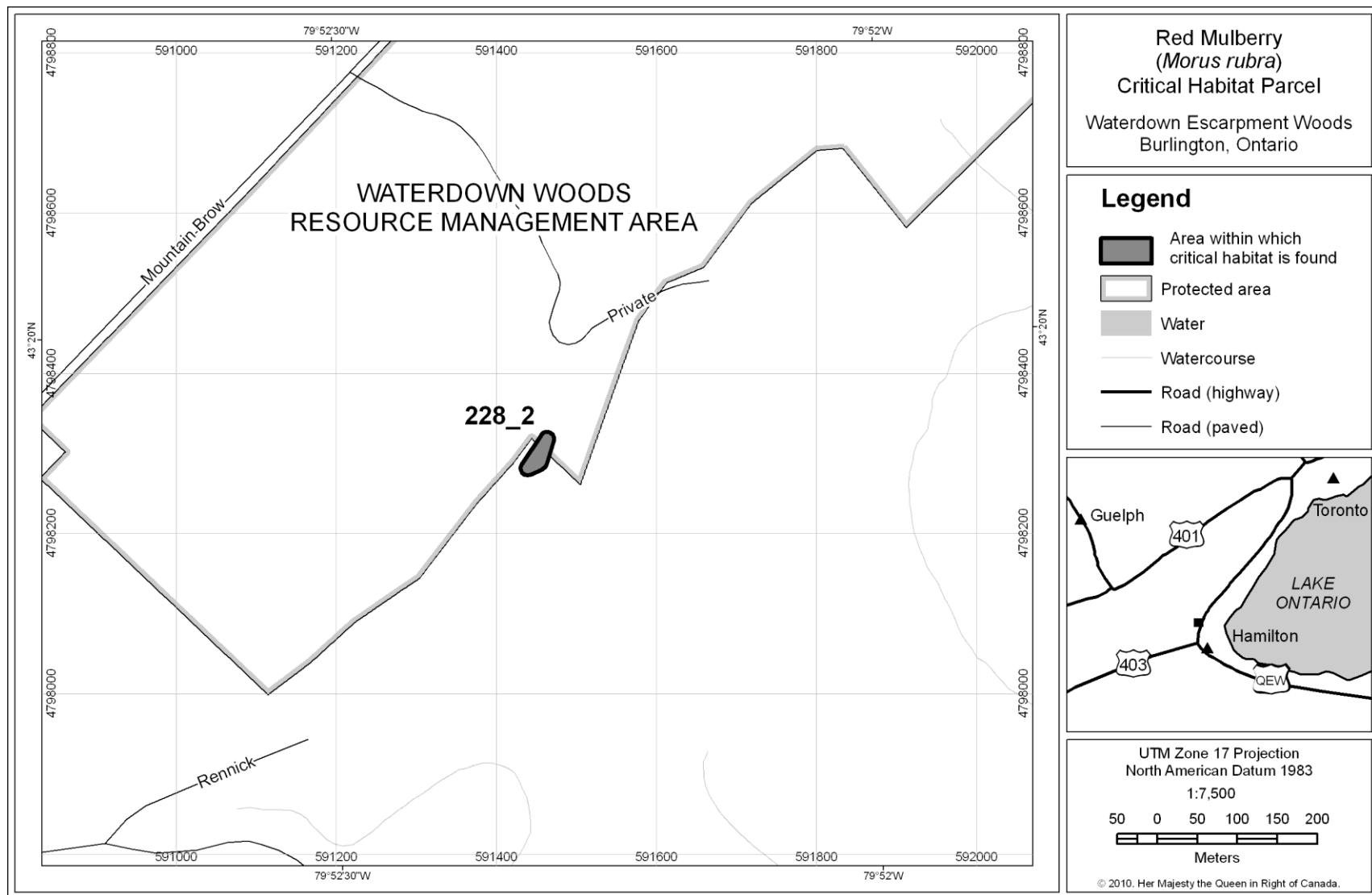
Addressing the large Double-crested Cormorant populations on Middle and East Sister Islands, which could include their control, will adversely affect individual cormorants, but will benefit many species of native plants, especially trees, which are killed by the cormorant's ammonia-rich excrement. Maintaining the ecological integrity of the island's Carolinian forest is the target. Efforts to control deer browse will positively benefit forest vegetation damaged by browsing. Both management practices have been assessed under their respective environmental assessment processes and project-specific environmental impacts and mitigation measures have been or will be implemented. Any potential conflicts arising from recovery efforts will need to be addressed early on through adaptive management.
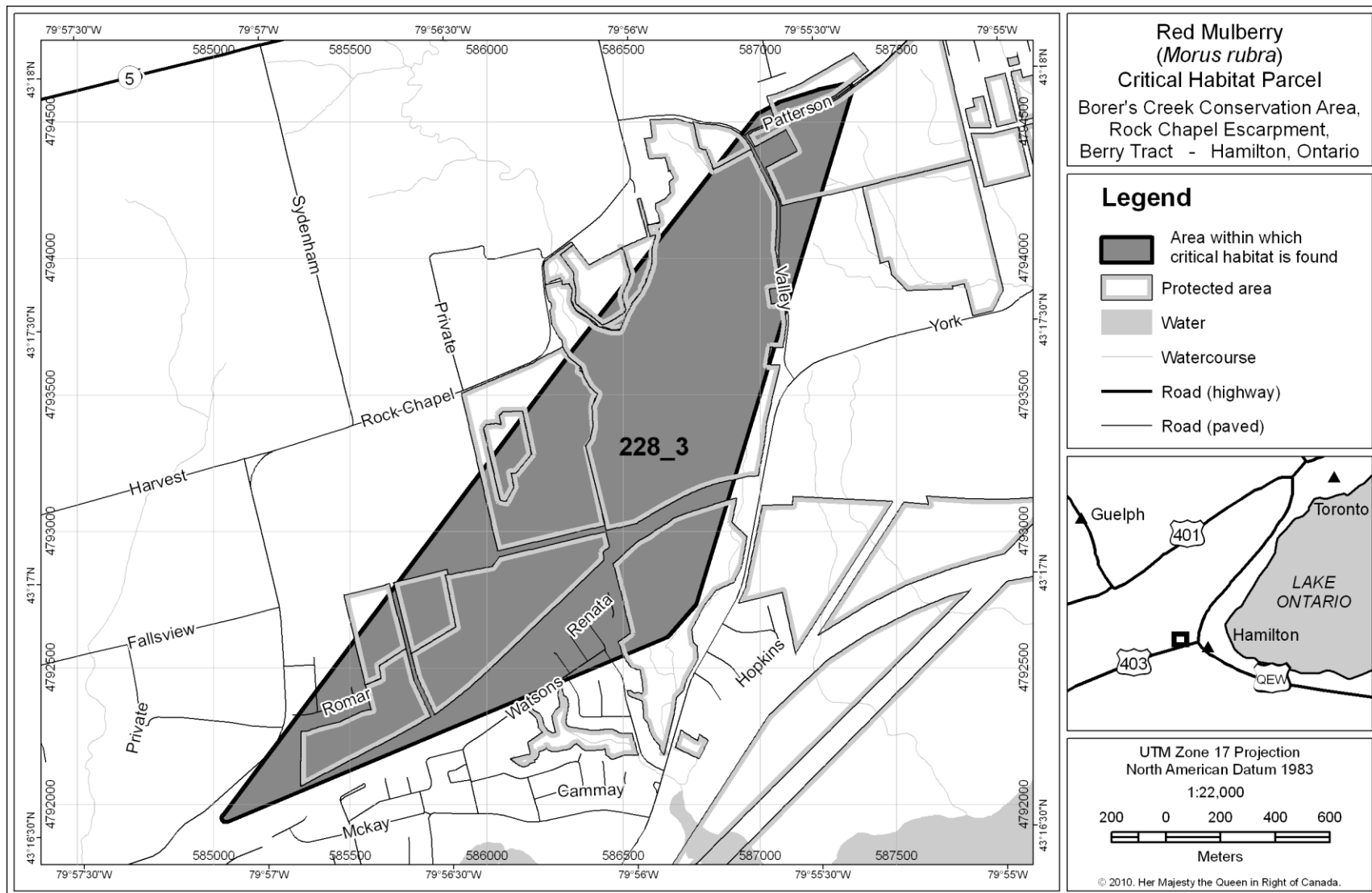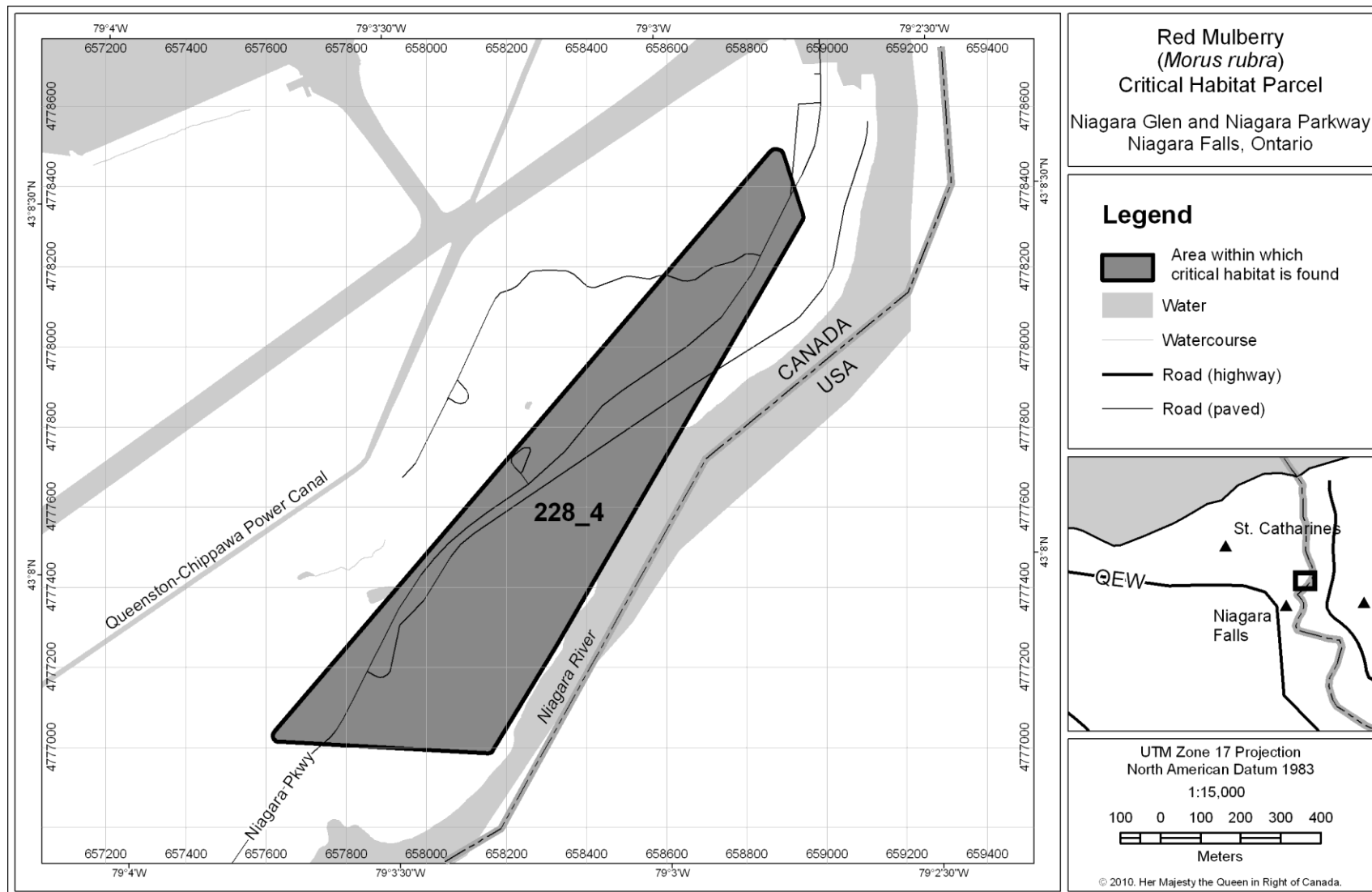
APPENDIX B: CRITICAL HABITAT MAPS

Figure 6:   Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_1). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
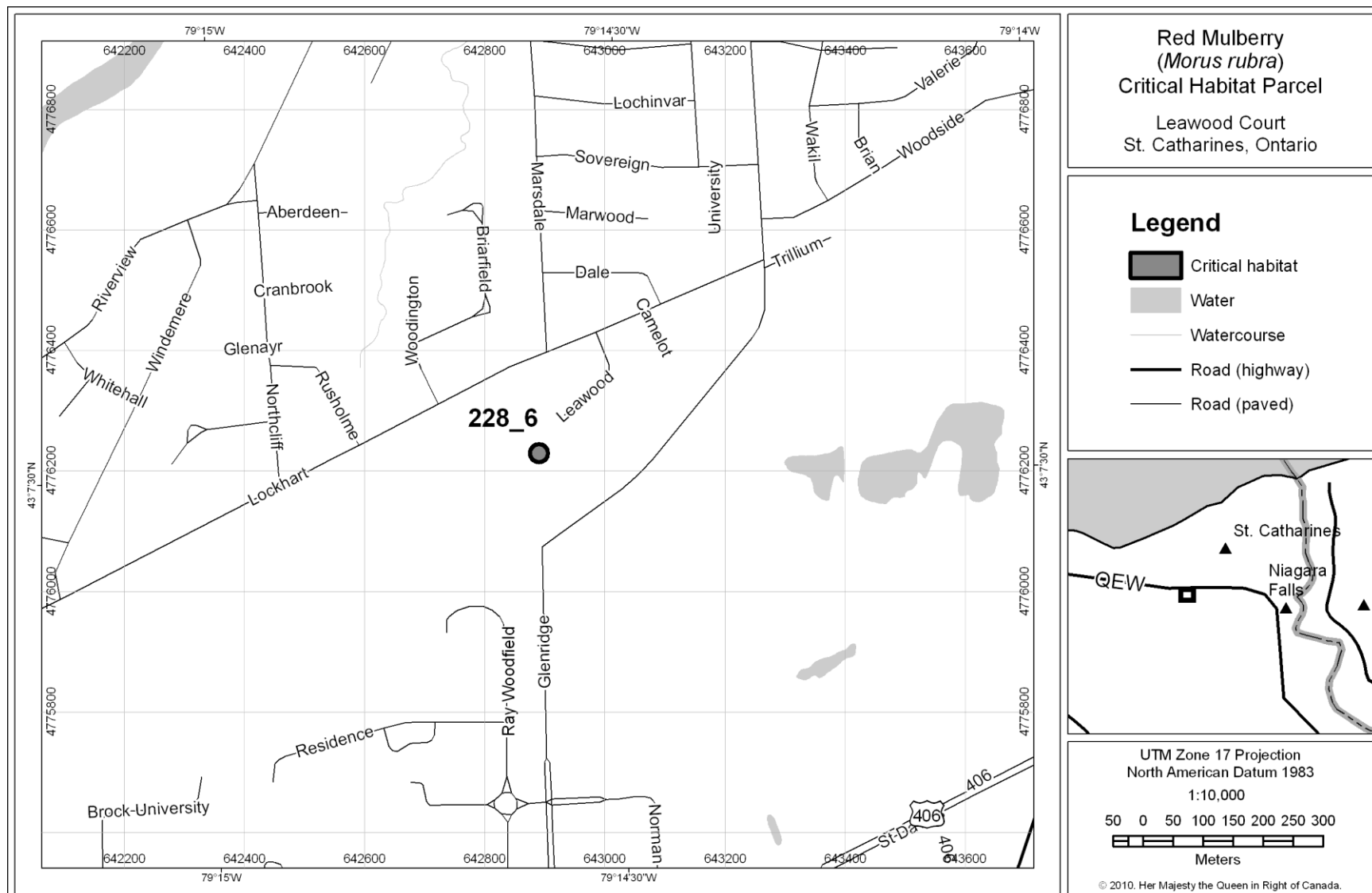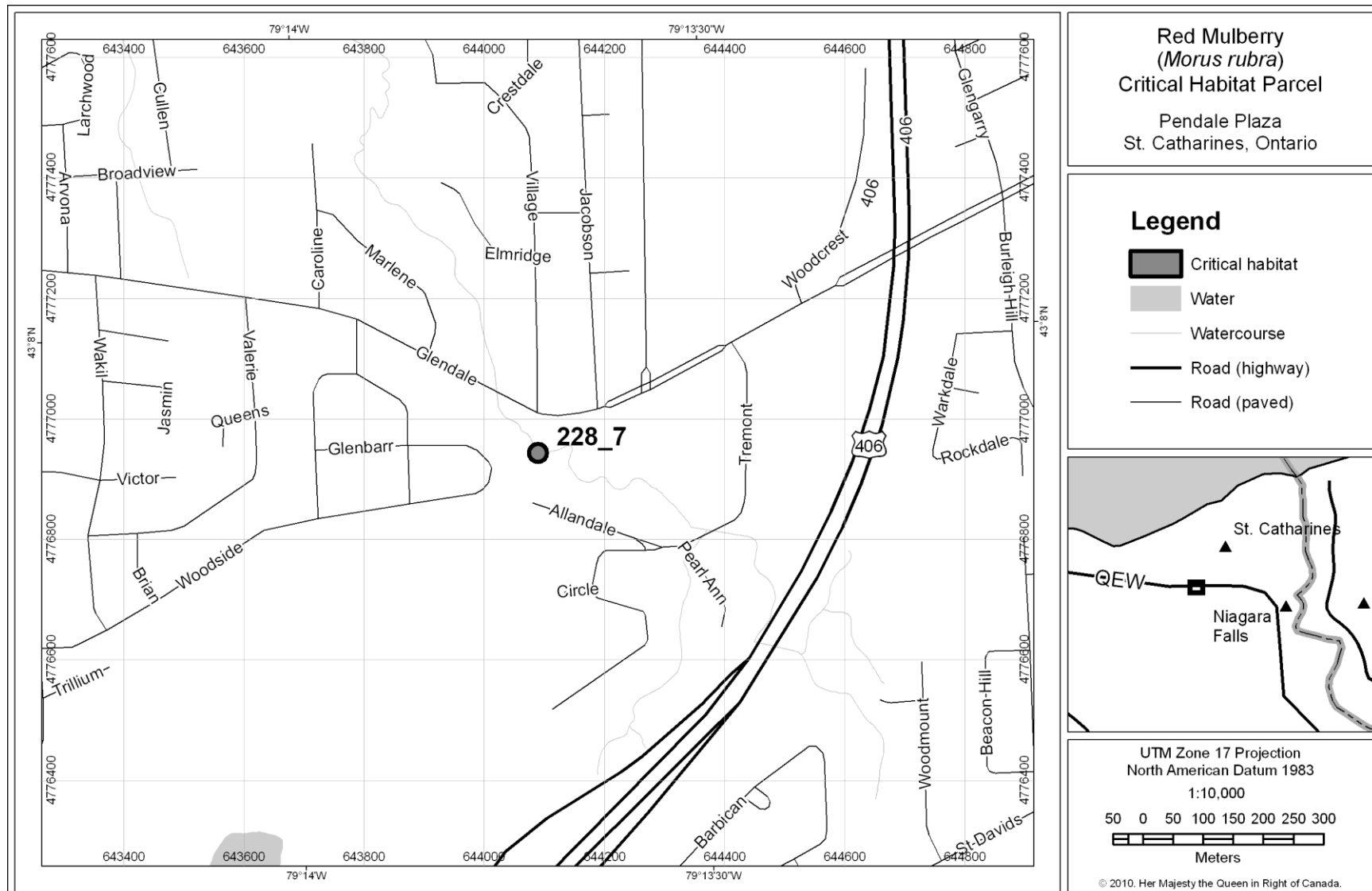

Note: The term "Protected Areas" used in the critical habitat maps has no relation to protection requirements under *SARA*.

Figure 7: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_2). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
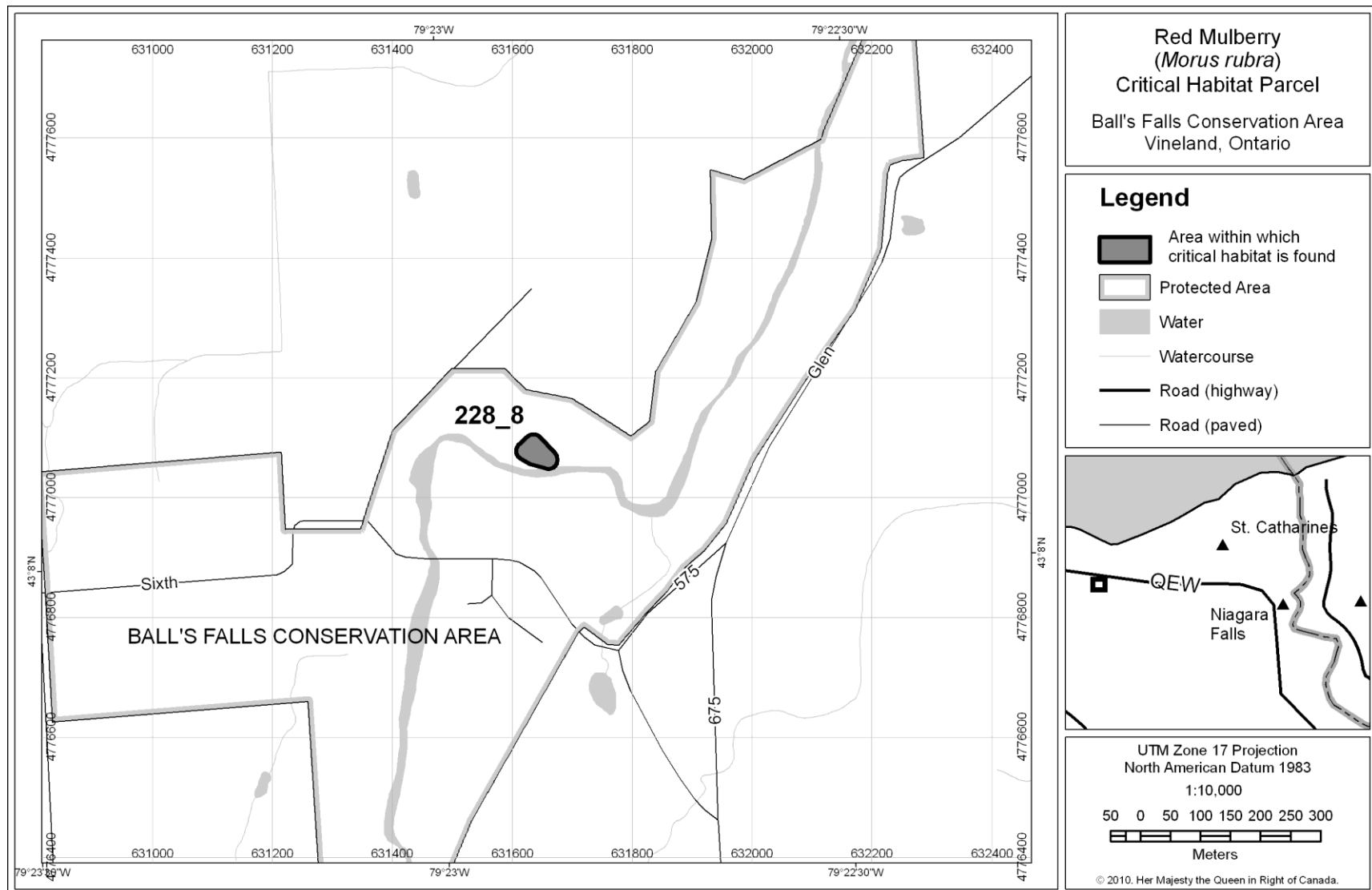
Figure 8: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_3). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
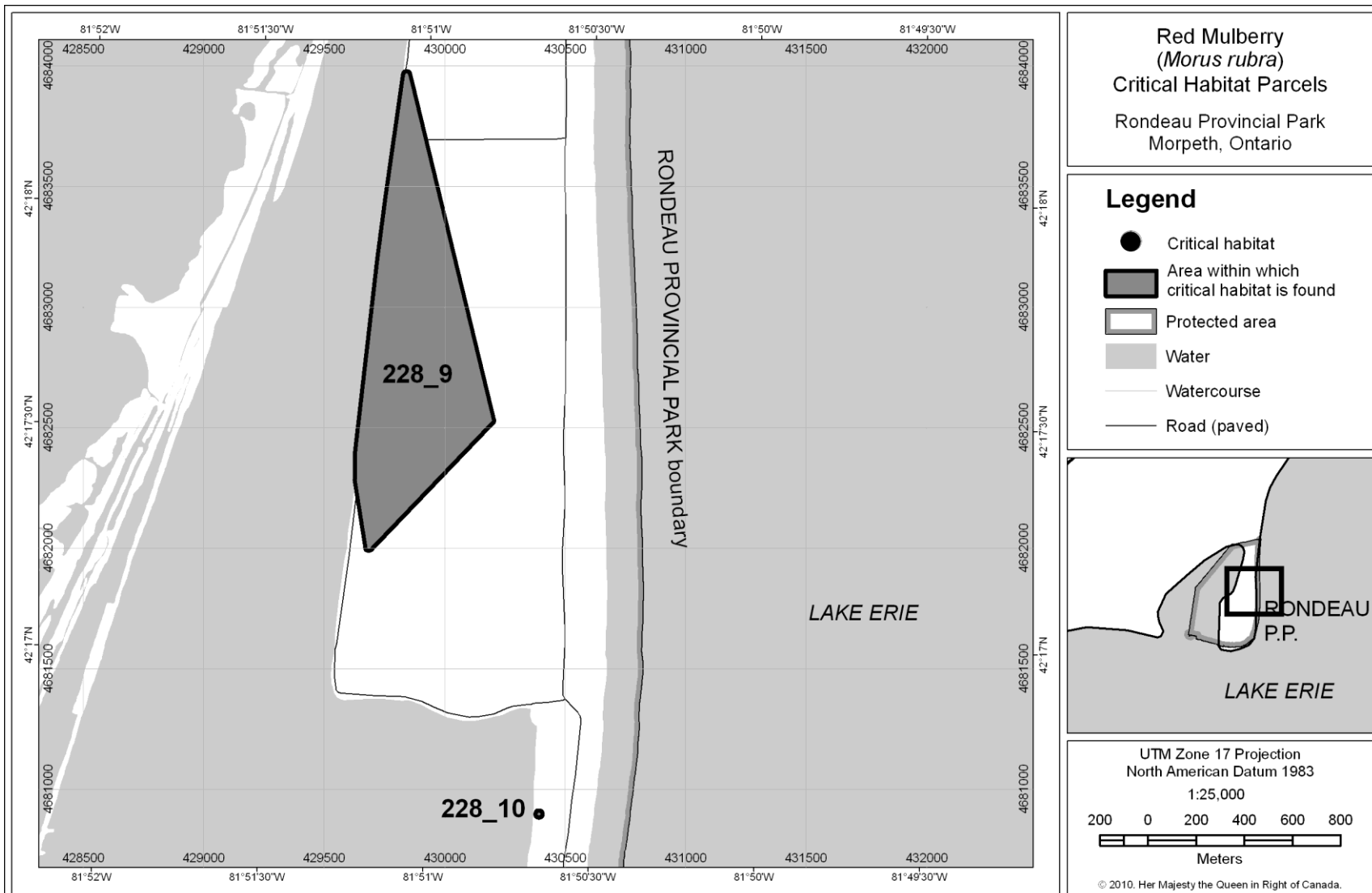
Figure 9: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_4). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
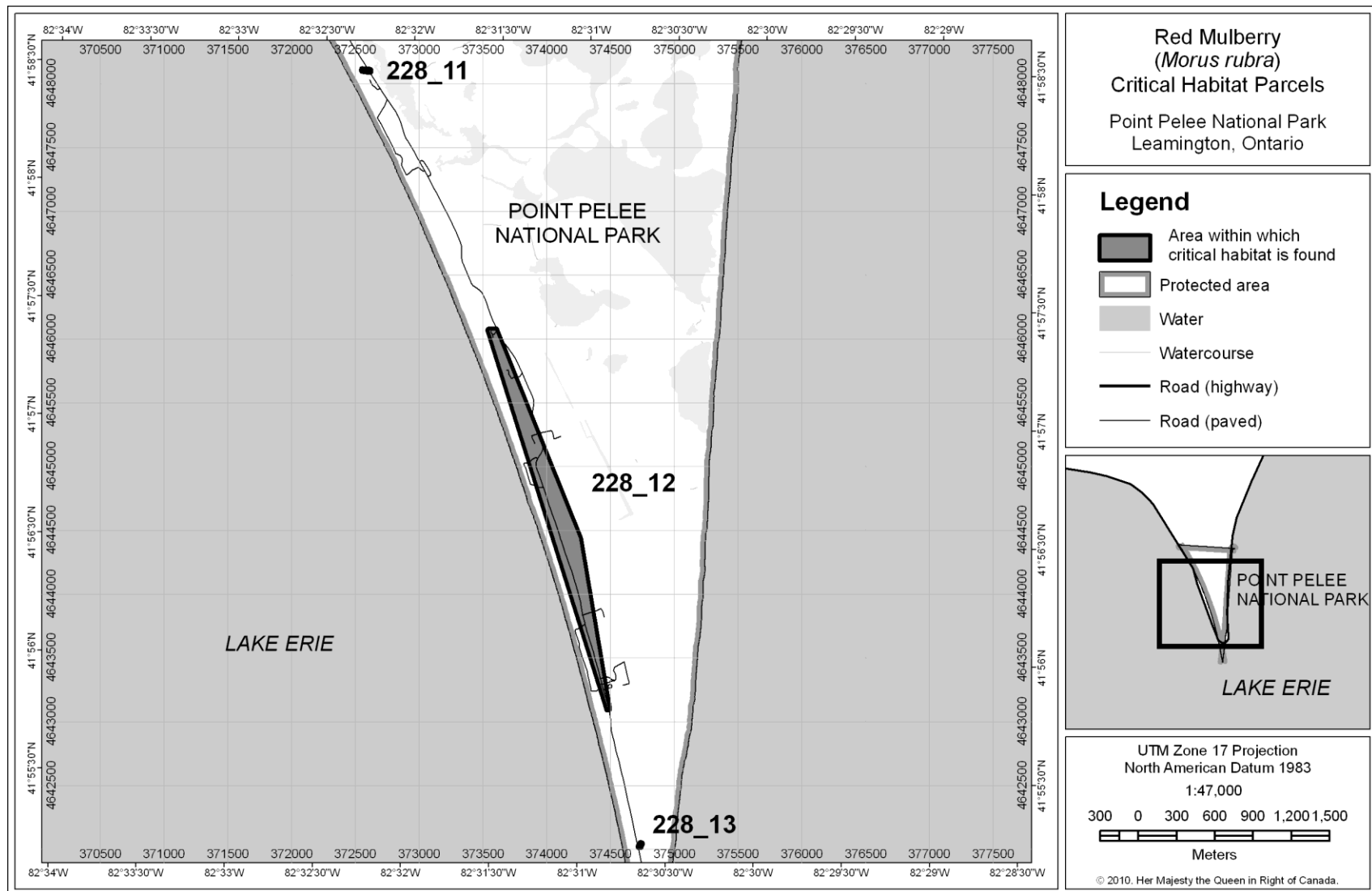
Figure 10:   **Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_5). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.**
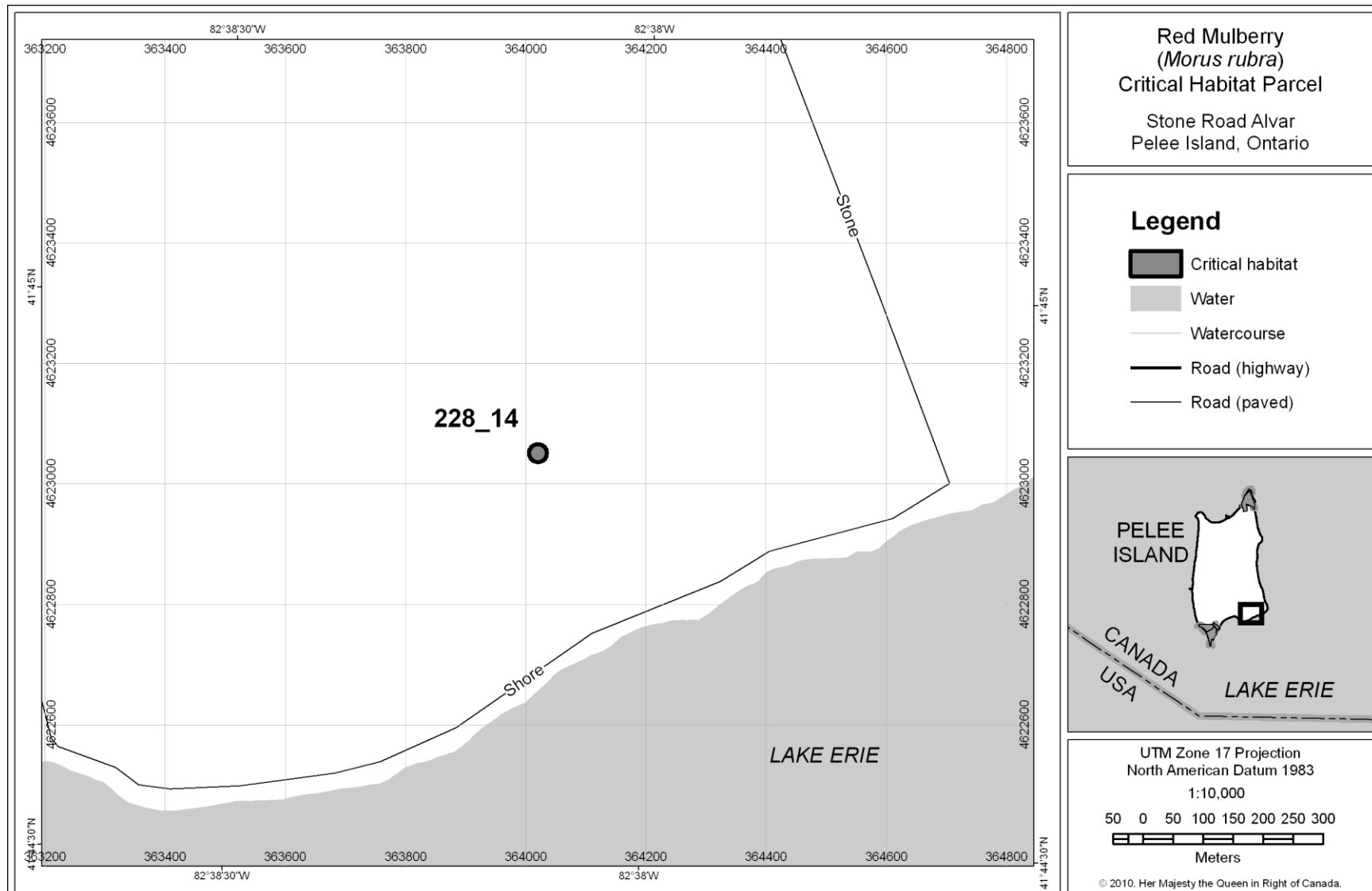
Figure 11: Location and extent of critical habitat parcel # 228_6 for Red Mulberry. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.

Figure 12: Location and extent of critical habitat parcel # 228_7 for Red Mulberry. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.

Figure 13: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_8). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
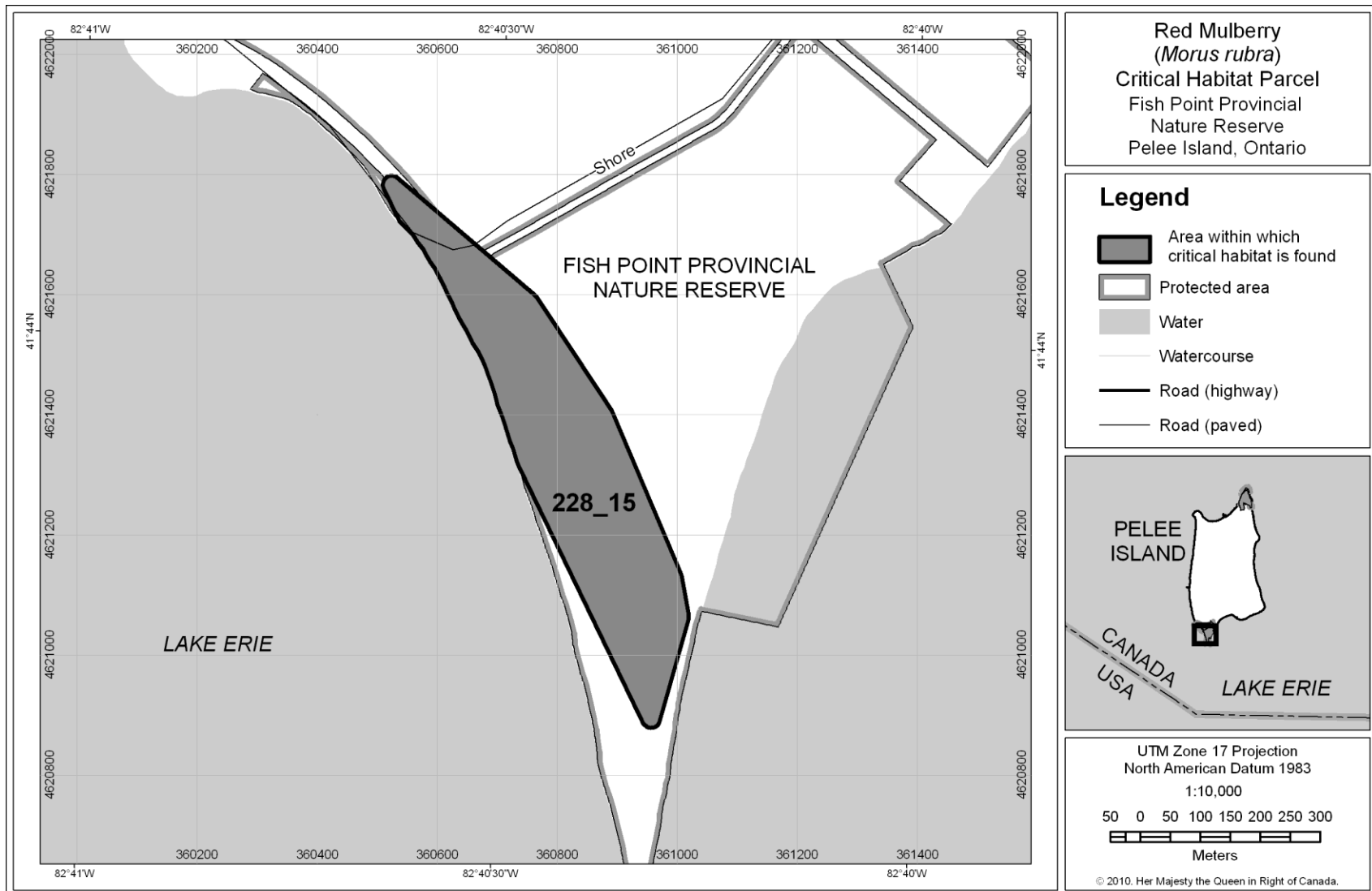
Figure 14: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_9) and location and extent of critical habitat parcel # 228_10 for Red Mulberry. Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
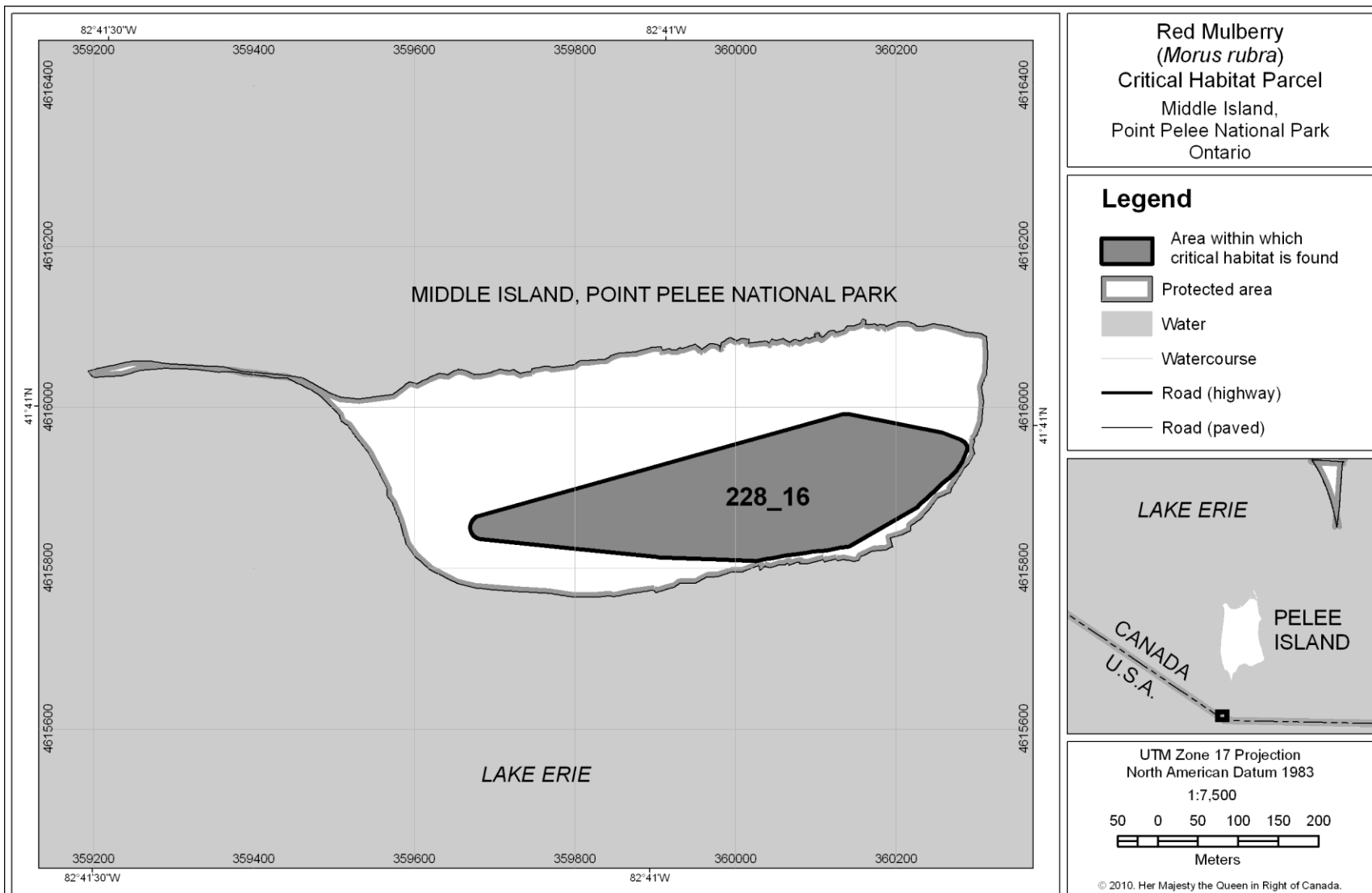
Figure 15: **Areas within which critical habitat for Red Mulberry are found (critical habitat parcel # 228_11, # 228_12, and # 228_13). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.**
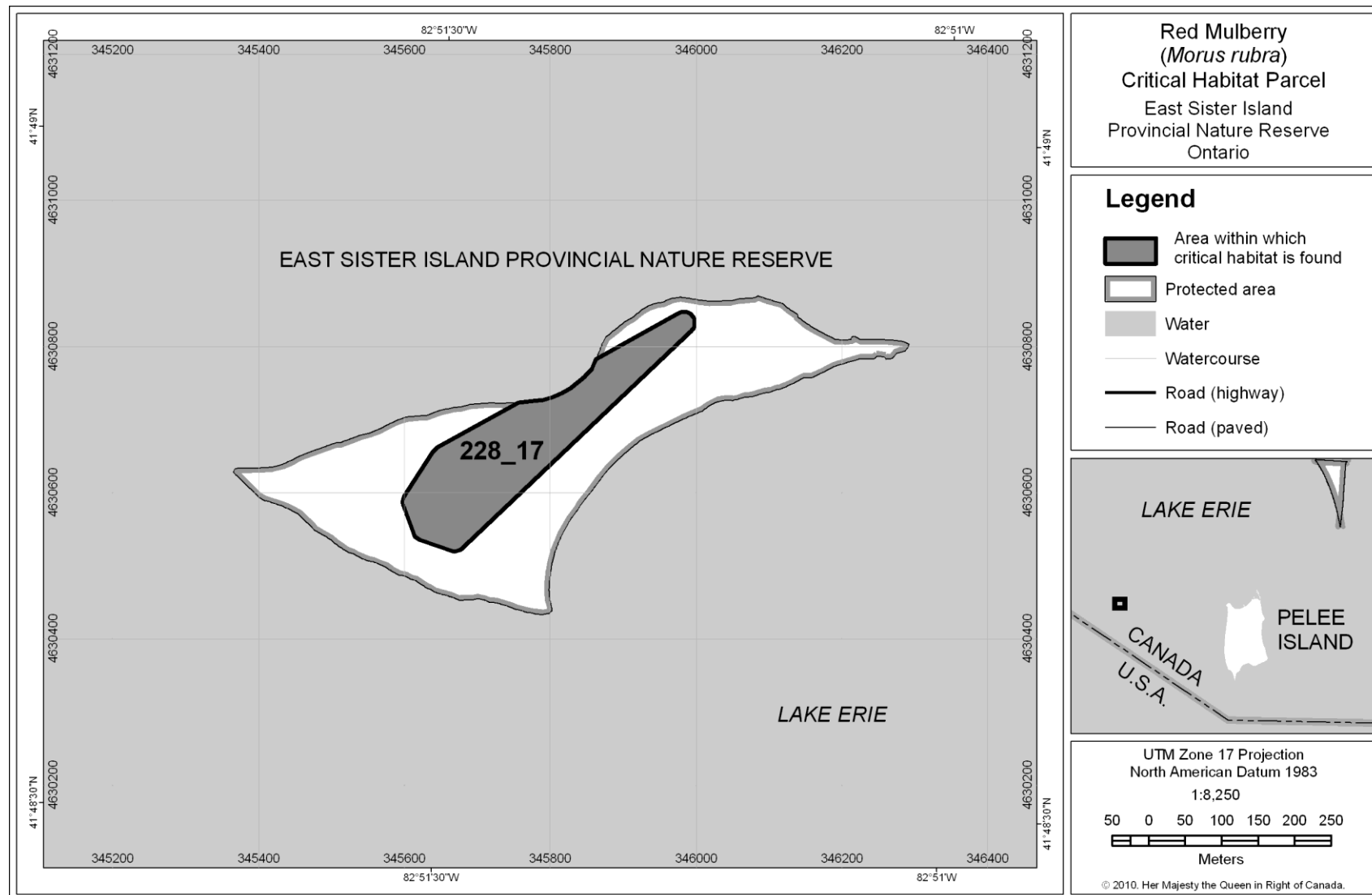
Figure 16: Location and extent of critical habitat parcel # 228_14 for Red Mulberry. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
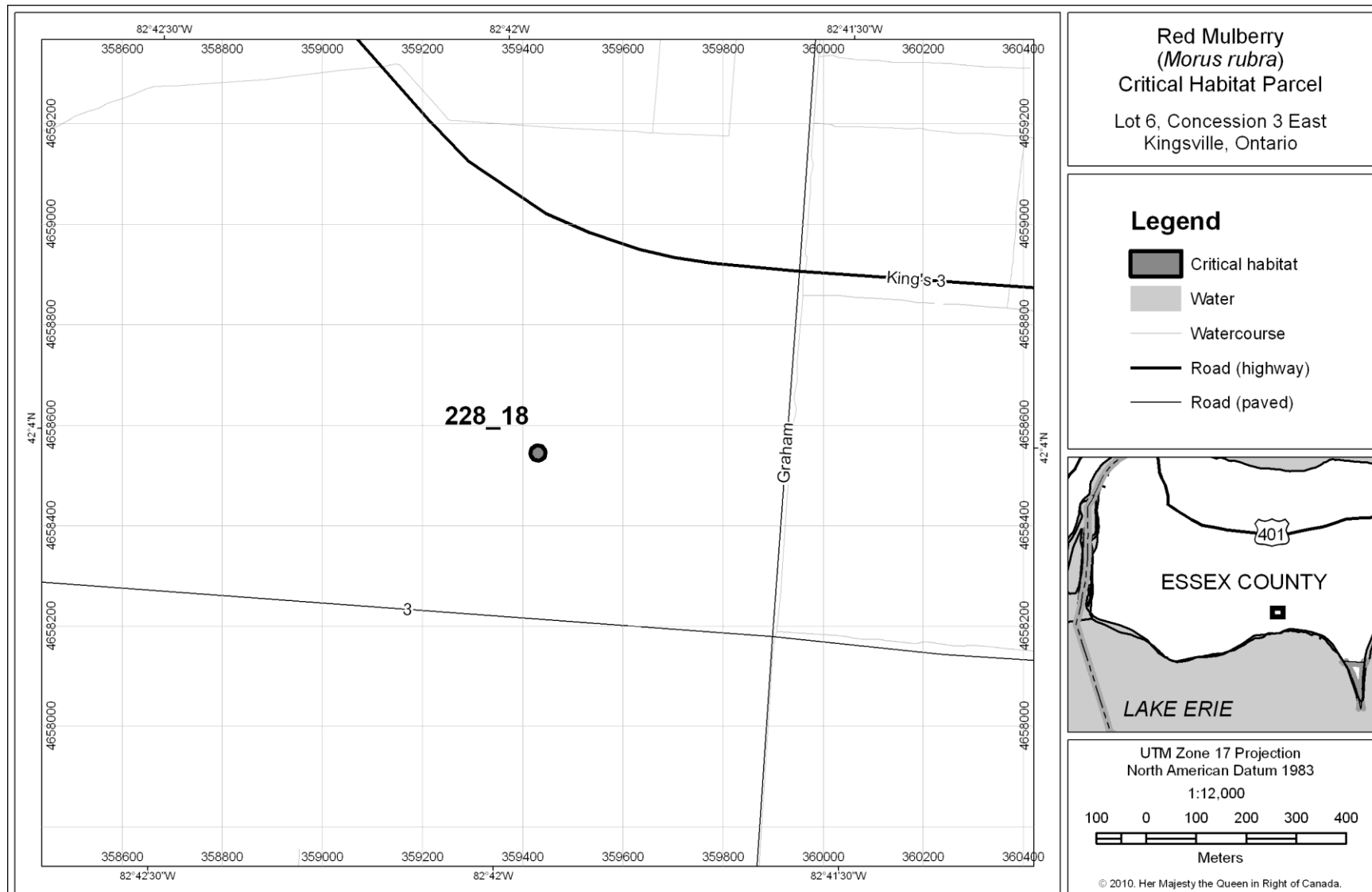
Figure 17: **Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_15). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.**
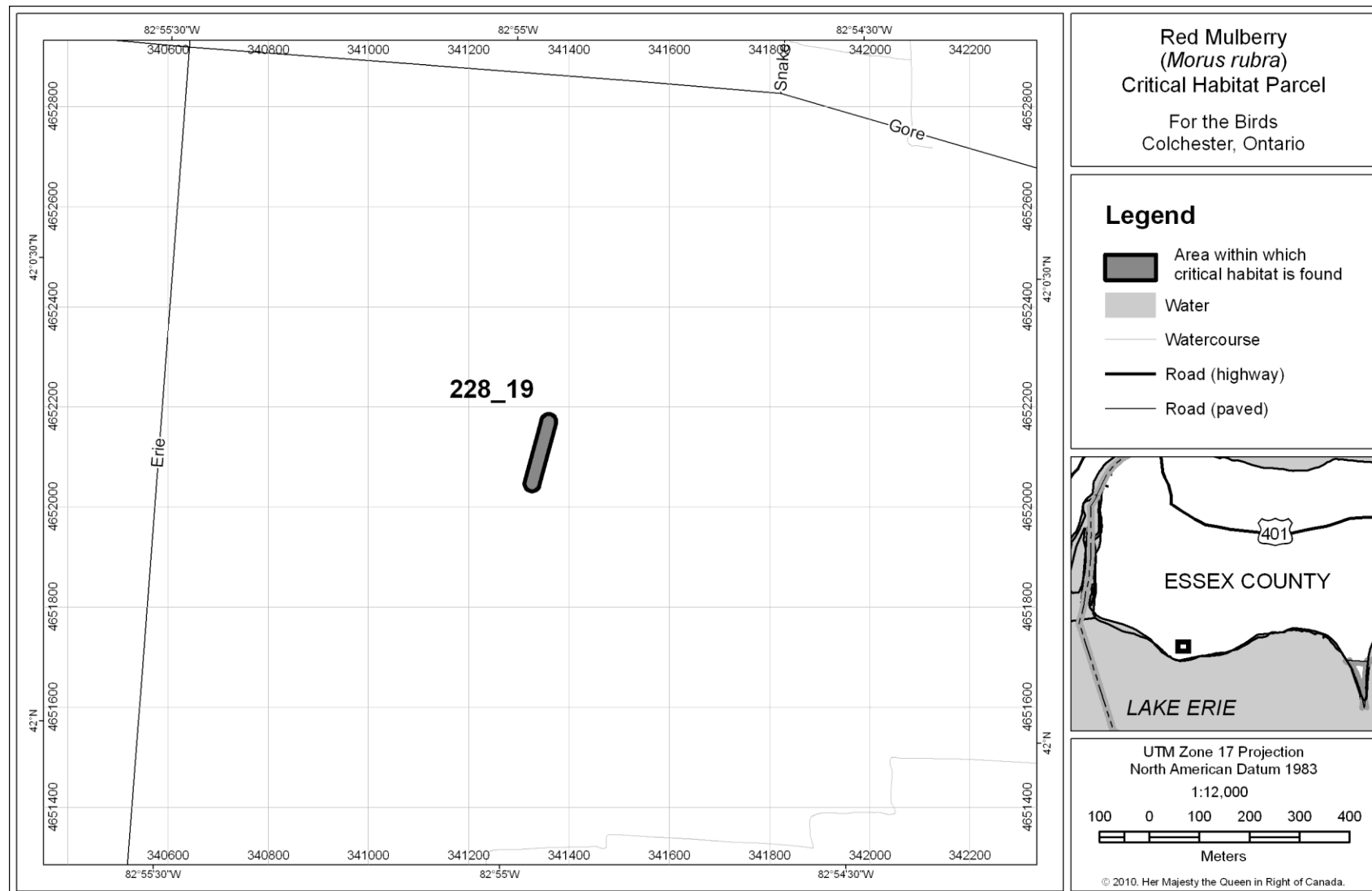
Figure 18: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_16). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
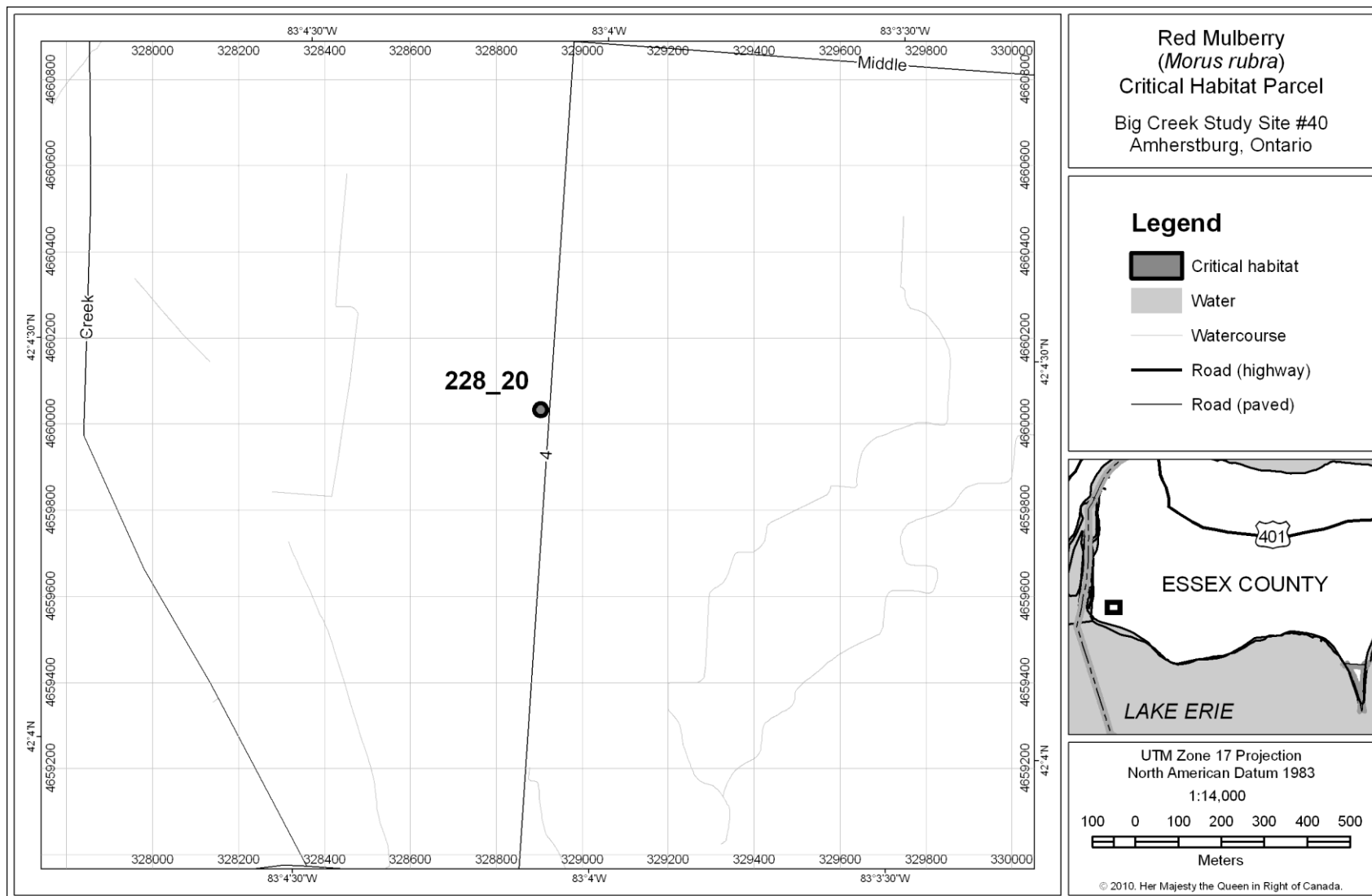
Figure 19: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_17). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.
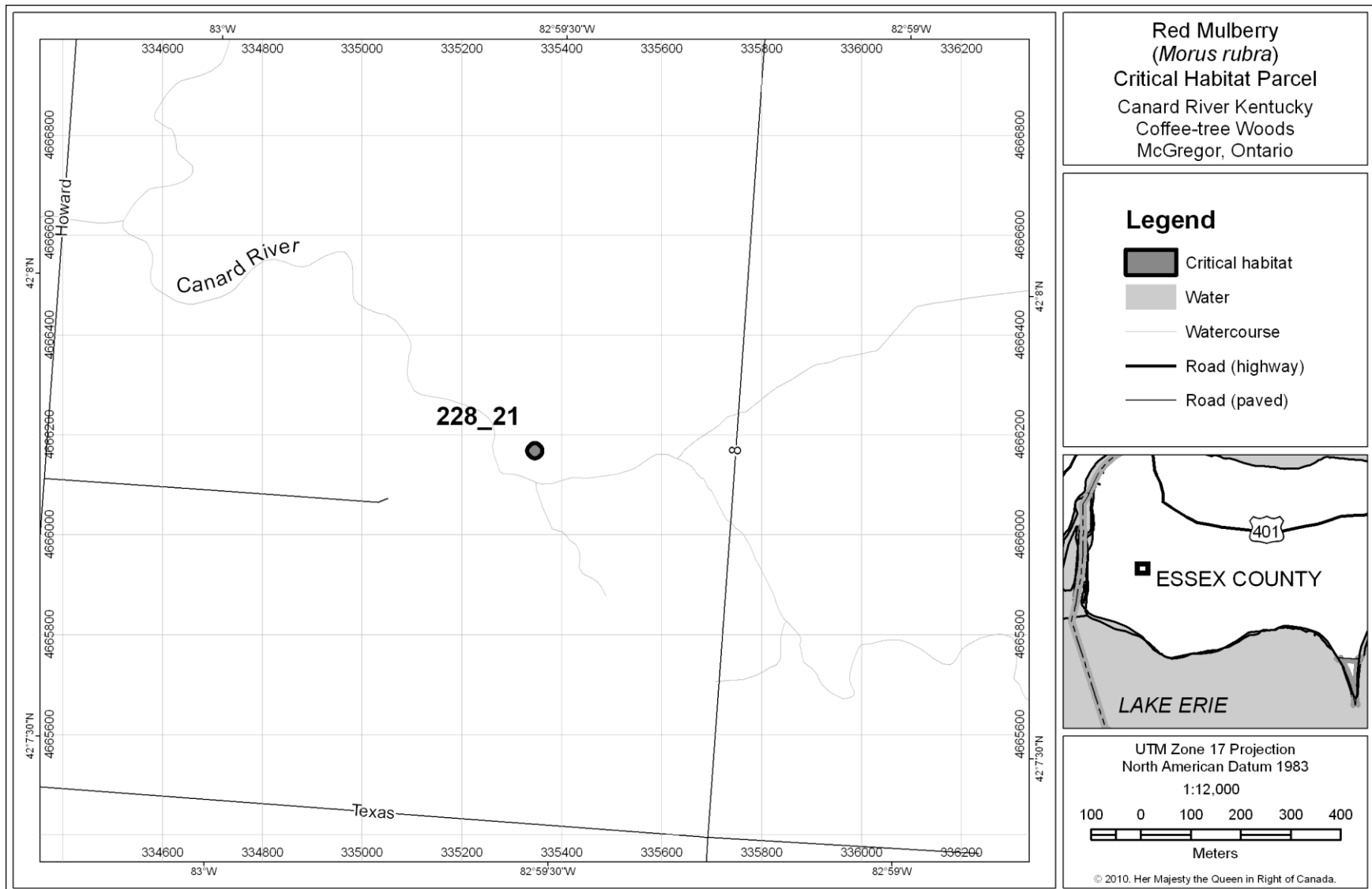
Figure 20: Location and extent of critical habitat parcel # 228_18 for Red Mulberry. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.

Figure 21: **Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_19). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.**
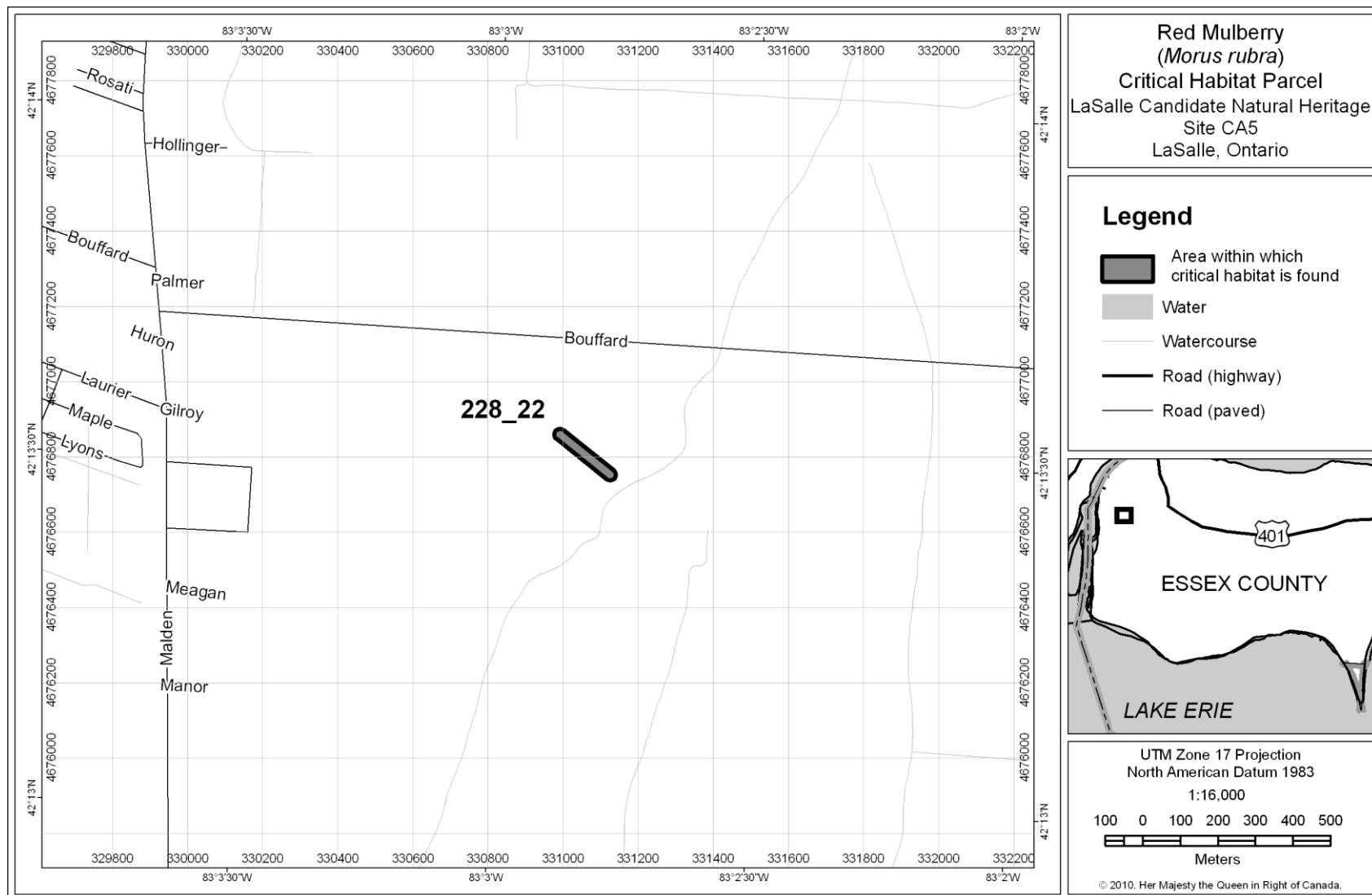
Figure 22: Location and extent of critical habitat parcel # 228_20 for Red Mulberry. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.

Figure 23: Location and extent of critical habitat parcel # 228_21 for Red Mulberry. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.

Figure 24: Area within which critical habitat for Red Mulberry is found (critical habitat parcel # 228_22). Please refer to Section 7 for the description of biophysical attributes to help locate the critical habitat within this area. Critical habitat does not include existing infrastructure, existing cultivated areas, or unnatural vegetation types, as described in Section 7.

APPENDIX C: RECOVERY TEAM MEMBERS

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Dennis Joyce, Provincial Forest Geneticist, OMNR, Sault Ste. Marie
Vicki McKay, Species at Risk Recovery Specialist, Parks Canada Agency
Natalie Iwanycki, Field Botanist and Herbarium Curator, Royal Botanical Gardens, Burlington

Recovery Network

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Ross Hart, Park Superintendent, Wheatley Provincial Park, Ontario Parks
Kim Frohlich, Ecologist, Niagara Peninsula Conservation Authority
Kim Barrett, Senior Ecologist, Conservation Halton
Sandy Dobbyn, Zone Ecologist, Ontario Parks, Southwest Zone
Melinda Thompson-Black, Species at Risk Biologist, Ministry of Natural Resources, Aurora District
Deborah Whitehouse, Senior Director of Parks, Niagara Parks Commission
John McLaughlin, Forest Research Pathologist, Ontario Forest Research Institute
Gerry Waldron, Consulting Ecologist, Amherstburg

Former Recovery Team and Network Members

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Linda DeVerno, former Acting Assistant Director, Science and Technology Directorate, Natural Resources Canada
Gary Mouland, former Park Ecologist, Point Pelee National Park of Canada
Paul Prevett, former Regional Ecologist, Southwest Zone and later Ecologist, Science and Technology Transfer Unit, OMNR
Robert Ritchie, Former Parks Naturalist, Niagara Parks Commission
Lisa Twolan, former RENEW Coordinator, Canadian Wildlife Service, Environment Canada
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