PROPOSED

Species at Risk Act
Recovery Strategy Series
Adopted under Section 44 of SARA

Recovery Strategy for Deerberry (*Vaccinium stamineum*) in Canada

Deerberry

August 2010

Parks Canada Parcs Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, recovery 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 the species' persistence in the wild. A species will be considered recovered when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (www.sararegistry.gc.ca/the_act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (www.sararegistry.gc.ca/).

Recovery Strategy for the Deerberry (*Vaccinium stamineum*)

in Canada
[PROPOSED]

August 2010

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

In the spirit of cooperation of the Accord, the Government of Ontario has provided the Recovery Strategy for Deerberry (*Vaccinium stamineum*) in Ontario to the Government of Canada. The federal Minister of the Environment as the competent minister under *SARA* incorporates the provincial recovery strategy, in part, into the federal strategy, pursuant to section 44(2) of the *Species at Risk Act*, with exceptions and modifications as detailed within the body of this document.

Following the 60-day comment period starting in [Month YYYY, date the proposed strategy is posted on the SARA Registry], and upon consideration of any comments received, the finalized recovery strategy once included in the public registry, will be the *SARA* recovery strategy for this species.

The federal Minister of the Environment's recovery strategy for Deerberry consists of two parts:

1. The federal text which completes the proposed recovery strategy in terms of meeting the requirements of subsection 41(1) of SARA.
2. Recovery Strategy for Deerberry (*Vaccinium stamineum*) in Ontario, prepared by the National Deerberry Recovery Team for the Ontario Ministry of Natural Resources (attached as Appendix III).

Recommended citation:

Parks Canada Agency. 2010. Recovery Strategy for Deerberry (*Vaccinium stamineum*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Parks Canada Agency. Ottawa. iv+ 15pp.

Additional copies:

Additional copies can be downloaded from the SARA Public Registry (http://www.sararegistry.gc.ca/).

Cover illustration: St. Lawrence Islands National Park

Également disponible en français sous le titre
Programme de rétablissement pour l'airelle à longues étamines (*Vaccinium stamineum*) au Canada.

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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 as the competent minister under SARA presents this document as the recovery strategy for Deerberry as required under SARA. It has been prepared in cooperation with the jurisdictions responsible for the species. 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 goals, objectives 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.

ACKNOWLEDGEMENTS

The Parks Canada Agency would like to acknowledge the work of Josh Van Wieren (St. Lawrence Islands National Park Ecologist) for writing this report, Greg Saunders (St. Lawrence Islands National Park Ecosystem Data Technician) for GIS support and map design, and Shaun Thompson, Briar Howes, Kara Vlasman, Kent Prior, Michele Rodrick, Kim Borg, Gary Allen for their review and input.

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

A strategic environmental assessment (SEA) is conducted on all *Species at Risk Act* recovery strategies, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals* (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 their intended benefits. Environmental effects, including impacts to non-target species and the environment, were considered during recovery planning. The SEA is incorporated directly into the strategy and also summarized below.

Recovery actions identified in the Recovery Strategy are expected to positively affect or have no significant adverse environmental impacts on the community in which Deerberry resides. Most of the recovery actions involve stewardship, outreach, collaboration, monitoring, research or management planning. These actions will not only improve the state of knowledge for Deerberry and the ecosystems in which it is found, but will also promote landowner stewardship and collaboration among conservation partners in Canada and the United States. Monitoring the results of different recovery approaches will provide insights into the health of Deerberry and the overall health of the broader ecological community. Recovery approaches that are targeted to meet the four recovery objectives will involve physical disturbances resulting in environmental impacts (e.g.: studying the effect of fire on Deerberry propagation, small-scale removal of flora). The impacts of each of these approaches were considered in the drafting of the recovery strategy and mitigations were identified where necessary. Most of these actions will focus on mitigating known stresses to Deerberry and will have positive environmental impacts on other species and the ecological community.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* [Subsection 2(1)].

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry: http://www.sararegistry.gc.ca/sar/recovery/residence_e.cfm.

PREFACE

This Recovery Strategy addresses the recovery of Deerberry. In Canada, this species is found only in Ontario: in the Niagara Region and the St. Lawrence Thousand Islands area.

The Parks Canada Agency, the Ontario Ministry of Natural Resources, and Environment Canada worked in cooperation to develop the federal Recovery Strategy for Deerberry. The proposed federal recovery strategy meets SARA requirements in terms of content and process (Sections 39-41) and fulfills commitments of all jurisdictions for recovery planning under the *Accord for the Protection of Species at Risk* (1996) in Canada.

RECOVERY FEASIBILITY SUMMARY

The recovery of Deerberry in Canada is considered feasible based on the criteria set outlined by the Government of Canada (2009):

1) Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.
Unknown. Individuals capable of reproduction are currently available and these individuals contain a diverse genetic pool to support long-term persistence. Although seeds have been taken from plants and successfully propagated in a greenhouse, very little reproduction has been noted in wild Canadian Deerberry populations.

2) Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.
Yes. There is currently enough habitat in both the Thousand Islands Region and the Niagara Region to support Deerberry recovery. Much of the available habitat or potential habitat would benefit from restoration efforts (such as prescribed burns or canopy thinning) to promote more suitable light and moisture conditions.

3) The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.
Yes. All significant threats to both the species and its habitat can be avoided and / or mitigated.

4) Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.
Unknown. Recovery techniques are currently being used and refined. Considerable work still needs to be completed to better understand certain recovery techniques (e.g. propagation and prescribed burning techniques); however, previous and ongoing work suggests that these recovery techniques will likely prove to be effective.

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1. ADDITIONAL SECTIONS TO ACHIEVE SARA COMPLIANCY

1.1 Population and Distribution Objectives

The recovery goal for Deerberry is "to ensure that Deerberry persists in its natural habitat at known sites with no decline in population sizes over the short term and with increases in both number of populations and population sizes until it is deemed that the species is no longer at risk in either of the two regions where it is found in Ontario" (see page 14 of the appended Provincial Recovery Strategy).

To meet the recovery goal, the population and distribution objectives for Deerberry in Canada are as follows:

I. Halt the decline of mature individuals and number of populations.
II. Increase the number of populations to 10 or more, if introduction or re-introduction of 'new' populations is deemed feasible.

Rationale:
In 2000, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed Deerberry as Threatened because of its small distribution range, small population size, and continuing decline in extent of occurrence, index of occupancy, area, extent and/or quality of habitat, number of locations or populations, and number of mature individuals. Objective I is meant to address the decline in extent of occurrence, index of area of occupancy, area, extent and/or quality of habitat, number of locations or populations, and number of mature individuals. Objective II is meant to raise the number of populations to 10 or more, based on the assumption that doing so is likely to increase the total number of mature individuals to above 1000, the threshold used by COSEWIC to designate a species as Threatened based solely on the population size. Distributing those mature individuals in 10 or more locations will also increase the likelihood of persistence of the species. Achieving these objectives may result in the downlisting of the species from Threatened to Special Concern.

Introduction of Deerberry plants has been attempted at four locations in St. Lawrence Islands National Park. As of 2010, plants at only one of the introduced locations is considered very healthy and many have not survived due to competition or stresses (e.g. shaded out by other *Vaccinium* species or overgrazed by hyperabundant White-tailed Deer). Please refer to Appendix II for more information on these introductions. Further research is being conducted in order to determine the long-term feasibility of Deerberry introductions.

1.2 Critical Habitat Identification

Section 2.5 of the Ontario Recovery Strategy for Deerberry provides a recommendation for an area to be considered in developing a habitat regulation (as defined under the *Endangered Species Act, 2007*). Recommendation for a habitat regulation is not a component of a recovery

strategy prepared under the SARA. Instead, SARA requires an identification of critical habitat in federal recovery strategies. As such, the critical habitat section outlined here replaces section 2.5 of the appended Ontario Recovery Strategy for Deerberry (attached as Appendix III).

Critical habitat is defined in the SARA (2002) section 2(1) 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*."

Information Used to Identify Critical Habitat

The locations and attributes of critical habitat were identified using the best available information, including information gathered from the Province of Ontario, St. Lawrence Islands National Park, and a variety of academic sources. The majority of the information used to identify critical habitat came from detailed community assessments and classifications (completed as recently as 2009), a Habitat Suitability Index Model developed for the Thousand Islands populations, and survey and monitoring data.

Thousand Islands Region

In the Thousand Islands Region natural Deerberry populations occur in eight different Ecological Land Classification (ELC) vegetation types (Lee *et. al*., 1998):

a. Dry – fresh red oak deciduous forest type (FODM1-1)
b. Dry – fresh White pine – oak mixed forest type (FOMM2-1)
c. Dry – fresh oak – hickory deciduous forest type (FODM2-2)
d. Dry oak – pine calcareous shallow mixed forest (FOMR2)
e. Dry Pitch pine – oak non-calcareous bedrock mixed forest type (FOMR2-1)
f. Dry red oak woodland type (open, tall-treed) (WODM3-1)
g. Dry – fresh mixed woodland ecosite (WOMM3)
h. Blueberry non-calcareous shrub rock barren type (RBSB2-1)

The three natural populations in the Thousand Islands Region are found exclusively on three islands, respectively, with all plants growing close to the shoreline. The distance from the nearest shoreline location to Deerberry plants is approximately 30 metres. Light and moisture levels are influenced by the waterfront edge and height of dominant trees found inland of Deerberry plants. Moving inland, forest communities become increasingly moist and shaded and unsuitable for Deerberry. A core group of experts from the Deerberry Recovery Team, as well as other local experts, have recommended that a 30 metre area surrounding each Deerberry plant is sufficient to support the persistence of Deerberry and generally encompasses the ecological community in which the species occurs.

Niagara Region

Of the seven populations known to occur in the Niagara area, six are now extirpated. It is unknown whether the locations of the six extirpated populations could provide suitable habitat for Deerberry anymore. At the time of this report only one population consisting of two plants could be confirmed (Lynch, 2009, D. Lindblad, pers. comm. 2009). This population is found in the Dry-Fresh Oak-Hardwood Deciduous ELC Forest Type and is surrounded by other forest types. Similar to the Thousand Islands population, a 30 metre area surrounding these two plants

will ensure site conditions that support the persistence of Deerberry, and generally encompass the ecological community in which the species occurs. In the Niagara population, the 30 metres surrounding the two individual plants is also suitable habitat for Deerberry to re-colonize (Lynch, 2009).

Critical Habitat Identification

Critical habitat is identified for all naturally occurring populations of Deerberry in both the Thousand Islands and Niagara regions. This includes the three natural populations occurring on three islands (Grenadier Island, Endymion Island and Deathdealer Island) in the Thousand Islands Region, as well as the one extant natural Niagara population.

Critical habitat identified here for Deerberry is a partial identification, based on the best available information at this time. Further work is required to identify additional habitat to support the recovery of this species and achieve the population and distribution objectives. As more information is gathered, as outlined in the Schedule of Studies, Section 1.4, critical habitat will be updated accordingly.

Critical habitat is identified and mapped as a 30 metre area surrounding individual Deerberry plants. In cases where occurrences were separated by more than 30 metres but were connected by contiguous suitable habitat (based on the eight ELC community types listed above for the Thousand Islands Region and the one for the Niagara Region), the contiguous area was also identified as critical habitat. The general locations of critical habitat parcels in the Thousand Islands Region are shown in Figure 1 followed by more detailed maps showing the extent of each critical habitat parcel for all four naturally occurring populations (Figures 2-5).

Biophysical attributes of Deerberry habitat were derived from the expertise of recovery team members, 2009 ELC plots completed for each population and from detailed information gathered directly from Canadian Deerberry populations. Within the identified critical habitat boundaries, the biophysical attributes of critical habitat in the Thousand Islands populations include the following:

- Dry deciduous or mixed forest types
- Open areas that receive sunlight, with percent forest canopy cover ranging from 0-75% with less than 60% preferred
- Slope 0-10%
- Exposed granite bedrock dominated by pitch pine or blueberry species
- Southeast to west aspect preferred
- Within 50 metres of the St. Lawrence River

Within the identified critical habitat boundaries, the biophysical attributes of critical habitat in the Niagara Region population include the following:

- Open dry oak dominated deciduous woodland
- Maximum forest canopy cover of 65%

The three surviving introduced populations within the Thousand Islands region, including Lyndoch Island, Georgina Island and Mallorytown Landing are not included in this critical habitat identification. Introduced populations are not identified as critical habitat until they persist for five years and become self-reproducing (D. Kristensen, pers. comm. 2010). When they meet these criteria they will be identified as critical habitat. This critical habitat definition does not include any individuals that have been or might be planted in private gardens. If historical Deerberry populations are re-discovered or new natural populations are found they will be identified as critical habitat. Any changes to the critical habitat outlined in this recovery strategy will be identified in an addendum to this recovery strategy or in an action plan.

Existing anthropogenic features are excluded from critical habitat. These features include, but are not limited to, existing infrastructure (e.g., roads, trails, docks, picnic shelters) and unnatural vegetation types (e.g., golf courses).

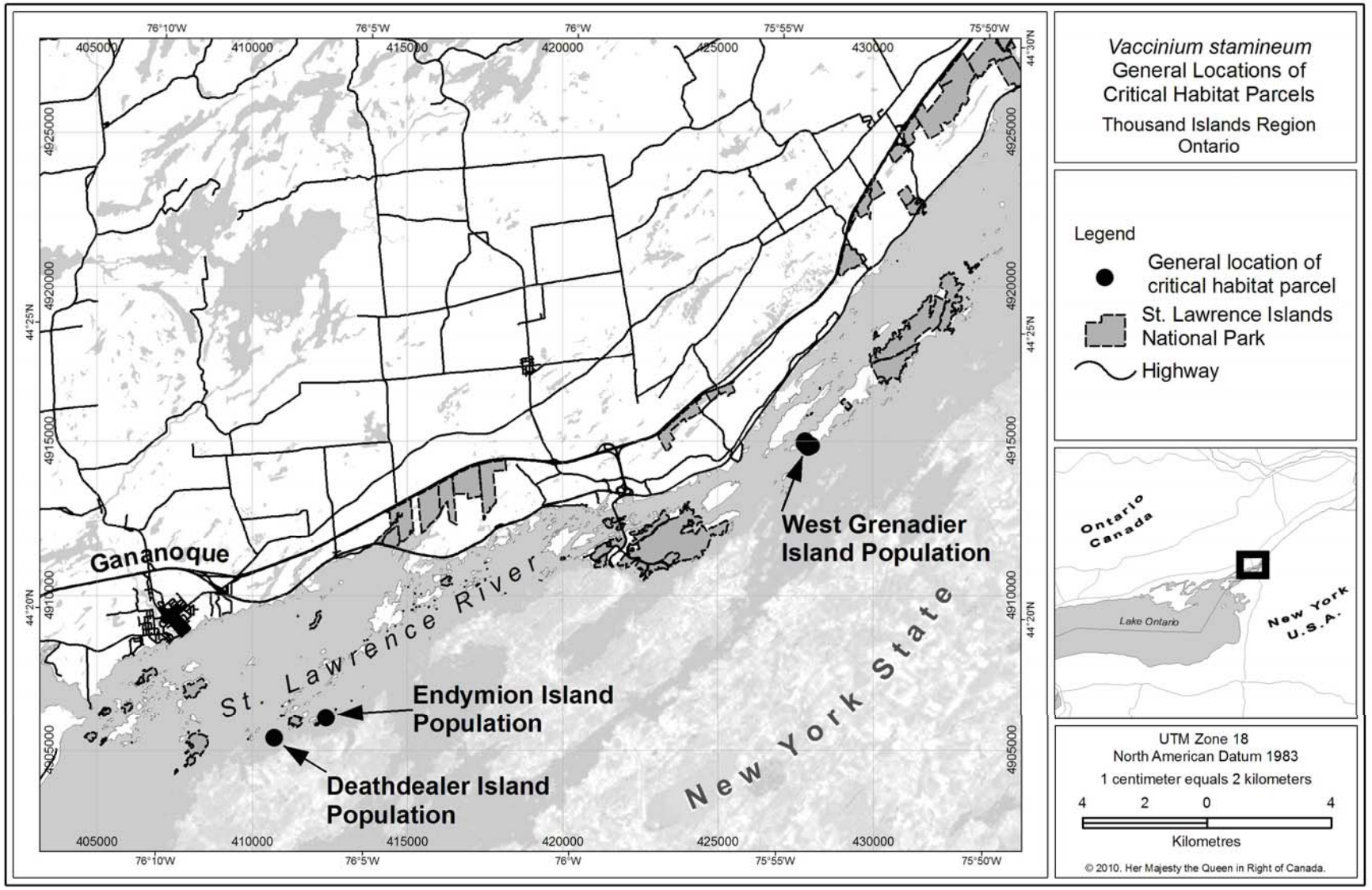

Figure 1: General locations of Deerberry critical habitat parcels in the Thousand Islands Region of Ontario. Detailed maps of parcels are presented later in this document.

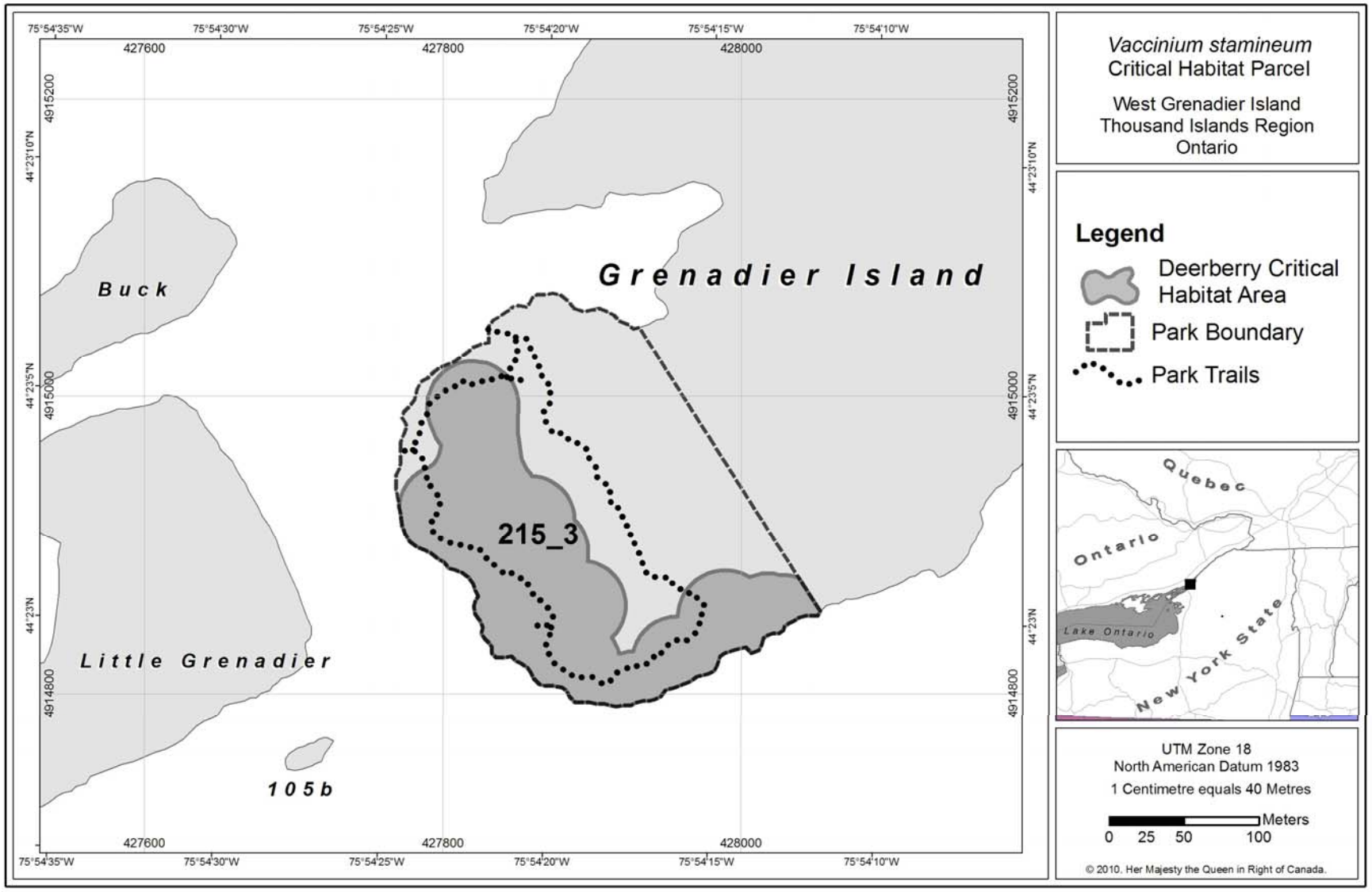

Figure 2: Deerberry critical habitat parcel #215_**3** on West Grenadier Island in the Thousands Islands Region of Ontario. Critical habitat does not include existing infrastructure, as described in Section 1.2.

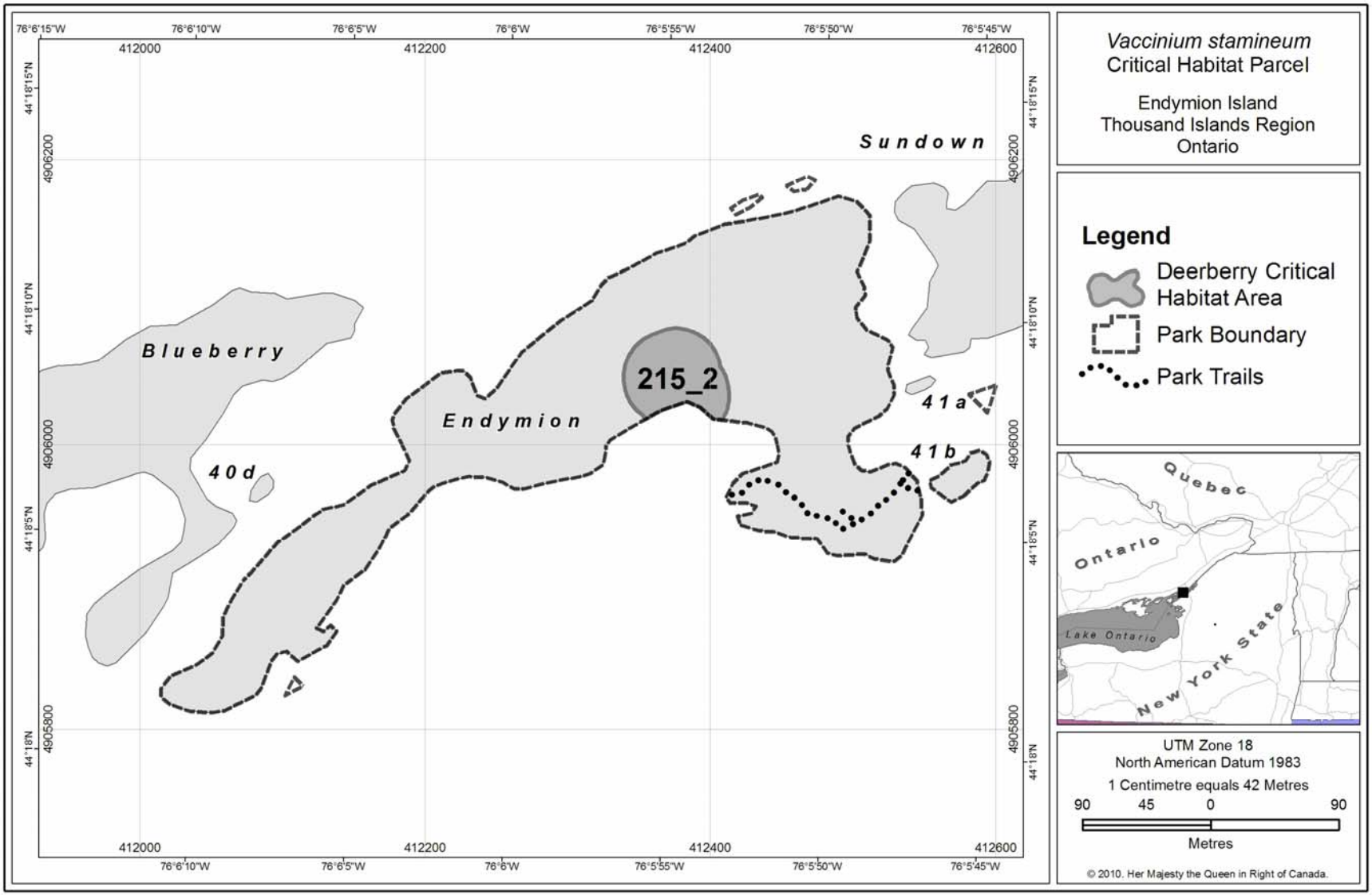

Figure 3: Deerberry critical habitat parcel #215_**2** on Endymion Island in the Thousands Islands Region of Ontario. Critical habitat does not include existing infrastructure, as described in Section 1.2.

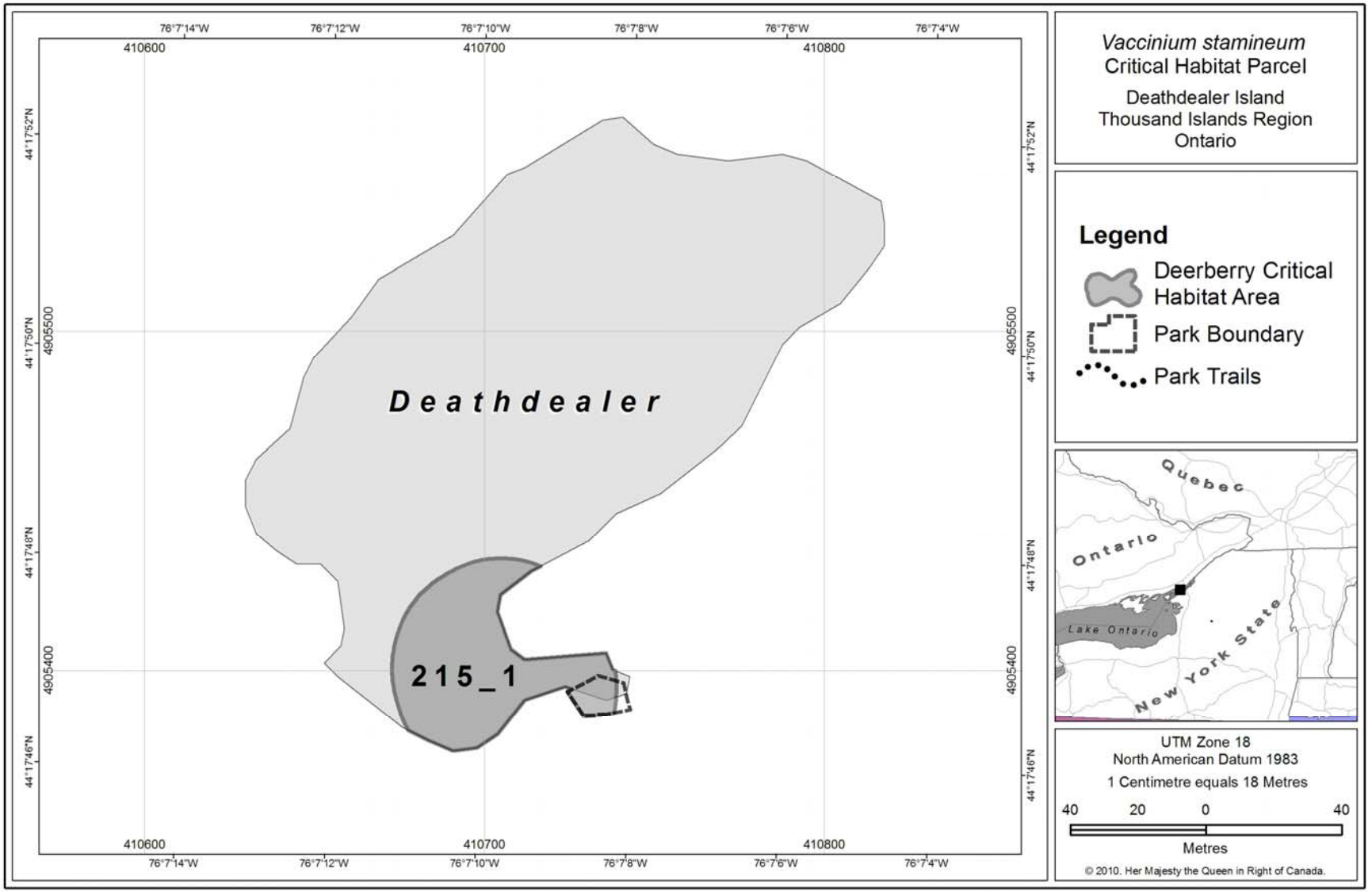

Figure 4: Deerberry critical habitat parcel #215_**1** on Deathdealer Island in the Thousand Islands Region of Ontario. Critical habitat does not include existing infrastructure, as described in Section 1.2.

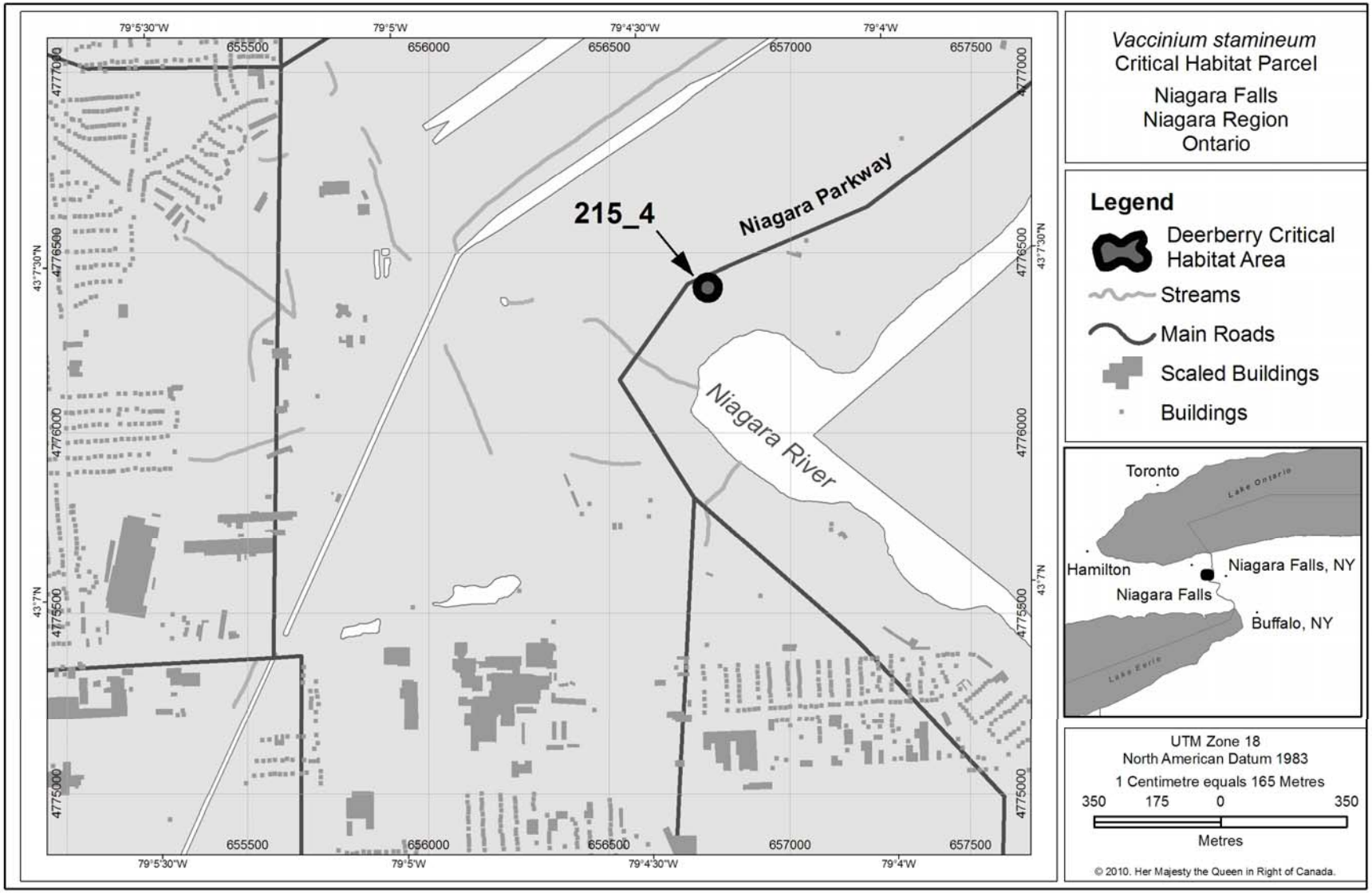

Figure 5: Deerberry critical habitat parcel #215_**4** in the Niagara Region of Ontario. Critical habitat does not include existing infrastructure, as described in Section 1.2

1.3 Activities Likely to Result in the Destruction of Critical Habitat

Destruction of critical habitat would result if any part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Examples of activities that may result in the destruction of critical habitat for the Deerberry include, but are not limited to, the activities listed in Table 1.

Table 1. Examples of Activities Likely to Result in the Destruction of Critical Habitat

Example of Activity Likely to Destroy Critical Habitat	**Potential Effect on Critical Habitat**
Deliberate introduction of alien invasive or native invasive species in or within seeding distance (or other reproductive means , such as reproduction via cloning) of the critical habitat	Competition crowding out Deerberry leading to degradation of habitat.
Use of motorized or non-motorized vehicles	Direct mortality of plants in surrounding community, alteration of light and soil moisture levels, soil compaction, facilitation of the introduction/spread of alien invasive species or other competitive species
Construction or expansion of new or existing infrastructure and/or trails	Alteration of light or soil levels, facilitation of the introduction/spread of alien invasive species or other competitive species
Removal of vegetation or alterations to habitat that reduce the suitability for Deerberry	Direct mortality of plants in surrounding community, alteration of light and soil moisture levels, soil compaction, facilitation of alien invasive species or other competitive species
Browsing by domestic ungulates	Reduced biomass which may affect growth and reproduction of plants in surrounding community, alteration of light and soil moisture levels
Excessive impacts (e.g. trampling) from off-trail activities	Direct mortality of plants in surrounding community, soil compaction, soil erosion or slumping, changes in ecosystem structure, facilitation of the introduction/spread of alien invasive species or other competitive species.
Ignition of any non-prescribed fires or uncontrolled fires	Loss of habitat
Resource extraction	Loss of habitat
Activities that causes erosion or soil slumping to migrate towards or occurs within critical habitat	Loss of habitat

1.4 Schedule of Studies to Identify Critical Habitat

This recovery strategy includes an identification of critical habitat to the extent possible, based on the best available information. A schedule of studies has been identified, reflecting remaining activities to be undertaken to identify additional critical habitat, more fully aligned with the population and distribution objectives. Specifically, in order to identify critical habitat for the introduced populations that aligns with population and distribution objective II, introduction or reintroduction feasibility must first be determined, and populations must be successfully established, which is the focus of the studies outlined below. In order to facilitate introductions and re-introductions, a number of studies must be completed to identify successful propagation

and competition reduction techniques (e.g. prescribed fires), which will ensure newly planted populations have a chance to establish themselves. While many of these studies do not directly involve the identification of critical habitat, their completion is required to determine if different sites will qualify as critical habitat in the future.

Table 2: Schedule of Studies Required to Identify Critical Habitat

Study Required	**Dates of Study**
Further refine Deerberry Habitat Suitability Index Model in order to determine best sites for introduction or reintroduction.	2010
Continue refining propagation techniques to establish sufficient numbers of plants that will support introduction or reintroduction efforts.	2010-2012
Plant and monitor Deerberry in post burn environments to determine if Deerberry survive in post burn soil conditions.	2009-2015
Monitor planted Deerberry at various years preceding prescribed burn (e.g.: 1 year pre-burn, two years pre-burn) to better understand how fire intensity affects different age classes of Deerberry plants and to establish the best timing and intensity for burning to enhance both natural and introduced Deerberry populations.	2010 – 2020
Identify factors that limit Deerberry reproduction and develop mitigation techniques which address those factors so that introduced and reintroduced populations can become self reproducing and be considered as established populations.	2016-2020

1.5 Statement on Action Plans

One or more action plans will be completed by December 2015.

REFERENCES

Government of Canada. 2009. Species at Risk Act Policies; Overarching Policy Framework. 38pp.

Kristensen, D. 2010. Personal communication. Deerberry Recovery Team Member.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfers Branch. SCSS Field Guide FG-02.

Lindblad, D. 2009. Personal communication. Park Naturalist, Niagara Parks Commission.

Lynch, M.B. 2009. Niagara Falls Deerberry Ecological Land Classification Plot. St. Lawrence Islands National Park, Mallorytown. Unpublished report.

Yakimowski, S.B., and C.G. Eckert 2007. Threatened peripheral populations in context: geographical variation in population frequency and size and sexual reproduction in a clonal woody shrub, Vaccinium stamineum (Ericaceae). Conservation Biology 21: 811-822.

APPENDIX I

Effects on the Environment and other Species

Recovery actions identified in the Recovery Strategy are expected to positively affect or have no significant adverse environmental impacts on the environment and other species. Most of the recovery actions involve stewardship, outreach, collaboration, monitoring, research or management planning. These actions will generally improve the state of knowledge, awareness and support for preserving these ecosystems and the species found within them. It will also promote collaboration between various conservation partners. Negative effects are short-term, low impact, local in magnitude and mostly involve small-scale removal of flora. The effects caused by the prescribed burns recommended in the Schedule of Studies, will also be mostly positive, as the burns will only be conducted in ecosystems that have evolved in response to fire or other similar disturbances in the past.

APPENDIX II

Deerberry Reintroduction

Deerberry plants have been introduced to four locations in St. Lawrence Islands National Park. As of 2010, plants on only one of the introduced locations are considered very healthy and many have not survived due to competition or stresses (e.g. shaded out by other *Vaccinium* species or overgrazed by hyperabundant White-tailed Deer). These introductions have provided a valuable learning opportunity to refine propagation and habitat selection methodology. The propagation program, a partnership between St. Lawrence Islands National Park and Queens University, has resolved most of the earlier germination issues, which should allow greater opportunities to introduce Deerberry populations in Canada in the future.

Deerberry plants start to reach maturity around two years and may require up to five years to become sexually mature (D. Kristensen, pers. comm. 2010). Even after persisting for five years, if the population is not self reproducing it may not be a well-established colony (D. Kristensen, pers. comm. 2010). Seed production and genetic diversity in natural populations of Deerberry are not low (Yakimowski and Eckert, 2007); nevertheless, Deerberry seedlings are rarely observed. Given that reproductive success is low and that other factors threatening the persistence of Deerberry populations are poorly understood, introductions serve as important opportunities for conservation managers to better understand Deerberry recovery in Canada. This includes improving the understanding of what role fire plays in the persistence of Deerberry through conducting various prescribed burns on introduced plants, without risking the few natural populations.

APPENDIX III

Recovery Strategy for Deerberry (*Vaccinium stamineum*) in Ontario

AS PROVIDED BY THE GOVERNMENT OF ONTARIO

National Deerberry Recovery Team. 2010. Recovery Strategy for Deerberry (*Vaccinium stamineum*) in Ontario. Prepared for the Ontario Ministry of Natural Resources. Peterborough, Ontario. vi + 27pp.

Photo: Rob Tervo

Deerberry

(*Vaccinium stamineum*) in Ontario

Ontario Recovery Strategy Series

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

February 2010

Natural. Valued. Protected.

Ministry of Natural Resources

Ontario

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the Endangered Species Act, 2007 (ESA, 2007) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

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

What is a recovery strategy?

Under the ESA, 2007, a recovery strategy provides the best available scientific knowledge onwhat is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA, 2007 outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. There is a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA, 2007. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

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

For more information

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

RECOMMENDED CITATION

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AUTHORS

National Deerberry Recovery Team (see list of members on page 27).

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We thank recovery team members for their contributions to the preparation of the Deerberry Recovery Strategy. We also thank Adele Crowder for her work in writing the initial draft recovery strategy. Special thanks to both the Ontario Ministry of Natural Resources and Parks Canada Agency for the financial support required to complete this strategy.

DECLARATION

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

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

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

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

RESPONSIBLE JURISDICTIONS

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

EXECUTIVE SUMMARY

Deerberry (*Vaccinium stamineum*) is a short, colonial shrub in the Heath family, in the genus *Vaccinium* which includes blueberries and cranberries. Deerberry is designated as threatened by both the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and by the Committee on the Status of Species at Risk in Ontario (COSSARO). Deerberry is listed as threatened under Schedule 1 of the federal Species at Risk Act (SARA) and under the Species at Risk in Ontario List (Ontario Reg. 230/08).

Less that one percent of the global range of Deerberry occurs in Canada, where it is located in only two areas, both in Ontario: the Niagara region and the Thousand Islands region. There are a total of six sites with extant populations in Ontario, one in the Niagara region and five in the Thousand Islands region. At least six additional populations in the Niagara region have been extirpated in the last 70 years. The overall population in the Thousand Islands region has been fairly stable for the last 40 years. The extant Niagara population consists of only three colonies with a total of nine stems and is protected by the Niagara Parks Commission. The population in the Thousand Islands region is larger. There, St. Lawrence Islands National Park protects four of the five sites. Two of these sites contain populations that originated from introductions. One site in the Thousand Islands region is located on private property.

Deerberry occurs in open oak woodland in the Niagara region and in woodland containing Red Oak (*Quercus rubra*), Pitch Pine (*Pinus rigida*), and White Pine (*Pinus strobus*) in the Thousand Islands region. These vegetation types are usually considered to be associated with past fires and are seral communities (intermediate successional stages).

Several inherent characteristics may be limiting factors for Deerberry at its northernmost range limit. These include low reproductive success, lack of winter hardiness, low genetic diversity, a possible lack of seed or pollen vectors, and competition from other plant species such as blueberries. The lack of reproductive success is the most serious challenge for Deerberry recovery. No natural seedling establishment has been observed in Ontario to date although plants set fertile fruit.

Threats to Deerberry include a lack of available habitat due to natural succession or fire suppression, trampling, and erosion or soil slumping. In some areas deer browsing may be a significant threat. Several factors not currently thought to seriously affect populations may actually be or become potential threats, including invasive species, urbanization, and disease pathogens.

Many recovery actions have already been completed or are underway, most notably reintroductions at St. Lawrence Islands National Park, research on germination and genetics, and spraying to eliminate European Buckthorn (*Rhamnus cathartica*) at the Niagara site.

Knowledge gaps that must be filled in order to make recovery efforts more effective include determining the cause of Deerberry's low reproductive success, the habitat

requirements of the species, the role of fire in habitat creation and maintenance, the genetic variability of local populations, the environmental conditions necessary for seedling establishment, and the life history of Deerberry such as knowledge of vectors, mycorrhizal associations and pathogens.

The goal of this recovery strategy is to ensure that Deerberry persists in its natural habitat at known sites with no decline in population sizes over the short term and with increases in both the number of populations and population sizes until it is deemed that the species is no longer at risk in either of the two regions where it is found in Ontario.

The recovery objectives are:

1. Persistence of Deerberry in its current habitat at all known natural and viable reintroduction sites, with population sizes remaining stable or increasing for the next 10 years and beyond.

2. Identification of measures necessary to mitigate threats to the species and its habitat, and implementation of mitigation as appropriate.

3. Completion of research and monitoring needed to document and assess habitat requirements, genetic diversity, life history, and population trends.

4. Provision of adequate habitat for species recovery through planning for, protecting and restoring existing and potential habitat, and the augmentation, reintroduction and introduction of populations into suitable habitat.

Recommended approaches to help achieve these objectives are outlined in areas of management and stewardship, research and monitoring, restoration, and outreach and collaboration. Performance measures are given which tie recovery milestones to timelines over the next five years.

It is recommended that areas where natural populations or successfully introduced populations occur be prescribed as habitat within a habitat regulation. It is further recommended that the area within 30 metres around the external extent of each occurrence be prescribed as habitat within the regulation. Where occurrences are separated by more than 30 metres but there is contiguous suitable habitat in the intervening area (based on Ecological Land Classification), this area should also be included in the habitat regulation.

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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME: Deerberry		
SCIENTIFIC NAME: *Vaccinium stamineum*		
SARO List Classification: Threatened		
SARO List History: Threatened (2004)		
COSEWIC Assessment History: Threatened (1994 and 2000)		
SARA Schedule 1: Threatened (June 5, 2003)		
CONSERVATION STATUS RANKS:		
GRANK: G5	NRANK: N1	SRANK: S1

The glossary provides definitions for the abbreviations above.

1.2 Species Description and Biology

Species Description

Deerberry is a colonial shrub that belongs to the Heath family and is one of twelve Canadian species in the genus *Vaccinium* which includes cranberries, blueberries, and bilberries. This shrub rarely grows over one metre tall and has alternate, oval-shaped leaves with no teeth. The twigs have very small hairs on the young plants, but they develop a papery bark as the plants age. Conspicuous pendant, white flower clusters on long slender stalks appear in the early summer. The fruit is round and greenish to bluish in colour. Deerberry can spread by seed dispersal and by underground rhizomes, forming colonies covering several square metres. See Cronquist (1991) for more information on Deerberry morphology.

Species Biology

Deerberry is pollinated by bees. The fleshy fruits are eaten by birds and mammals which disperse Deerberry seed in their droppings.

The seeds of *Vaccinium* species in the wild typically require several weeks of wet cold stratification followed by gradually warming temperatures and exposure to light before they germinate (e.g., winter followed by spring). Temperatures at or below 3-5° C for 6-8 weeks are sufficient to break dormancy. In the greenhouse, Deerberry germinates most readily when harvested from fresh fruit (with 2-3 weeks on wet peat in moderate light) with much lower success if the seed has been allowed to dry (D. Kristensen pers. comm. 2008).

Mycorrhizal fungi may be an important biological need for establishment and growth of seedlings. Greenhouse studies have shown good germination from seeds of Canadian Deerberry plants; however, this has been followed by poor growth which Kristensen (pers. comm. 2008) speculates may be due to a lack of mycorrhizal organisms. Young plants that have been transplanted to the wild seem to require continuing care for several years (more than five) to become established (A. Crowder pers. comm. 2008). The role of mycorrhizae is an important knowledge gap.

Ecological Role

Deerberry is not an ecologically dominant species in any community type, except in successional blueberry heaths in New York state (Reschke 1990) where it probably plays an ecological role in the succession of areas recently burned in forest fires. In the Thousand Islands area, Deerberry is associated with a number of fire-tolerant species such as Pitch Pine (*Pinus rigida*) and other blueberry species.

The fruit of Deerberry plants provides a source of nutrition for numerous small mammals and avian species, such as fruit-eating birds. The flowers of Deerberry provide a source of nectar for a host of bee pollinators (Cane et al. 1985).

Bird populations are known to have fluctuated widely in the region in historic times, including an increase in ground-feeding birds after logging and fires in the nineteenth century (Weir 1989). Fires not only provide a new site for plant germination but also for bird foraging (Farrar et al. 1978). Deerberry may play some role in connection with this since the fleshy fruits are eaten by birds. In fact, several aspects of bird ecology relate to the future management of Deerberry. American Robins (Turdus migratorius) have been observed to perch and defecate on rock tops, after which seeds are washed into crevices where they find moisture (Howe 1986). This behaviour could account for many Deerberry sites. As well, other bird species which defecate or spit out seeds also like to perch after feeding (McNamee 1997). They perch at the edges of forest openings leading to mixed clusters of fruit-producing shrubs developing in successional sites (Crowder and Harmsen 1998). In the Thousand Islands, the shrub most often found with Deerberry is Low Sweet Blueberry (Vaccinium angustifolium), possibly as a result of this type of behaviour.

1.3 Distribution, Abundance and Population Trends

Global Range

The global distribution of Deerberry ranges from central Mexico and Florida to southern and eastern Ontario and Maine. The global conservation status rank of Deerberry is G5, or secure. Further information on the distribution and conservation status by jurisdiction north of Mexico can be found on the NatureServe.org website (NatureServe 2008).

In the United Sates, Deerberry grows from Texas and the Gulf states, north to Maine, and west to Kansas. It is considered Not at Risk or S5 in 28 states, including New York state

(which abuts both of the Ontario regional populations), but has the rank of S1 or imperiled in Kansas and Vermont (NatureServe 2008). Deerberry is not currently found in Michigan, and a record from 1903 may have been a garden plant (Voss 1996).

Canadian Range

Deerberry is found in two regions of Ontario: the Niagara Region and the St. Lawrence Thousand Islands area (Argus et al. 1982-1987, Argus and Pryer 1990, Ford 1984, Ford 1993, Soper and Heimburger 1982). Figure 1 shows a map of Deerberry distribution in Canada.

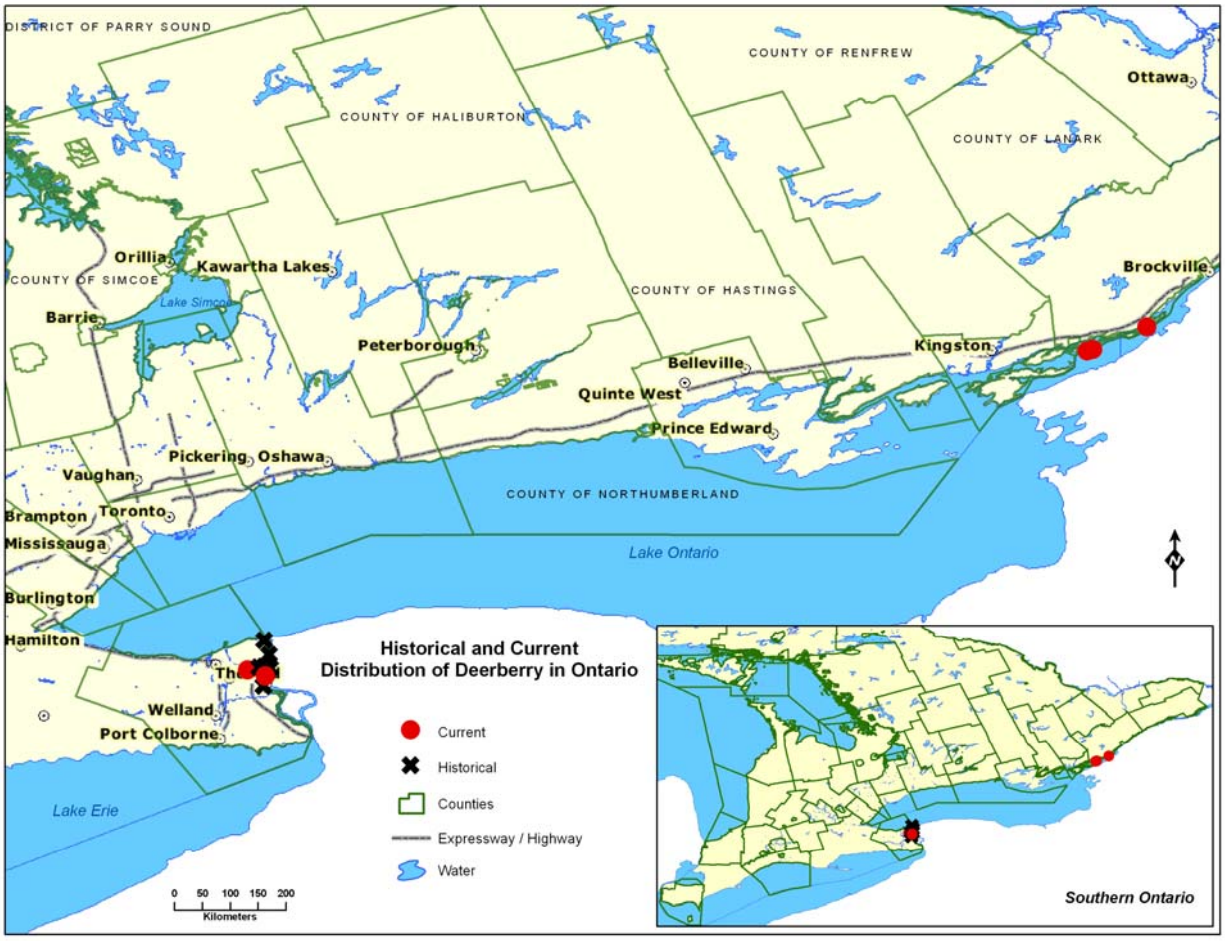

Figure 1. Historical and current distribution of Deerberry in Ontario

The Niagara Region has a single, small population located near the City of Niagara Falls on land owned and managed by the Niagara Parks Commission (a provincial agency). In 2001, this population consisted of nine stems in three patches (M. Thompson-Black pers. comm. 2008). In 2006, two of the three patches were reconfirmed by Mike Oldham (M. Oldham pers. comm. 2008). The patches are located fairly close together in a remnant Black Oak (*Quercus velutina*) savanna overlooking the west side of the Whirlpool area of the Niagara River Gorge. No attempt has been made to survey the

steep slope nearby (climbing gear would be needed) for plants that may be growing below the currently known individuals.

The Thousand Islands region supports the larger proportion of the extant Deerberry population in Canada. Currently, the region supports five Canadian populations, including four in St. Lawrence Islands National Park and one on a privately-owned island, as well as one additional population located on Wellesley Island on the U.S. side of the border. Two of the extant populations in the national park are natural, while the other two are from introductions. A third introduction site in the national park (on Lyndoch Island) is thought to have failed. Information on Deerberry populations in Canada is summarized in Table 1.

Table 1. Populations of Deerberry with ownership and reintroduction information

Location name	Natural or Introduced?	Ownership	Comments
Niagara Region	N	Niagara Parks Commission	
West Grenadier Island	N and I (1994)	St. Lawrence Islands National Park	Augmented from seed collected in situ
Endymion Island	N	St. Lawrence Islands National Park	
Lyndoch Island	I (1994)	St. Lawrence Islands National Park	No plants observed in 2006
Georgina Island	I (2006 and 2009)	St. Lawrence Islands National Park	
Mallorytown Landing	I (2001 and 2005)	St. Lawrence Islands National Park	
Deathdealer Island	N	Private	

Percent of Global Distribution in Canada

The percentage of the global distribution in Canada is estimated to be less than one percent (based on NatureServe 2008). Deerberry has a widespread distribution in the United States.

Distribution Trend

The geographic distribution in Canada has decreased by at least 50% over the past 70 years, due to extirpation of sites in the Niagara region (Ford 1995, 1994). The Niagara population is located near the City of Niagara Falls, in an area that has been subject to extensive urbanization. At least six previously known populations in that area disappeared in the last century. Ford (1994) listed extirpated sites as St. David's Gorge, Niagara Falls, Niagara-on-the-Lake, Niagara Glen, Queenston and Queenston Heights. These locations were searched by Meyers in 1985, Ford and Varga in 1989, and Thompson in 2000 (M. Thompson-Black pers. comm. 2001) among others. While it is not possible to give a rate of decline for the Niagara area, the decline appears to have been rapid.

One well-documented extirpation is St. David's Buried Gorge, where Deerberry was seen in the late 1960s by Meyers (G. Meyers pers. comm. 2001), but was later found to have

been destroyed by grazing and/or trampling (Meyers 1985). The Niagara Deerberry population currently consists of three patches with a total of nine stems, all in one fairly small area. This is a very small proportion of its former distribution in the region.

The closest plants to Canadian populations are in the Thousand Islands at Wellesley Island State Park, New York. In 1981, two patches of plants there were observed and photographed (Crowder 1982). As of 2001, there had not been any recovery work on Wellesley Island (R. Caccia pers. comm. 2001). Deerberry is common to abundant in upper New York state (Howe 1968, Weldy et al. 2002, Cane et al. 1985). Meyers (pers. comm. 2001) is familiar with the populations at Niagara and considers the population at Presqu'ile State Park, Erie, Pennsylvania of particular interest because of its proximity to the Niagara population.

Population Trend

Due to the species clonal growth, Deerberry abundance is estimated by counting patches of plants and assessing the health, stem diameter, height and flowering/fruiting status of each plant (El-Fityani 2006). Determining what constitutes one individual plant is not always straightforward.

The Thousand Islands population appear to have been relatively stable since the 1960s (Ford 1995, 1994), but there was no regular monitoring until 1994 when Parks Canada began monitoring on Lyndoch and West Grenadier Islands. Monitoring on Endymion Island began in 2002. In 2006, no Deerberry was observed on Lyndoch Island; however, in previous years 11 plants had been recorded (El-Fityani 2006). It is not known if Deerberry was once more common in the region; it may always have been scarce or may be a relatively recent arrival (A. Crowder pers. comm. 2008).

1.4 Habitat Needs

Deerberry can grow well in a variety of habitat types and soils. In the Niagara region, the site where Deerberry presently grows is considered by some to be a reflection of logging which caused large canopy openings. However, others consider the area to be a remnant Black Oak savanna which has now grown in. The presence of tall-grass prairie species supports the latter view (M. Thompson-Black pers. comm. 2008, R. Ritchie pers. comm. 2008).

Open oak woodland is probably the most useful term to describe the Niagara habitat and the type of habitat that is used throughout the species range in the U.S. Ritchie (pers. comm. 2008) described the Niagara plants as being on the edge of a very steep and eroding slope to the east, with the immediate forest overhead to the north, west and south containing mature Red Oak (*Quercus rubra*), White Oak (*Quercus alba*), Ash (*Fraxinus*) species, and Sugar Maple (*Acer saccharum*), with Hop-Hornbeam (*Ostrya virginiana*), Sassafras (*Sassafras albidum*), Witch-hazel (*Hamamelis virginiana*), and Gray Dogwood (*Cornus racemosa*) in the understory and immediately surrounding the Deerberry plants.

In the Thousand Islands, Deerberry is found in a different vegetation type, containing oaks, mainly Red Oak, but with Pitch Pine and White Pine (*P. strobus*) as co-dominants (Crowder 1982). Whereas the oak woodlands of Niagara are similar to those in states such as Ohio, Pitch Pine forests resemble those on the sands of the coastal plain of the United States. In New Jersey, sandy dry areas often support only a scrub of Pitch Pine and plants of the heath family.

Using the Southern Ontario Ecological Land Classification (ELC) system (Lee et al. 1998), the two areas can be described as follows: The treed rock barrens in the Thousand Islands belong to the Pitch Pine Acidic Treed Rock Barren type (ELC code: RBT3-1). The Niagara population can be described as belonging to the Dry-Fresh Mixed Oak Deciduous Forest type (ELC code: FOD 1-4) or a Dry-Fresh Deciduous Forest Ecosite (ELC code: FOD-4) (M. Thompson-Black pers. comm. 2001). The Niagara sites are in Ecoregion 7E and the Thousand Island sites in Ecoregion 6E (Crins & Uhlig 2000).

Habitat in both regions is found in close proximity to water, possibly creating a microclimate with above average relative humidity and buffered extremes of temperature.

Soil requirements are varied and described as sandy, heathy, granitic, gravelly, organic and inorganic. Overall, soils are described as acidic. *Vaccinium* species as a whole cannot tolerate excess calcium (Jacquemart 1996). Korcak (1998) mentions the possibility of calcicole and calcifuge strains of mycorrhizal fungi being available, according to soil type. The Niagara region site would appear to be an exception to this intolerance, but the site is likely to be on dolostone rather than limestone (D. Larson pers. comm. 2001, G. Meyers pers. comm. 2001). Surface reactions of soils derived from Queenston shale are often acidic.

1.5 Limiting Factors

In Canada, Deerberry is a pioneer species. Its occurrence here is at the northern edge of its range. As a result, it is limited here by a number of factors that may or may not be limiting in the United States in the core of its range. Five limiting factors of the species are described below in perceived order of importance. All require further work to establish the extent to which they limit recovery of the species here at its range limit.

<u>Reproduction</u>
Lack of reproductive success is a serious limitation for Deerberry. Yakimowsky and Eckert (2007) found that the reproductive rate for Deerberry was low throughout its entire range and that for the Canadian populations this was not a function of the plants being at the edge of the range. Their results showed that seed production was low and quite variable from year to year, and that clonal growth did not reduce the amount of seed production. In fact, an increase in seed mass (size) in the northern-most populations led to faster germination and seedling growth in the laboratory.

In spite of setting fertile fruit, naturally established Deerberry seedlings have not been observed in Ontario (Ford 1995, R. Ritchie pers. comm. 2008, J. Van Wieren pers. comm. 2008). VanderKloet and Hill (1994) considered that the much more abundant blueberry can only produce seedlings after a favourable sequence of weather. In general, in the genus *Vaccinium* suitable germination conditions are considered to be disturbed areas with high moisture and organic content (Eriksson and Froborg 1996). There is also a high mortality rate of established seedlings, and functional roots require mycorrhizae for seedling establishment. Deerberry probably utilizes the same fungus as blueberries (Varma and Hock 1995); however, given the difficulty of establishing Deerberry seedlings in and among blueberries, this theory requires further consideration. Deerberry may require similar "windows of opportunity" for seedling establishment, or equally specific germination conditions as other species in the genus. The cause of the low reproductive success of the Canadian Deerberry populations remains an urgent knowledge gap.

Vectors

The transportation of pollen between Deerberry plants and seed from plant to sites suitable for germination may be a limiting factor for reproduction. Deerberry produces a fleshy berry which is eaten by birds and mammals. The fruits usually contain 10 seeds which are dispersed after passing through the gut. The Thousand Islands population produces viable seeds (El Fityani 2006), but to date there are no studies on seed dispersal at any Ontario sites. This has been identified as a knowledge gap.

Deerberry requires pollination by bees. Crowder (1982) observed pollination of Deerberry in the Thousand Islands area. A comparison of the species and number of pollinators in Ontario with those observed by Cane et al. (1985) near Ithaca, NY would assist in understanding the ecological relationship between pollinators and Deerberry, and would clarify whether a scarcity of pollen vectors is a limitation.

Genetic diversity

The majority of Canadian populations are small and isolated. Small populations are known to have low genetic diversity and thus may have limited reproductive capacity (Caughley and Gunn 1996). Deerberry's lack of seedlings may be due to a possible genetic shortcoming (Schonewald et al. 1983, Clegg and Brown 1983, Lande and Barrowclough 1987, Gilpin 1987, Husband and Barrett 1996). Flowers of Deerberry are strongly self-sterile. However, greenhouse studies have shown seed from Canadian plants to be fertile and to have good germination capabilities. Also, genetic studies conducted by Yakimowsky and Eckert (2008) showed that genetic diversity in Deerberry was not reduced at the northern edge of the range. The same study did find some evidence of genetic differentiation between local populations that could be attributed to population isolation. How genetic diversity and the presence or absence of specific genes or alleles may be affecting Deerberry reproduction remains a knowledge gap.

Hardiness

Deerberry reaches its current northern limit in Ontario and New York state. A restriction to specific microclimates might not allow it to survive further north, but its northern range limit may be expected to shift about with minor climatic changes (Huntley 1991). The

Thousand Islands and Niagara sites are in plant hardiness zones 6a and 7b, respectively, with microclimates moderated by Lake Ontario and the St. Lawrence River, and by Lake Erie and the Niagara River. Chamberlain (1994) states that Deerberry cannot survive prolonged exposure to temperatures of -25°C or below, and winter minimum temperatures in these zones range to -23° C. Therefore, Deerberry in Canada may be restricted to these moderated areas because it is not hardy enough for more northern latitudes, and humidity (from the close proximity of large bodies of water) may play a role in moderating the climate.

Plant Competition

In general, competition cannot be said to be a threat to seedlings; it is a fact of plant life. However, it may certainly be a limiting factor. In the Thousand Island region, transplanted seedlings on Lyndoch Island were noted as being largely out-competed by blueberry plants (El-Fityani 2006). Although no quantitative data is available on competition, the presence of blueberry is considered adverse to Deerberry seedlings at St. Lawrence Islands National Park (Chamberlain 1994, Bramwell 1998). In the Niagara region, competing vegetation includes Gray Dogwood (*Cornus racemosa*), a colonial shrub which surrounds the Deerberry plants. The Deerberry plants are on the edge of a steep slope to the east, so they are not shaded or crowded on one side (R. Ritchie pers. comm. 2008). Fire suppression may cause increased competition for Deerberry as the habitat becomes more densely vegetated.

1.6 Threats to Survival and Recovery

The most serious problem for Deerberry appears to be low reproductive success, which is a limiting factor, rather than a threat (see previous section). It is mentioned again here because many of the external threats may contribute to the problem, and addressing the identified threats through recovery efforts may help to address the reproduction issue. Threats, which are mostly external in nature (rather than inherent), are discussed below. The number of external threats is fairly low because almost all of the extant patches are in protected areas. Table 2 shows the severity of all threats by region. Severity levels provided in the table were provided by biologists familiar with the species and the respective region but are still subjective in nature.

Table 2. Threats to Deerberry and their severity by region (information from R. Ritchie pers. comm. 2008, J. Van Wieren pers. comm. 2008, and other recovery team members). Letters indicating threat severity are Nil-Low-Medium-High. Italicized lines in the table indicate potential threats.

Threat	Niagara Region	Thousand Islands Region
Lack of Reproduction*	H	H
Lack of Available Habitat (due to Natural Succession & Fire Suppression)	M	H
Trampling	H	M
Erosion and Soil Slumping	H	N
Plant Competition*	M	H
Invasive Species	*L*	*M*
Browsing	*L*	*H*
Urbanization	*N*	*L*
Pathogens	*Unknown*	*unknown*

*Limiting factors (not considered threats) which need to be addressed in recovery efforts.

Lack of Available Habitat (due to Fire Suppression and Natural Succession)

Deerberry is often associated with Pitch Pine in the Thousand Islands region (Crowder 1982) and is found in a remnant Black Oak Savanna in the Niagara Region. Pitch Pine forest was historically subject to frequent fires (Whelan 1986, Matlack et al. 1993, Anderson et al. 1999), and the importance of fire in maintaining oak savannas has also been well documented (Sceicz and Macdonald 1990, Vanzant and Miyanksi 1993, Clark and Royall 1996, Will-Wolf and Stearns 1999). Cultivated blueberries are managed with fire (Badcock 1958, Scott 1967, Catling and Brownell 1999). These three lines of evidence for pines, oaks, and blueberries suggest that Deerberry is generally found in seral communities (or intermediate successional stages) which may have originated from fire. Skinner and Foré (2002) noted that burning caused patch movement and patch size changes, driving genetic composition changes in Deerberry. The suppression of fire in the Niagara and Thousand Islands regions has occurred for over a century, allowing vegetation to fill in and habitat to become unsuitable for Deerberry. This is very likely the main cause of a lack of available habitat for Deerberry. Note that with the very small populations found in Canada, any use of fire for habitat improvement must be done extremely cautiously to ensure there is no damage to the existing patches.

Trampling

Trampling by park visitors in the Niagara region and at St. Lawrence Islands National Park is a threat to Deerberry. The current Niagara patches are adjacent to trails, and the disappearance of one population in Niagara, which was close to the Bruce Trail, may have been the result of dirt bike use. The small size of the extant population in the Niagara region may be due to pedestrian traffic (S. Thompson pers. comm. 2001, G. Meyers pers. comm. 2001). Trails were re-directed at the Niagara site in 2004-2005 to protect Deerberry patches (K. Vlasman pers. comm. 2009). At St. Lawrence Islands National Park in 1981, two patches of plants showed signs of damage from trampling (Crowder 1982), and Parks Canada relocated the trail as a result. While work has been

done to mitigate impacts at priority sites, the threat is still present for some populations in low-use areas.

Erosion and Soil Slumping

The Niagara site has a high probability of future erosion and soil slumping. Major soil slumping has occurred in the past at and adjacent to the present Deerberry location, as evidenced by comparing historical and current aerial photography. During 2006, MNR (Vineland office) planted 400 Eastern White Cedar (*Thuja occidentalis*) saplings to rehabilitate slumping areas where large mudslides had occurred to try to mitigate threats to nearby "seeps" where two species of Dusky Salamanders (*Desmognathus fuscus* and *D. ochrophaeus*) are known to exist (R. Tervo pers. comm. 2008, R. Ritchie pers. comm. 2008).

Browsing

Small mammals and White-tailed Deer (*Odocoileus virginianus*) are known to browse Deerberry. Although damage to Deerberry has not been measured, browsing was shown to be a major cause of mortality for other shrub seedlings in successional plots in the Frontenac Axis (McNamee 1997, Crowder and Harmsen 1998). Browsing of Deerberry is widespread and episodic. Heavy deer browsing has resulted in the failure of at least one Deerberry introduction in the Thousand Islands region (El-Fityani 2006) and appears to be a significant factor in the lack of success at one or more additional transplant locations (S. Thompson pers. comm. 2009). Cattle are known to have destroyed a patch of Deerberry at St. David's Gorge in the Niagara region, but it is not known whether they trampled plants or browsed them (G. Meyers pers. comm. 2001). Cattle are unlikely to be an issue at any of the currently extant sites due to location, ownership or access. In addition, non-lethal leaf damage by insects was noted in the Niagara region (M. Thompson-Black pers. comm. 2001). Currently, the threat from browsing is considered to be 'variable', because of fluctuations in deer populations, especially in the Thousand Islands region. However, browsing remains a significant threat.

Invasive Species

In the Niagara Region, European Buckthorn (*Rhamnus cathartica*) occurs in the area of the Deerberry plants. However, a major effort to remove Buckthorn was undertaken in 2006 by the Niagara Parks Commission, and the threat is currently considered low. Garlic Mustard (*Alliaria petiolata*) is also found in this location, and a prescribed burn is being considered for this site in the next 5 years (R. Ritchie pers. comm. 2008). Garlic Mustard is also a problem on West Grenadier Island in the St. Lawrence Islands National Park (J. Van Wieren pers. comm. 2008). Invasive species are a stress on the landscape at St. Lawrence Island National Park although they may not be a direct threat to Deerberry at present. Thus, in general, invasive species are considered a potential threat rather than an immediate threat.

Urbanization

Loss of habitat that is apparently suitable for Deerberry is occurring in the St. Lawrence Islands region on some islands, such as West Grenadier Island. These islands have a patchwork of park and private ownership, and continuing development on private land

may be eliminating habitat that could support Deerberry. Habitat loss has also been a major cause of extirpation of populations in the Niagara Region. However, the severity of the threat of urbanization is currently considered fairly low because the main effects have already taken place and the majority of the remaining Canadian population is protected within parks. Urbanization of suitable recovery habitat remains a potential threat.

Pathogens

The literature on the genus *Vaccinium* contains lists of fungal and viral pathogens because blueberries are an important commercial crop, but it is not known if these pathogens also affect Deerberry. The presence of pathogens could have a detrimental impact on seedling survivorship with transplants (D. Kristensen pers. comm. 2007) and may have been responsible for the extremely poor survival rate of seedlings transplanted in St. Lawrence Islands National Park in 2005 (El Fityani 2006). The severity of the effect of pathogens is not known and is a knowledge gap and recommended research topic.

1.7 Knowledge Gaps

There are a number of important knowledge gaps for Deerberry in Canada. These are summarized in Table 3.

Table 3. Knowledge gaps for Deerberry

Need to know:	**In order to:**
Historic, current and future habitat requirements (both short-term and long-term)	Effectively direct recovery/restoration efforts (including the selection of sites for introduction/reintroduction)
The role of fire in habitat creation and maintenance	Determine whether controlled burning is a useful tool for recovery; Determine whether fire is necessary to maintain habitat over the long-term
Cause of Deerberry's low reproductive success	Increase size of populations and accomplish recovery
Genetic variability of populations	Know to what extent low reproductive success is due to genetics, and to determine relative distinctiveness of regional populations
Environmental and ecological conditions necessary for germination and seedling establishment	Help with planning and implementation of recovery actions to help Deerberry become self-sustaining in Ontario
Deerberry life history (pollination, dispersal vectors, herbivory, mycorrhizae, competition, pathogens)	Help plan recovery actions to address threats and inherent limitations of the species
Forest history, e.g. using tree-ring analysis	Learn approximate age of Deerberry populations and fire history of the area thereby helping to plan management activities such as controlled burns.

1.8 Recovery Actions Completed or Underway

Existing Species and Habitat Protection

The ESA 2007 protects Deerberry and also provides the means to protect habitat for this species through a regulation. If a habitat regulation is not developed for Deerberry, then its habitat will be protected under the general habitat provisions of the ESA 2007 as of June 30, 2013. Five of the six extant populations in Ontario have additional species and habitat protection. Four are protected and managed by St. Lawrence Islands National Park under the Canada National Parks Act. One population and its habitat is protected and managed by the Niagara Parks Commission under the Niagara Parks Act. The one population on private property is identified as a high priority for stewardship. Contact with the landowner has been made, and the population has been surveyed by staff from Parks Canada Agency.

Other Actions Completed or Underway

- Cuttings were successfully grown in the Guelph Arboretum but plants needed careful monitoring throughout the process. The cuttings were taken from the extirpated St. David's population in the 1980s (exact date unknown).
- Deerberry Recovery Plan was completed for St. Lawrence Islands National Park (Crowder 1982, Brownell 1984).
- Transplantation at St. Lawrence Islands National Park was undertaken at several locations (1994, 2001, 2005, 2006, 2009). Success of introductions has been variable.
- Endymion Island in St. Lawrence Islands National Park has been closed to visitors.
- Deerberry Recovery Team was formed in 2000.
- Leaves were collected for genetic analysis in 2001.
- Educational pamphlets were developed and distributed to visitors at St. Lawrence Islands National Park.
- Methods for starting seedlings were developed through research at Acadia University in partnership with St. Lawrence Islands National Park. Germination percentages varied from 40-92%.
- ELC mapping was completed at St. Lawrence Islands National Park.
- Niagara populations were surveyed by M. Thompson-Black in 2001.
- Trail improvement was done in Niagara region to lessen the threat of trampling in 2004.
- Information on Deerberry was incorporated into websites and stewardship materials were developed by Niagara Escarpment Commission and St. Lawrence Islands Commission.
- Plants were surveyed in the Niagara region in 2006 (M. Oldham pers. comm. 2008).
- The Niagara Parks Commission undertook removal of invasive Common Buckthorn in 2006. This included cutting of shrubs by lopper or chainsaw and subsequent treatment of the 6" to 8" stumps with Garlon 4; a 99% kill rate was determined later in the season.

- Landscape-level genetics research was completed at Queen's University. (Yakimowsky and Eckert 2007, 2008); their work also showed good germination rates in the laboratory and no loss of "genetic diversity" at the northern range limit of the species.
- During 2006, 2007 and 2008 the Niagara Peninsula Conservation Authority conducted natural areas inventory throughout its jurisdiction.
- Testing of the habitat mapping approach recommended in section 2.5 was undertaken in St. Lawrence Islands National Park in 2008-2009.
- Habitat modeling has been ongoing for several years; work on the most recent iteration that was begun in 2008 continues.

2.0 RECOVERY

2.1 Recovery Goal

The Recovery Goal is to ensure that Deerberry persists in its natural habitat at known sites with no decline in population sizes over the short term and with increases in both number of populations and population sizes until it is deemed that the species is no longer at risk in either of the two regions where it is found in Ontario.

2.2 Protection and Recovery Objectives

Four objectives have been identified. These are presented in Table 4.

Table 4. Protection and recovery objectives

No.	Protection or Recovery Objective
1	Persistence of Deerberry in its current habitat at all known natural and viable reintroduction sites with population sizes remaining stable or increasing for the next 10 years and beyond
2	Identification of measures necessary to mitigate threats to the species and its habitat, and implementation of mitigation as appropriate
3	Completion of research and monitoring to document and assess habitat requirements, genetic diversity, life history, and population trends
4	Provision of adequate habitat for species recovery through planning for, protecting and restoring existing and potential habitat, and the augmentation, reintroduction and introduction of populations into suitable habitat

2.3 Approaches to Recovery

Approaches to achieve recovery objectives are prioritized and listed in Table 5. For relative priority of approaches, the recovery team has used the terms high, medium and low. High priority approaches are those needed to mitigate threats in the short term or to meet legal/regulatory requirements. Medium priority approaches are intended to address longer-term threats. Low priority approaches include general communications with the public, collaboration with other jurisdictions, surveys for new populations and research which could improve longer-term planning and management, especially at landscape and meta-population levels.

While a number of the approaches are intended to address more than one objective, they are listed under the objective that they are most closely linked to.

Table 5. Approaches to recovery of Deerberry in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Objective 1: Persistence of Deerberry in its current habitat at all known natural and viable reintroduction sites with population sizes remaining stable or increasing for the next 10 years and beyond				
High	Ongoing	Management and Stewardship	**1.1** Continue to protect sites managed by Parks Canada Agency and Niagara Parks Commission	• All threats
High	Ongoing	Management and Stewardship	**1.2** Create, update and implement management plans	• All threats
High	Ongoing	Stewardship	**1.3** Continue to work with private landowner on stewardship of non-park population	• Potential to address any or all threats
High	Short-term	Management and Stewardship	**1.4** Map occupancy-based habitat in each region (underway)	• Historic, current and future habitat requirements
Low	Long-term	Stewardship	**1.5** Discuss Deerberry with municipalities, including potential for finding new populations and important examples of potential habitat on private property.	• Urbanization
Low	Ongoing	Outreach	**1.6** Continue public education on Deerberry, species at risk, and species at the northern limit of their range at St. Lawrence Islands National Park (underway)	• Trampling
Low	Ongoing	Outreach and Collaboration	**1.7** Educate landowners, conservation authorities, stewardship councils, municipalities, and the general public about Deerberry habitat (underway)	• Urbanization • Lack of habitat
Low	Long-term	Collaboration	**1.8** Collaborate with organizers of the Algonquin to Adirondacks (A2A) and Carolinian Canada landscape initiatives to protect habitats for species dispersal	• Urbanization • Lack of habitat

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Low	Ongoing	Collaboration	**1.9** Collaborate with the Niagara Escarpment Commission, Frontenac Arch Biosphere Reserve and St. Lawrence Parks Commission to identify and protect potential habitat for species dispersal (underway)	• Urbanization • Lack of habitat
Objective 2: Identification of measures necessary to mitigate threats to the species and its habitat, and implementation of mitigation as appropriate.				
High	Ongoing	Management and Stewardship	**2.1** Identify further threat mitigation measures needed through management planning	• All threats
High	Ongoing	Stewardship	**2.2** Continue to work with private landowner to identify and mitigate threats to non-park population	• Potential to address any or all threats
High – Niagara Medium - St. Lawrence Islands	Short-term	Management	**2.3** Erect barriers and signage to keep park visitors away from Deerberry (underway)	• Trampling
High	Short-term	Management	**2.4** Plan and effect re-routing of trails away from Deerberry populations	• Trampling, erosion
Medium	Ongoing	Management	**2.5** Discuss with MNR success of past actions to reduce slumping elsewhere; Investigate what can be done to mitigate this threat; Implement actions as it becomes possible	• Erosion/slumping
Objective 3: Completion of research and monitoring needed to document and assess habitat requirements, genetic diversity, life history, and population trends.				
High	Ongoing	Research	**3.1** Continue research on conditions required for successful seedling establishment (underway)	• Lack of reproduction

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
High	Ongoing	Research	**3.2** Study the effects of fire on propagation of the species and maintenance of habitat (underway)	• Lack of habitat • Lack of reproduction • Competition • Invasive species • Pathogens
High	Ongoing	Monitoring	**3.3** Improve and implement the existing monitoring protocol for the St. Lawrence Islands population; Implement same protocol at Niagara site. Continue monitoring sites that have been restored or augmented (underway)	• Potential to address any or all threats
High	Short-term	Research	**3.4** Examine habitat of historical and extant populations; Include fire history where possible	• Lack of habitat • Lack of reproduction • Competition • Invasive species
Medium	Long-term	Research	**3.5** Investigate the genetic variability of Deerberry populations at a landscape and site level (underway)	Lack of reproduction
Medium	Ongoing	Research and Restoration	**3.7** Continue to develop and improve a habitat model for Deerberry incorporating fire history and other life history and landscape variables as they become available	• Lack of reproduction • Lack of habitat
Low	Long-term	Research	**3.6** Investigate life history of Deerberry including pollination, dispersal vectors, mycorrhizae, browsing, competition, and pathogens	• Lack of reproduction • Competition • Invasive species • Browsing • Pathogens
Low	Long-term	Research	**3.8** Collaborate with agencies in the USA to obtain more information on New York populations	• Lack of reproduction • Lack of habitat • Pathogens

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Objective 4: Provision of adequate habitat for species recovery through planning for, protecting and restoring existing and potential habitat, and the augmentation, reintroduction and introduction of populations Into suitable habitat.				
High	Ongoing	Restoration	**4.1** Collect and cultivate a stock of cuttings and seeds from the two regions (underway)	• Lack of reproduction
High	Ongoing	Restoration	**4.2** Enhance or augment existing populations; Using experience gained from past and ongoing introductions in St. Lawrence Islands National Park, begin efforts in Niagara Region	• Lack of reproduction
High	Short-term	Restoration	**4.3** Review and update criteria developed for restoration of populations in St. Lawrence Islands National Park; Establish criteria for restoration of Niagara populations.	• Lack of habitat • Lack of reproduction • Competition
Medium	Ongoing	Restoration	**4.4** Incorporate restoration of Deerberry into oak forest/savanna restoration activities being done by the Niagara Parks Commission (underway)	• Lack of habitat • Lack of reproduction • Competition
Low	Ongoing	Restoration	**4.5** Develop seed and cutting collection guidelines	• Lack of reproduction

Narrative to Support Approaches to Recovery

Preventing trampling of the few remaining plants in the Niagara Region is a top priority. Other management tools that have been used to maintain stable Deerberry populations at St. Lawrence Islands National Park should begin as soon as feasible for the Niagara population. Efforts to ensure successful germination and transplantation programs should continue.

2.4 Performance Measures

Success in meeting the recovery objectives should be measured as follows over the short term:

Objective 1 -- Persistence of Deerberry in its current habitat at all known natural and viable reintroduction sites with population sizes remaining stable or increasing for the next 10 years and beyond

- There is no loss of populations, no loss of sites, and size of patches is relatively stable for the next ten years and beyond as demonstrated by a monitoring program (Objective 3).
- All unsurveyed potential habitat has been identified and searched for Deerberry by 2010.
- Habitat is identified and mapped based on occupancy by 2010.

Objective 2 -- Identification of measures necessary to mitigate threats to the species and its habitat, and implementation of mitigation as appropriate

- The threat of trampling is very much reduced or completely eliminated by 2010.
- Park management plans are in place for populations in protected areas by 2010.
- Management planning to address soil slumping is underway by 2010.

Objective 3 -- Completion of research and monitoring to document and assess habitat requirements, genetic diversity, life history, and population trends

- Monitoring program is tracking actual and potential threats by 2010.
- Research on seedling germination and establishment is underway by 2010.
- Research on the use of fire as a habitat improvement tool is underway by 2011.
- Other research is begun as opportunities and funding arise.

Objective 4 -- Provision of adequate habitat for species recovery through planning for, protecting and restoring existing and potential habitat, and the augmentation, reintroduction and introduction of populations into suitable habitat

- Transplantation begins in the Niagara Region with the creation of at least one new population and increase in size of extant population by 2011.
- Transplantation continues in St. Lawrence Islands National Park with establishment of at least 2 new or restored sites by 2011.
- Work on habitat restoration (controlled burns, mechanical improvements, reintroductions) is begun in both regions by 2012.

2.5 Area for Consideration in Developing a Habitat Regulation

Under the ESA 2007, a recovery strategy must include a recommendation to the Minister of Natural Resources on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the recovery team will be one of many sources considered by the Minister when developing the habitat regulation for this species.

Given the small number and size of Deerberry populations, it is recommended that areas where natural populations or successfully introduced populations occur be prescribed as habitat within a habitat regulation. There has been variable success in introducing Deerberry to sites within St. Lawrence Islands National Park (S. Thompson pers. comm. 2009). Therefore, only introduced populations that remain present and appear well established five years after restoration should be considered to have been successfully introduced. A 30 metre area around the external extent of each occurrence is also recommended to be prescribed as habitat within a habitat regulation. This distance is precautionary to capture the variability of site conditions that support the persistence of this species and generally encompasses the ecological communities in which the species occurs. In cases where occurrences are separated by more than 30 metres but there is contiguous suitable habitat in the intervening area (based on Ecological Land Classification), this area should be included within the habitat regulation. This approach was tested in the Thousand Islands in 2008 and 2009 and appears to work well at capturing the habitat that the species depends on (J. Van Wieren, pers. comm. 2009). For greater certainty, maps to support this recommendation should be created using a high resolution GPS.

If future scientific studies indicate that additional areas of habitat are necessary to achieve the recovery goals for this species, that information should also be considered in developing the habitat regulation.

GLOSSARY

Calcicole: (usually referring to plants) growing best on calcareous soils.

Calcifuge: (usually referring to plants) growing best on acidic soil.

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

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

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

1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, 5 = secure

Dolostone: Sedimentary rock type akin to limestone, comprised primarily of the mineral dolomite ($CaMg(CO_3)_2$).

Endangered Species Act, 2007 (ESA 2007): The provincial legislation that provides protection to species at risk in Ontario. The Act was passed by the Ontario Legislature in 2007 and came into effect June 30, 2008.

Metapopulation: An assemblage of discrete local populations with migration among them. With plants, migration is most often accomplished by the movement of seeds, or by pollen -- either by wind, insects or some other vector.

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

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

REFERENCES

Anderson, R.C., J.S. Fralish and J.M. Baskin. 1999. Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge University Press. 470 pp.

Argus, G.W., K.M. Pryer, D.J. White and C.J. Keddy (Eds). 1982-1987. Atlas of the Rare Vascular Plants of Ontario. National Museum of National Sciences, Ottawa.

Argus, G.W. and K.M. Pryer. 1990. Rare Vascular Plants in Canada. Our Natural Heritage. Canadian Museum of Nature, Ottawa. 191 pp.

Badcock, A.C. 1958. Prescribed burning and the growing of blueberries. Newfoundland Res. Comm. Symp. Prescribed Burning. Memorial University of Newfoundland. 1958: 53-56.

Bramwell, K. 1998. Review of Deerberry Monitoring. St. Lawrence Island National Park. Mallorytown. Unpublished Report.

Brownell, V.R. 1984. A management plan for rare vascular plants in St. Lawrence Islands National Park. Parks Canada, Cornwall.

Caccia, R. 2001. Personal communication.

Cane, J.H., G.C. Eickwort, F.R. Wesley and J. Speilholz. 1985. Pollination ecology of *Vaccinium stamineum* (Ericaceae: Vacciniadeae). Amer. J. Bot. 72(1): 135-142.

Catling, P.M. and V.R. Brownell. 1999. Granite Barrens, the flora and ecology of southern Ontario Granite Barrens. Pp 392-405 in (eds). R.C. Anderson, J.S. Fralish and J.M. Baskin. Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge University Press. 470 pp.

Caughley, G. and A.G. Gunn. 1996. Conservation Biology in Theory and Practice. Oxford University Press. 459 pp.

Chamberlain, B. 1994. Rare Plant Monitoring. St. Lawrence Islands National Park, Mallorytown. Unpublished Report.

Clark, J.S. and P.D. Royall. 1996. Local and regional sediment charcoal evidence for fire regimes in presettlement northeastern North America. Journal of Ecology 84: 365-382.

Clegg, M.T. and A.H.D. Brown. 1983. The founding of plant populations. Pp 216-228 *in* (ed.) C.M. Schonewald Cox, S.M. Chambers, B. MacBryde and W.L. Thomas, 1983. Genetics and Conservation. Benjamin Cummings Publishing Company. Menlo Park, California.

Crins, W.J. and P.W.C. Uhlig. 2000. Ecoregions of Ontario: Modifications to Angus Hills' Site Regions and Districts: Revisions and Rationale. Ontario Ministry of Natural Resources. 7 pp.

Cronquist, A. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada 2nd ed. New York Botanical Gardens, NY. 910 pp.

Crowder, A. 1982. Resource management study of selected rare plants in St. Lawrence Islands National Park. 4. *Vaccinium stamineum*. Kingston.

Crowder, A. 2008. Personal communication.

Crowder, A. and R. Harmsen. 1998. Notes on forest succession in old fields in southeastern Ontario; the woody species. Canadian Field-Naturalist 112: 410-418.

El-Fityani, T. 2006. The Recent Progress of St. Lawrence Islands National Park towards the Recovery of Deerberry, *Vaccinium stamineum,* in the Thousand Islands Region. St. Lawrence Islands National Park, Resource Conservation. August 2006.

Eriksson, O. and H. Froberg. 1996. 'Windows of opportunity' for recruitment in long-lived clonal plants; experimental studies of seedling establishment in *Vaccinium* shrubs. Canadian Journal of Botany 74: 1329-1374.

Farrar, J., A. Crowder and M. Hummel. 1978. Ecological effects of fire and its management. Parks Canada. 2 vols.

Ford, B.A. 1984. Deerberry (*Vaccinium stamineum L.*) in Ontario. The Plant Press. 2(2): 40-42.

Ford, B.A. 1993. Conservation Recommendations for Deerberry, *Vaccinium stamineum* L. a threatened species in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Ottawa. 3 pp.

Ford, B.A. 1994. Status report on the Deerberry, *Vaccinium stamineum* L., in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Ottawa. pp 24.

Ford, B.A. 1995. Status of the Deerberry, *Vaccinium stamineum* L. (Ericaceae) in Canada. Rhodora 97: 255-263.

Gilpin, M.E. 1987. Spatial structure and population vulnerability *in* (ed.) M.E. Soule, Viable populations for conservation. Cambridge University Press.

Howe, H.F. 1986. Seed dispersal by fruit-eating birds and mammals. Pp. 123-190 *in* (ed.) D.R. Murray. Seed Dispersal. Academic Press, New York.

Howe, M.D. 1968. Vascular Plants of Oneida County. Utica College, Syracuse.

Huntley, B. 1991. How plants respond to climate change: migration rates, individualism and consequences for plant communities. Annals of Botany 67: 15-22. Supplement.

Husband, B.C. and S.C.H. Barrett 1996. A metapopulation perspective in plant population biology. Journal of Ecology 84: 461-469.

Jacquemart, A.L. 1996. *Vaccinium uliginosum* L. Biological Flora of the British Isles. Journal of Ecology 84: 771-785.

Korcak, R.F. 1998. Nutrition of blueberry and other calcifuges. Horticultural Reviews 10: 183-228. Timber Press, Portland Oregon.

Kristensen, D. 2007. Personal communication. Deerberry Recovery Team member.

Lande, R. and G. Barrowclough. 1987. Effective population size, genetic variation and their use in population management. In (ed.) M.E. Soule, Viable populations for conservation. Cambridge University Press.

Larson, D. 2001. Personal communication. Professor. University of Guelph, Department of Biology.

Lee, H., W. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario. Ontario Ministry of Natural Resources. North Bay, Ontario. 225 pp.

Matlack, G.R., D.J. Gibson and R.E. Good. 1993. Clonal propagation, local disturbance and the structure of vegetation; ericaceous shrubs in the pine barrens of New Jersey. Biological Conservation 63: 1-8.

McNamee, S.D.W. 1997. Factors affecting the establishment of woody plants during old field succession. M.Sc. thesis. Queen's University, Kingston, Ontario.

Meyers, G. 2001. Personal communication.

NatureServe. 2008. Online Explorer available at http://www.natureserve.org

Oldham, Michael J. 2008. Personal communication. Botanist-Herpetologist. Natural Heritage Information Centre, Ontario Ministry of Natural Resources.

Reschke, C. 1990. Ecological Communities of New York State. New York Natural Heritage Program, Latham, N. Y. 96 pp.

Ritchie, R. 2008. Personal communication. Deerberry Recovery Team member.

Sceicz, J.M. and G.M. MacDonald. 1990. Postglacial vegetation history of oak savannah in southern Ontario. Canadian Journal of Botany 69: 1507-1519.

Scott, J. 1967. Burning as a management tool. Department of Lands and Forests. Prescribed Fire Symposium, Ontario. Toronto, Ontario.

Skinner, J.R and S. Foré. 2002. Influence of burning on changes in the size, shape and random amplified polymorphic DNA (RAPD) profile composition of *Vaccinium stamineum* L. patches. Truman State University. Kirksville. Missouri.

Soper, J.H. and M.L. Heimburger. 1982. Shrubs of Ontario. Royal Ontario Museum. Toronto. 495 pp.

Tervo, Rob. 2008. Personal communication. Ontario Ministry of Natural Resources, Vineland, Ontario.

Thompson, S. 2009. Personal communication, Deerberry Recovery Team chair (teleconference, August 24, 2009)

Thompson-Black, M. 2001. Personal communication. Deerberry Recovery Team member

Van Wieren, Josh. 2008. Personal communication. Park Ecologist, St. Lawrence Islands National Park, Parks Canada.

VanderKloet, S.P. and N.M. Hill. 1994. The paradox of berry production in temperate species of *Vaccinium*. Canadian Journal of Botany 72: 52-58.

Vanzant, H. and K. Miyanishi. 1993. Impacts of prescribed burning and deer browsing on *Quercus muehlenbergii* in a southern Ontario oak savanna. Abstract of 78th meeting of the Ecological Society of America.

Varma, A. and B. Hock (eds). 1995. Mycorrhiza: Structure, function, molecular biology and biotechnology. Springer Verlag. New York.

Vlasman, K. 2009. Personal communication.

Voss, E.G. 1996. Michigan Flora: Part III. Cranbrook Institute of Science and University of Michigan Herbarium, Bulletin 61. Ann Arbor, Michigan.

Weir, R.D. 1989. Birds of the Kingston Region. Quarry Press Kingston. 608 pp.

Weldy, T., R. Mitchell and R. Ingalls. 2002. New York Flora Atlas (http://nyflora.org/atlas/atlas.htm). New York Flora Association, New York State Museum, Albany, NY.

Whelan, R.J. 1986. Seed Dispersal in relation to fire. Pp. 237-272 *in* (ed.) D.R. Murray. Seed Dispersal, Academic Press, New York.

Will-Wolf, S. and F. Steams, 1999. Dry Soil Oak Savanna in the Great Lakes Region. Pp. 135-154 *in* (eds.) R.C. Anderson, J.S. Fralish and J.M. Baskin. Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge University Press. 470 pp.

Yakimowsky, S.B. and C.G. Eckert, 2007. Threatened peripheral populations in context: geographical variation in populations frequency and size and sexual reproduction in a clonal woody shrub. Conservation Biology 21(3): 811-822.

Yakimowsky, S.B. and C.G. Eckert. 2008. Populations do not become less genetically diverse or more differentiated towards the northern limit of the geographical range in clonal *Vaccinium stamineum* (Ericaceae). New Phytologist 180: 534-544.

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