RECOVERY PLAN FOR THE *GYPSY CUCKOO BUMBLE BEE (BOMBUS BOHEMICUS)* IN NOVA SCOTIA

A recovery plan adopted by the Nova Scotia Department of Natural Resources and Renewables

2023 – 2028

Recommended citation:

Nova Scotia Department of Lands and Forestry. 2023. Recovery Plan for the Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) in Nova Scotia [Final]. *Nova Scotia Endangered Species Act Recovery Plan Series*.

Cover illustration: Gypsy cuckoo bumble bee — Photo by Ivar Leidus

Adoption of a Recovery Plan per Section 15(9) of the Endangered Species Act

Species:

Gypsy cuckoo bumble bee (*Bombus bohemicus)*

Reference:

Environment and Climate Change Canada. 2022. Recovery Strategy for the Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 80 pp.

Whereas a Species at Risk Act Recovery Strategy has been prepared for this species by Environment and Climate Change Canada, and that plan has been reviewed by members of the applicable Nova Scotia Recovery Team and determined to fulfil the requirements of Section 15(4) of the Endangered Species Act as they pertain to Nova Scotia, the above-named recovery strategy shall be adopted in lieu of a Nova Scotia Recovery Plan subject to the following:

Date of Adoption: 07 February 2023

Expiry/renewal Date: 07 February 2028

Conditions:

1. Adoption of this recovery plan will be reviewed 5 years from the Date of Adoption.

2. Only elements of this plan that are relevant to Nova Scotia and are in accordance with the Endangered Species Act (Nova Scotia) shall be used. This includes the following sections of the report:

   Environment and Climate Change Canada (2022): Species description (3.1), Needs of the species (3.3), Threats (4), Population and distribution objectives (5), Strategic direction for recovery (6.2), Narrative to support the recovery

planning table (6.3), Information and methods used to identify critical habitat (7.1.1), Activities likely to result in the destruction of critical habitat (7.3), Measuring progress (8).

3. Population and distribution objectives (5) will be amended to the following: Assuming the Gypsy Cuckoo Bumble Bee is currently present in Nova Scotia, the population and distribution goal will be to maintain a stable or increasing population in the province.

4. Threats facing the Gypsy Cuckoo Bumble Bee within Nova Scotia are directly related to those facing its host species, the Yellow-banded Bumble Bee (YBBB). With the release of the YBBB management plan, actions addressing threats impacting the host species will also address those threats impacting the Gypsy Cuckoo Bumble Bee in Nova Scotia.

5. The Province of Nova Scotia explicitly adopts the written definition of critical habitat as described in this Recovery strategy in lieu of core habitat and that core habitat be described as laid out in Section 7 of ECCC (2022). This definition will be applicable to any new occurrences discovered in the province.

6. Identified core habitat requires the presence of physical habitat as described in Section 7, plus verified records for the species. At the time of adoption, there are no precise records and as such, no mapped core habitat.

7. Should any additional requirements be identified the Nova Scotia Department of Natural Resources and Renewables may prepare an addendum to this plan under the Endangered Species Act.

Approved: **Date:**

Donna Hurlburt, Manager of Biodiversity 07 February 2023

Appendix A:

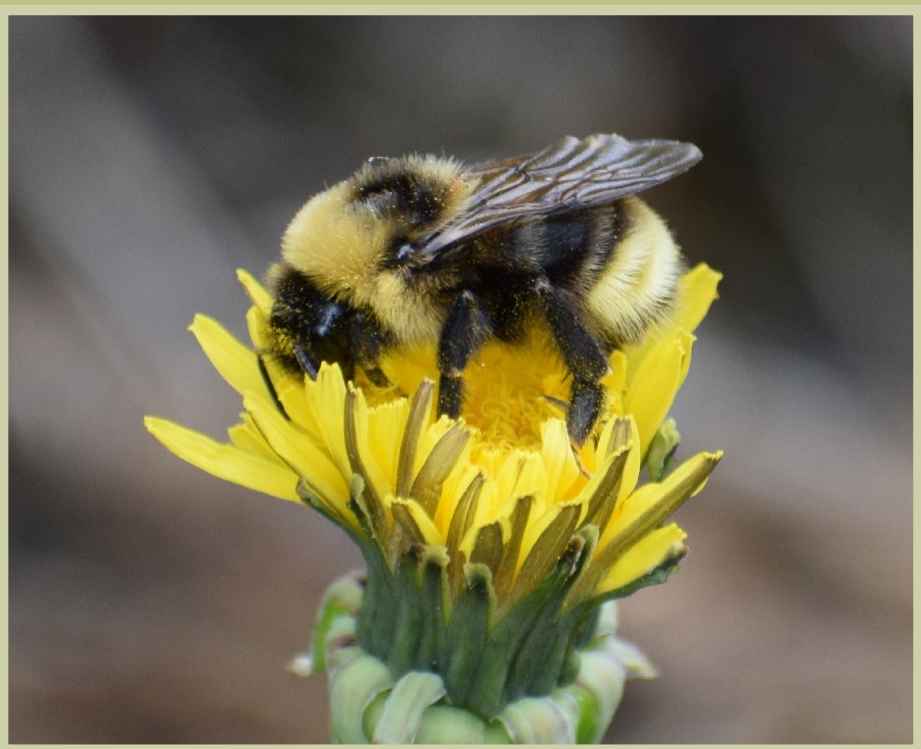
Environment and Climate Change Canada. 2022. Recovery Strategy for the Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 80 pp.

PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) in Canada

Gypsy Cuckoo Bumble Bee



2022

Government of Canada
Gouvernement du Canada

Canada

Recommended citation:

Environment and Climate Change Canada. 2022. Recovery Strategy for the Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. viii + 80 pp.

Official version

The official version of the recovery documents is the one published in PDF. All hyperlinks were valid as of date of publication.

Non-official version

The non-official version of the recovery documents is published in HTML format and all hyperlinks were valid as of date of publication.

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

Cover illustration: Gypsy Cuckoo Bumble Bee queen, Yukon. Photo: Syd Cannings

Également disponible en français sous le titre
« Programme de rétablissement du psithyre bohémien (*Bombus bohemicus*) au Canada [Proposition] »

ISBN
Catalogue no.

[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SARA Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Gypsy Cuckoo Bumble Bee and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the governments of Newfoundland and Labrador, Nova Scotia, Prince Edward Island, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, Northwest Territories, and Yukon; and Parks Canada Agency and Wildlife Management Boards, as per section 39(1) of SARA.

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

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

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

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

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

identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

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

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

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

Acknowledgments

This recovery strategy was prepared by Syd Cannings (Environment and Climate Change Canada, Canadian Wildlife Service (CWS) Northern Region), with the able and necessary assistance of a technical team made up of Julie McKnight (CWS Atlantic Region), Judith Girard (CWS Ontario Region), Emmanuelle Fay, Sandrine Bureau and Marianne Gagnon (CWS Quebec Region), Medea Curteanu and Lea Craig-Moore (CWS Prairie Region), Matthew Huntley (CWS Pacific Region), Darien Ure (Parks Canada Agency), David McCorquodale (Cape Breton University), Sheila Colla (York University), Cory Sheffield (Royal Saskatchewan Museum), Shelley Garland and Shelley Moores (Newfoundland and Labrador Fisheries and Land Resources), Donna Hurlburt (Nova Scotia Lands and Forestry), Maureen Toner (New Brunswick Energy and Resource Development), Garry Gregory (Prince Edward Island Communities, Land and Development), Colin Jones (Ontario Ministry of Natural Resources and Forestry), Joanna Wilson (Northwest Territories Environment and Natural Resources), Megan Evans (Alberta Environment and Parks), Jennifer Heron (British Columbia Environment and Climate Change Strategy), and Tom Jung (Yukon Environment).

Special thanks to Kella Sadler (CWS Pacific Region) for her advice on the recovery strategy process and extensive comments on a number of drafts. Michel Saint-Germain (Montreal Insectarium) wrote an earlier version of this document, and provided comments on later drafts. Other experts consulted include Nigel Raine (University of Guelph), Leif Richardson (University of Vermont), Lincoln Best, and Ralph Cartar (University of Calgary). Leif Richardson and Bonnie Fournier (Government of Northwest Territories) were kind enough to create the range maps, and Tyler Kydd (CWS Northern Region) produced the Critical Habitat maps. Lincoln Best (@beesofcanada), Jennifer Heron (British Columbia Environment and Climate Change Strategy), Paul Galpern (University of Calgary), David Misfeldt (City of Calgary), and Dave Prescott (Alberta Environment and Parks) provided information on recent, unpublished records.

Acknowledgement and thanks are also given to all other parties that provided advice and input used to help inform the development of this recovery strategy including various Indigenous Organizations and individuals, provincial and territorial governments, other federal departments, landowners, citizens, and stakeholders.

Executive Summary

In May 2014, the Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, owing to a large (>50%) inferred decline in abundance over the previous decade, primarily in southern Canada. It was added to Schedule 1 of the *Species at Risk Act* (SARA) in May 2018.

The Gypsy Cuckoo Bumble Bee is a specialist nest parasite; it only targets the nests of bumble bee species within the subgenus *Bombus*. Its decline in North America can be attributed directly to significant declines in three of these host species: the Rusty-patched Bumble Bee (*B. affinis*), the Yellow-banded Bumble Bee (*B. terricola*), and the Western Bumble Bee (*B. occidentalis*).Therefore, the recovery of the Gypsy Cuckoo Bumble Bee largely depends on the continued survival and/or recovery of its hosts.

The four main threats impacting the Gypsy Cuckoo Bumble Bee are: natural system modifications (i.e., the declines of its host bees); pathogen transmission and spillover from managed bumble bee populations in greenhouses, and to a lesser extent from Honey Bees (mediated primarily through losses in host bees); pollution (the use of insecticides, herbicides and fungicides in agriculture and silviculture); and climate change (habitat shifting and alteration, temperature extremes). Intensification of agriculture, and urban/suburban and industrial development may exacerbate local impacts or combine to produce cumulatively negative impacts over a larger scale. Competition with Honey Bees and escaped populations of managed bumble bees may also be a threat in some areas. All of these threats act primarily on the hosts of the Gypsy Cuckoo Bumble Bee, but also act directly on the bee itself.

The Gypsy Cuckoo Bumble Bee is naturally limited by the densities of its hosts; its hosts in turn require a constant suite of floral resources to support colony growth: pollen and nectar need to be available throughout the growing season. Bumble bees have a type of genetic sex determination that makes them extremely susceptible to extinction when effective population sizes are small.

There are unknowns regarding the feasibility of recovery of the Gypsy Cuckoo Bumble Bee. Nevertheless, in keeping with the precautionary principle, this recovery strategy has been prepared as per subsection 41(1) of SARA, as would be done when recovery is determined to be feasible. This recovery strategy addresses unknowns surrounding the feasibility of recovery.

The population and distribution objectives for the Gypsy Cuckoo Bumble Bee in Canada are: to maintain a stable or increasing population within its current range; and to regain the representation of the Gypsy Cuckoo Bumble Bee in different ecozones in Canada, to the extent possible. Broad strategies are presented to address the threats to the survival and recovery of the species. Implementation of these broad strategies is required to meet the population and distribution objective.

Critical habitat for the Gypsy Cuckoo Bumble Bee has been identified to the extent possible with the best available information to address the population and distribution objectives. A schedule of studies outlines the activities required to complete the identification of critical habitat.

One or more action plans will follow this recovery strategy and will be posted on the Species at Risk Public Registry within ten years of the posting of the final recovery strategy.

Recovery Feasibility Summary

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

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

Yes. The species is still present and apparently has individuals capable of reproduction in populations in the Yukon, Northwest Territories, Alberta, and (although surveys are lacking) probably elsewhere in the boreal and sub-boreal regions of Canada. Single individuals have been found recently in the Okanagan and Pend d'Oreille Valleys of British Columbia; the species' status in British Columbia is uncertain. Although the species has not been confirmed in eastern Canada since 2008, photographs from Québec indicate the species probably still occurs there. However, it is now exceedingly rare and possibly extirpated from southern Ontario, parts of southern Québec, and the Maritime Provinces.

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

Yes. There is sufficient suitable habitat available to support the species in the Yukon, Northwest Territories, and probably elsewhere in the boreal and montane woodlands of Canada. An essential element of suitable habitat for Gypsy Cuckoo Bumble Bee is the availability of host bee nests that it requires to lay eggs and rear its young. Its host bumble bees in North America include: the Yellow-banded Bumble Bee (*Bombus terricola*), Western Bumble Bee (*Bombus occidentalis*), and Rusty-patched Bumble Bee (*Bombus affinis*), which are also at risk—assessed as Special Concern, Threatened, and Endangered respectively. The Cryptic Bumble Bee (*Bombus cryptarum*) of the northwest is also a probable host; it is not at risk. Host bumble bees are still common in the northwest and probably throughout the boreal forest portion of its range. It may be possible to make additional suitable habitat available in the south, for example through habitat restoration activities aimed at promoting the re-establishment and recovery of host bumble bees in that part of the species' historical range. These restoration activities would need to include control of managed bees, diseases and pesticides that have caused the declines in the Gypsy Cuckoo Bumble Bee's hosts. It remains unknown, however, whether increased habitat quality in the south will actually lead to the natural re-establishment and recovery of host populations. With regard to physical habitat needs, its hosts are generalist foragers and somewhat flexible in terms of habitat for nesting and overwintering sites.

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

Unknown. The proximate cause of the decline of the Gypsy Cuckoo Bumble Bee is undoubtedly the loss of its host bumble bee species that it requires to rear its young. However, the primary threats affecting those species are numerous and not completely understood. The primary threats to the hosts are: pathogen/disease spillover from bumble bees used in commercial greenhouse operations and from Honey Bees (*Apis mellifera*), the use of systemic insecticides and other pesticides, and climate change; these threats probably interact in a cumulative manner. Habitat loss (loss of foraging and nesting habitat) as a result of urbanization and intensification of agriculture is a threat primarily in the south, but has only a small effect over the Gypsy Cuckoo Bumble Bee's broad Canadian range. While it is unlikely that past habitat losses due to urbanization and intensive agriculture can be restored, it is possible that some threats to remaining habitat could be avoided or mitigated—for example through stronger controls over the use of managed bumble bees in greenhouses, restrictions on neonicotinoid and other similar pesticides, and managing future developments. It is unlikely that negative impacts resulting from climate change can be mitigated or avoided.

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

Unknown. Techniques for increasing the availability of habitat for host bees exist, as do techniques for improving habitat quality for Gypsy Cuckoo Bumble Bee and its host bees through reducing or mitigating primary threats and applying best management practices. However, it is unknown whether increased habitat availability and improved habitat quality will lead to the natural re-establishment and recovery of host populations. If host populations do not respond to habitat restoration efforts, the recovery of Gypsy Cuckoo Bumble Bee will not be successful. The feasibility of recovering the Rusty-patched Bumble Bee is particularly uncertain; the species is currently SARA-listed as Endangered, and has not been seen in Canada since 2009. The Yellow-banded Bumble Bee was always uncommon in extreme southern Ontario, and is now rare or absent there. If host bee populations are successfully re-established where they are now absent, it may be necessary to deliberately re-introduce Gypsy Cuckoo Bumble Bees (through population augmentation). It is unknown whether Gypsy Cuckoo Bumble Bee individuals originating from the remaining extant populations in northern ecoregions would be successful in southern re-introduction efforts.

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1. COSEWIC* Species Assessment Information

Date of Assessment: May 2014

Common Name (population): Gypsy Cuckoo Bumble Bee

Scientific Name: *Bombus bohemicus*

COSEWIC Status: Endangered

Reason for Designation: This large and distinctive bee is a nest parasite of other bumble bees. It had an extensive range in Canada and has been recorded from all provinces and territories except Nunavut. Although not known to be abundant, there has been a large observed decline in relative abundance in the past 20-30 years in areas of Canada where the species was once common, with the most recent records coming from Nova Scotia (2002), Ontario (2008) and Quebec (2008). Significant search effort throughout Canada in recent years has failed to detect this species, even where its hosts are still relatively abundant. Primary threats include decline of hosts (Rusty-patched Bumble Bee, Yellow-banded Bumble Bee, and Western Bumble Bee), pesticide use (particularly neonicotinoids), and the escape of non-native, pathogen-infected bumble bees from commercial greenhouses.

Canadian Occurrence: Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador

COSEWIC Status History: Designated Endangered in May 2014.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

The International Union for Conservation of Nature (IUCN) has designated the Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) as Critically Endangered in North America, based on a decline estimated as greater than 90% (Hatfield *et al.* 2014); however, this decline estimate did not take into account the likelihood of the species' widespread persistence in northwestern Canada. In other words, the Critically Endangered status is probably an overestimation of extinction risk. In Europe, in contrast, the species is assessed by the IUCN as Least Concern, "in view of its wide distribution, presumed large overall population with a stable population trend and no major threats" (Rasmont *et al.* 2015a). Because of the disparate situations in different parts of its range, the IUCN assessed the species as Data Deficient globally (Hatfield *et al.* 2016).

The conservation ranks for the Gypsy Cuckoo Bumble Bee in various jurisdictions are presented in Table 1. The Gypsy Cuckoo Bumble Bee is listed as Endangered in Ontario and the Province has published a recovery strategy (Colla 2017) and a

government response statement (Ontario Ministry of the Environment, Conservation and Parks 2018); no other jurisdictions have produced such documents.

The majority of this species' range is in Eurasia; although no range-wide map exists for this species, it is estimated that approximately 10-20% of the species' historical range occurs in Canada.

Table 1. Conservation Status of the Gypsy Cuckoo Bumble Bee (from Canadian Endangered Species Conservation Council 2016, NatureServe 2018, Ontario Natural Heritage Information Centre 2018, British Columbia Conservation Data Centre 2019, Northwest Territories Species at Risk Committee 2019, and Nova Scotia Lands and Forestry 2019).

Global (G) Rank[a]	National (N) Rank[a]	Sub-national (S) Rank[a]	COSEWIC Status	BC List	ON Status - SARO[b]	NS Status - NSESA[c]	NT Status - NWT SARC[d]
G4	Canada (N1) United States (NU)	Canada: Northwest Territories (S2S3), Yukon (S1S2), British Columbia (S1S2), Alberta (S1S2), Saskatchewan (S1S2), Manitoba (S1S2), Ontario (S1S2), Quebec (S1), Labrador (SU), Newfoundland (S1?), New Brunswick (S1), Nova Scotia (S1), Prince Edward Island (S1), United States: multiple states[e]	Endangered (2014)	Red List (Extirpated, Endangered, or Threatened status in BC)	Endangered (2015)	Endangered (2017)	Data Deficient (2019)

[a] Rank 1– critically imperiled; 2– imperiled; 3- vulnerable to extirpation or extinction; 4- apparently secure; 5– secure; X – presumed extirpated; H – historical/possibly extirpated; NR – status not ranked; U – unrankable

[b] The Species at Risk in Ontario (SARO) List is a regulation under Ontario's *Endangered Species Act, 2007* similar in context to Schedule 1 of the *Species at Risk Act*.

[c] Nova Scotia lists species at risk as regulations under the *Nova Scotia Species at Risk Act*

[d] The NWT Species at Risk Committee is established under the *Species at Risk (NWT) Act*, and assesses species to recommend whether they should be added to the NWT List of Species at Risk.

[e] Alaska (SNR), Connecticut (SX), Indiana (SH), Maine (SH), Maryland (SH), Massachusetts (SH), Michigan (SH), Minnesota (SNR), New Hampshire (SH), New York (SH), Pennsylvania (SH), Vermont (SH), Virginia (SU), Wisconsin (S1?)

3. Species Information

3.1 Species Description

The Gypsy Cuckoo Bumble Bee is a medium-sized bumble bee, one of six cuckoo bumble bees (subgenus *Psithyrus*) occurring in North America. Because cuckoo bumble bees take over the nests of other bumble bees and have the workers of the other species rear their young, they do not have a worker caste (smaller female worker bees that raise the young) of their own; the population consists entirely of males and queen-sized females. The females have an almost entirely black head, a yellow band at the front of the thorax, mostly black sides to the thorax, and a black abdomen with a broad white (or very pale yellow) band near the tip (COSEWIC 2014a; Williams *et al.* 2014). The males have a similar, but less distinct colour pattern; they often have a yellow base to the abdomen (Figure 1). The males are smaller (12-16 mm long) than females (17-18 mm long; COSEWIC 2014a). The females have an exceptionally armoured exoskeleton and have a strongly curved abdomen, but lack the pollen baskets on the hind legs typical of most bumble bees. For more details see COSEWIC (2014a) and Williams *et al.* (2014).

Figure 1. Female (left) and male (right) Gypsy Cuckoo Bumble Bees. Photos by Syd Cannings and Magne Flåten (Wikimedia Commons), respectively.

The Gypsy Cuckoo Bumble Bee is a sister species to Suckley's Cuckoo Bumble Bee (*B. suckleyi*), and the two can be easily mistaken for one another in the field. In general, the lower sides of the thorax are usually predominantly black in Gypsy Cuckoo Bumble Bee (although this is not apparent in Figure 1), whereas they are predominantly yellow in Suckley's Cuckoo Bumble Bee. Under a microscope, both Gypsy and Suckley's Cuckoo Bumble Bees have obvious lateral ridges on the underside of the end of the female's abdomen, but these are much more prominent in Suckley's Cuckoo Bumble Bee and can easily be seen in a dorsal view, whereas they are much less apparent in the Gypsy Cuckoo Bumble Bee (Williams *et al.* 2014).

In North America, the taxon was formerly referred to as *Bombus ashtoni* (Ashton's Bumble Bee) but is now considered to be conspecific with the Old World species *Bombus bohemicus* (Cameron *et al.* 2007; Williams *et al.* 2014; Williams 2018).

3.2 Species Population and Distribution

The Gypsy Cuckoo Bumble Bee occurs throughout most of northern Europe, parts of north and central Asia,and across northern North America from Alaska to Newfoundland and Labrador; and south to Washington State, Montana and West Virginia (Figure 2). In Canada, the Gypsy Cuckoo Bumble Bee has been recorded in every province and territory except Nunavut (although it likely occurs in the forested but unsampled southwestern corner of that territory). In the late 20th century, it was not rare in Canada, making up about 2-5% of the bumble bees in insect collections across its wide range (COSEWIC 2014a). This percentage is an underestimate of its true relative abundance (i.e. the relative abundance of breeding females) because insect collections contain many worker bumble bees—since cuckoo bumble bees do not have a worker caste, they will appear to be even rarer than they actually are when compared with their hosts.

In North America, the species has now apparently vanished from much of its southern range, and it is this abrupt decline that led to the species being assessed as Endangered by COSEWIC (2014a). Despite inventory efforts in parts of southern Canada (especially in southern Ontario), the most recent confirmed (i.e., specimen) records in southeastern Canada are from Pinery Provincial Park in Ontario (2008); Parc national des Monts-Valin in Québec (2008); 15 sites in the Saguenay, Rivière-Saint Jean, and Anticosti Island regions of Quebec (2000-2007), Whycocomagh and Middleton, Nova Scotia (2002); and Dunks Bay, Oliphant Fen, and Presqu'ile Provincial Park in Ontario (2000) (COSEWIC 2014a; Colla 2017). Limited survey work has been undertaken in the boreal regions of central and eastern Canada since 2008; as such, information about the species' presence in these areas is lacking. Given that much of the habitat in these areas remains relatively undisturbed (e.g., in the vicinity of the 2000-2008 records from the Saguenay and Rivière St. Jean regions of Québec), it is possible that the species persists and even thrives in some areas. However, if the declines are the result of foreign pathogens spreading through host populations, the appearance of natural habitat is not necessarily a reliable indicator of persistence. A 2020 photographic record of a probable Gypsy Cuckoo Bumble Bee at Mont-Joli, Quebec indicates that the species likely persists along the south shore of the St. Lawrence (iNaturalist 2020), and recent records in Maine within 3 km of the Canada-U.S. border (L. Richardson, pers. comm. 2019) indicate that the Gypsy Cuckoo Bumble Bee may still persist in parts of adjacent New Brunswick.

Because the major declines in the Gypsy Cuckoo Bumble Bee occurred from about 1995 to about 2010 (National Research Council (NRC) 2007; COSEWIC 2014a), records from 2010 and later are believed to represent populations that are still extant, and are treated as such in this document. Records from sites where no recent records exist represent populations that are either extirpated or of unknown status. In remote

parts of the country these populations are probably extant, but in the south it is difficult to distinguish between these two last options without further inventory.

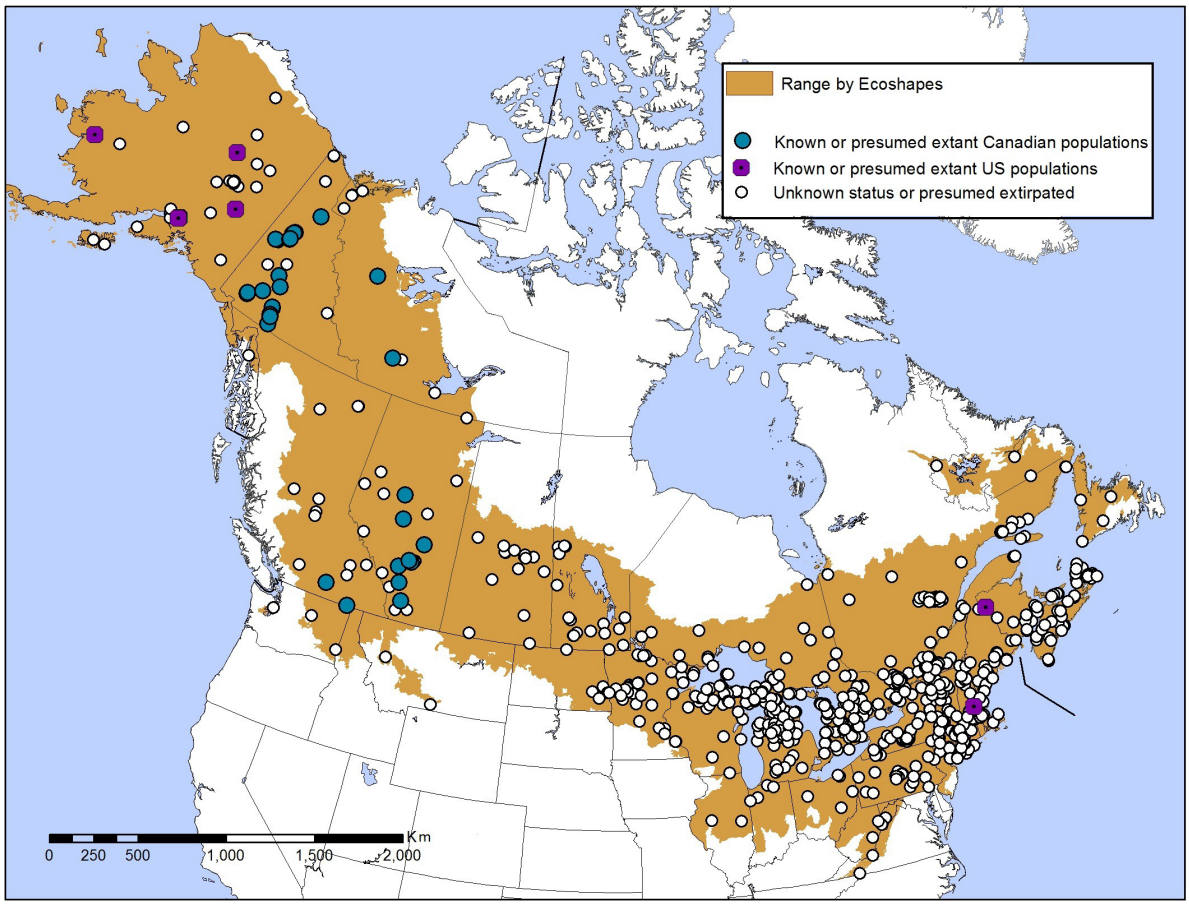

Figure 2. The distribution of Gypsy Cuckoo Bumble Bee in North America, as of 2019. Solid blue circles: Canadian occurrences where the species is presumed to be extant (i.e., records from 2010 and later). Purple squares with dot centres: U.S. occurrences where the species is presumed to be extant. White circles: occurrences where the species' status is unknown or presumed extirpated. Range depicted using the Ecosystem-based Automated Range (EBAR) mapping method, where a mosaic of ecological regions or districts (called ecoshapes) are symbolised based on documented location data and modified by documented expert knowledge. Northern limit of range uncertain, especially in central Canada. Data from L. Richardson; map created by S. Carrière and modified by S. Cannings (15 July 2019).

Since the COSEWIC assessment (COSEWIC 2014a), the Gypsy Cuckoo Bumble Bee has been recorded regularly in the Yukon (S. Cannings, J. Heron, and P. Rasmont, unpubl. data) and Alberta (Best *et al.* 2018a; Best *et al.* 2018b; Prescott *et al.* 2019). Although it is widespread in Alberta, it is apparently rare there, at least within agricultural landscapes (Best *et al.* 2018b). It has also been recorded recently in the Northwest Territories (2017 and 2018) and in southern British Columbia (2017 and 2018) (Figure 2) (Best 2018, J. Heron pers. comm. 2019). There is an additional record

(as *B. ashtoni*) from Ivvavik National Park in the northern Yukon from 2009 that was not included in the COSEWIC (2014a) report. Finally, there are two photographs of bumble bees in central Alberta, one in southeastern Quebec, and one in the southern Yukon that are believed to be Gypsy Cuckoo Bumble Bees, but these records are not substantiated with specimens and therefore are not included in Figure 2 and Table 2 (BugGuide 2018; iNaturalist 2020). The summary below (Table 2) lists the known or presumed extant subpopulations in Canada.

Observations in northern Maine in 2017 and 2018, and in New Hampshire in 2010 (Figure 2; McFarland *et al.* 2016; L. Richardson pers. comm. 2019) suggest that the species may still be extant in New Brunswick and other parts of southeastern Canada.

Table 2. Summary of presumed extant Gypsy Cuckoo Bumble Bee subpopulations in Canada. These are defined by specimen records from 2014-2019, and depicted in Figure 2 as dark blue dots. In cases where the records are less than 20 km apart, they have been merged into one subpopulation. This distance was chosen based on the presumed maximum dispersal distance of female bumble bees (Lepais *et al.* 2010).

Province/ Territory	Subpopulation	Last Observation
AB	Baptiste Lake	2018
AB	Calgary, Canyon Meadows	2018
AB	Camrose	2018
AB	Claresholm	2018
AB	Faust	2018
AB	Harmattan	2018
AB	Red Deer, southeast (2 sites in Figure 2)	2018
BC	Kelowna, South Mission	2017
BC	Pend d'Oreille Valley	2018
NT	Norman Wells	2017
NT	Fort Simpson	2018
YT	Aishihik Road, km 95	2019
YT	Dawson (2 sites in Figure 2)	2018
YT	Eagle Plains Lodge	2017
YT	Emerald Lake	2017
YT	Fox Lake (2 sites in Figure 2)	2017
YT	Frenchman Lake	2017
YT	Kluane Lake (3 sites in Figure 2)	2016
YT	Lhútsäw Lake	2017
YT	Stewart Crossing	2014
YT	Tombstone Territorial Park, Blackstone River (4 sites in Figure 2)	2017
YT	Tombstone Territorial Park, North Fork Pass (2 sites in Figure 2)	2018
YT	Whitehorse (3 sites in Figure 2)	2019

3.3 Needs of the species

The recovery of Gypsy Cuckoo Bumble Bee in Canada depends on meeting the species' needs for survival of individuals, reproduction, foraging, dispersal, and overwintering.

Gypsy Cuckoo Bumble Bees have specific needs for successful reproduction. They are obligate social parasites; the females must invade nests of host bumble bee species and employ the host workers to rear their own offspring (Fisher 1984; Suhonen *et al.* 2015; Lhomme and Hines 2018). Timing of the takeover is important—colonies with more workers put up more resistance by workers; if the nest contains more than 30 workers, the success rate drops to well below 50% (Fisher 1984). If the takeover occurs too early, too few workers will be available to successfully rear the cuckoo bee's young. Host bumble bee nests typically occur in abandoned underground rodent and rabbit burrows, and rotten logs. Host nests are parasitized by Gypsy Cuckoo Bumble Bee in the late spring or early summer.

The host species of the Gypsy Cuckoo Bumble Bee are all in the subgenus *Bombus*. In eastern North America it parasitizes the nests of Rusty-patched Bumble Bee (*B. affinis*) and the Yellow-banded Bumble Bee (*B. terricola*). In the west its hosts are not confirmed, but presumed to include the Western Bumble Bee (*B. occidentalis*) and the Cryptic Bumble Bee (*B. cryptarum*) (COSEWIC 2010; 2014a, b; 2015; Lhomme and Hines 2018). Figure 3 shows the North American range of these hosts. The primary need of the Gypsy Cuckoo Bumble Bee is viable populations of these hosts, presumably at densities great enough to enable successful parasitism.

The Gypsy Cuckoo Bumble Bee and their host bee species require suitable habitat for foraging, although these needs are not thought to be particularly restrictive. They and their hosts occur in a wide range of habitats, including open meadows, mixed farmlands, urban areas, boreal woodlands, taiga, and montane meadows (COSEWIC 2014a). In areas of intensive agriculture in central Alberta, this species frequents the edges of wetlands (Best *et al.* 2018b). The Gypsy Cuckoo Bumble Bee and its host bee species require an abundant supply of pollen and nectar sources throughout their active season, from late spring through late summer (Goulson 2010). They feed on pollen and nectar from a wide variety of plants (see Appendix A for a few examples). Many of the flowers used are considered invasive or exotic weeds in disturbed habitats (e.g., White Sweet-clover, *Melilotus alba*; Common Dandelion, *Taraxacum officinale*; White Clover, *Trifolium repens*). Geographic availability of floral resources within home range areas may vary both within and among years (e.g., blueberries may have abundant blooms one spring, but not the next). Given this variability, these species require a variety of floral sources at a landscape scale. The host bee species are short-tongued, so they require relatively shallow flowers for pollen gathering, but can rob nectar from deeper flowers by chewing through the corolla (Evans *et al*. 2008).

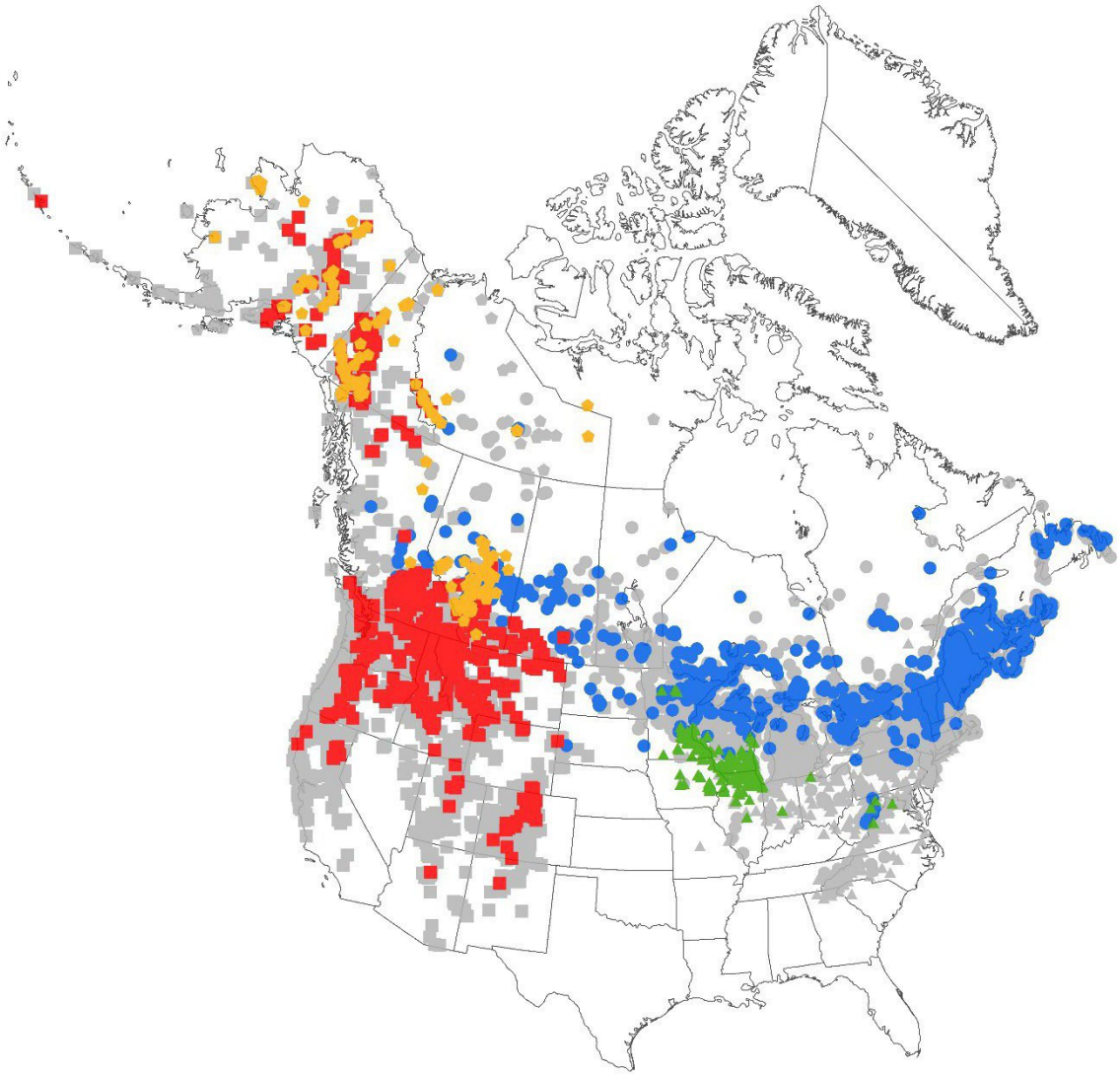

Figure 3. The North American distribution of the hosts of Gypsy Cuckoo Bumble Bee. Recent records (2010 and later) are coloured: (green triangles: Rusty-patched Bumble Bee, blue dots: Yellow-banded Bumble Bee, red squares: Western Bumble Bee, and yellow pentagons: Cryptic Bumble Bee) in North America. Grey shapes represent records from 2009 and earlier. Sampling in the northern portions of the range has been scanty so that the status of populations represented by older records there is uncertain. Map created by L. Richardson (7 October 2019).

In the late summer and early autumn (late July in the Yukon, mid-August in southern regions), Gypsy Cuckoo Bumble Bee females and males emerge from the host nest and leave to find mates (S. Cannings, unpublished data; C. Sheffield pers. comm.). Mated females of both the Gypsy Cuckoo Bumble Bee and their host species disperse to select an overwintering site, travelling an unknown distance to do so. Like other bumble

bees, Gypsy Cuckoo Bumble Bee males die at the onset of cold weather, as do the queens of the previous summer (COSEWIC 2014a; Williams *et al.* 2014).

Overwintering habitat requirements of Gypsy Cuckoo Bumble Bee and host females are unknown but in general, bumble bees overwinter in the ground, in mulch or other decomposing vegetation, and in rotting logs near nesting sites (Macfarlane 1974). Females do not survive more than one winter so there is no overwintering site fidelity by individuals.

Gypsy Cuckoo Bumble Bee females emerge from overwintering sites later in the spring than their host bumble bees, and search for potential host nests that are already active (COSEWIC 2014a). Studies have estimated that queens of most bumble bee species can usually disperse at least 3-5 kilometres, but rarely travel more than 10 km to nest (or, in the case of cuckoo bumble bees, locate a target nest for parasitism; Lepais *et al*. 2010).

A summary of the essential functions, features, and attributes required by Gypsy Cuckoo Bumble Bee in different life stages is summarized below (Table 3). Note that because the Gypsy Cuckoo Bumble Bee is dependent on healthy populations of hosts, which are in turn generalist, wide-ranging foragers in a variety of open habitats, and because the females of both host and parasite disperse every spring and fall to nesting and overwintering sites, this species has large-scale habitat needs that are only met at a scale of tens or hundreds of square kilometres, or more.

Table 3. Summary of essential functions, features, and attributes required by Gypsy Cuckoo Bumble Bee in different life stages.

Life stage	Function	Biophysical Features	Attributes
Adults, eggs, larvae, pupae	Reproduction: • infiltrating host nest • egg-laying • care of developing young	Host bumble bee nests • Active season is May through September in southern Canada, mid-May through mid-August north of 60°N Nests will be abandoned following active season (all bees have permanently left or have died)	• rodent (e.g. vole, groundsquirrel) or rabbit burrows • rotting stumps or fallen dead wood
Larvae, reproductive adults	• foraging: nutrition for larval provisions, adults and host bumble bee workers • mating: finding mates • dispersal: to and	Open areas including but not limited to: open woodland, shrubland, savanna, prairie, subalpine meadows, taiga, shrub tundra, marshes, peatlands, dunes, old fields and	• presence of suitable flowering plants throughout the active season (see above); (see Appendix A for examples of plant species) • low toxicity

	from host nest and hibernation site	meadows, gardens, berry farms, orchards, and vegetated road verges and utility corridors	(absence or acceptable levels of pesticides) • low pathogen load (absence or low levels of pathogens from commercially-raised bumble bees and honey bees)

4. Threats

4.1 Threat Assessment

The Gypsy Cuckoo Bumble Bee threat assessment (Table 4) is based on the International Union for Conservation of Nature-Conservation Measures Partnership (2006) (IUCN-CMP) threats classification system (Salafsky *et al.* 2008; Master *et al.* 2009).

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). In these calculations, Limiting factors (factors that may limit population growth or spread, but do not cause declines) are not considered during this assessment process. For purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

The calculated overall threat impact for Gypsy Cuckoo Bumble Bee is Medium. Only direct threats to the Gypsy Cuckoo Bumble Bee are scored; the greatest threat to this species is the decline in its host bumble bees, and this is scored in “7.3 Other Ecosystem Modifications” in Table 4. Because the Gypsy Cuckoo Bumble Bee does not have foraging workers, some serious threats to its hosts do not directly impact it to the same degree (for example, exposure to pathogens transferred from managed bees, pesticides, etc.). However, these indirect threats to Gypsy Cuckoo Bumblee Bee need to be addressed in order to recover the host species, which will in turn aid the recovery of Gypsy Cuckoo Bumblee Bee.

611
612 **Table 4.** Threat calculator assessment for Gypsy Cuckoo Bumble Bee in Canada (25 September 2018, Gypsy Cuckoo
613 Bumble Bee technical group). Threats are scored as to how they directly impact the Gypsy Cuckoo Bumble Bee. The
614 greatest direct threat is the decline of its hosts, which is scored in Threat 7.3 only. Note that the direct threats to the hosts
615 are considered to be indirect threats to the Gypsy Cuckoo Bumble Bee; these are not scored, but are summarized in the
616 Detailed Threats column.

Threat	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
1	Residential & commercial development	Negligible	Negligible	Slight	High	Most of species' range is not experiencing urban development; however, cumulative impacts of housing and industrial development surrounding the urban centres can result in complete loss of local habitat. See Threat 7.3 for the impact of this Threat on the host species.
1.1	Housing & urban areas	Negligible	Negligible	Slight	High	Urbanization has the potential for greatly reducing floral resources, although bee-friendly green spaces mayallow bees to still live within cities. Host bumble bees require large amounts of pollen over a long period of time, as reproductives for the next generation are only produced towards the end of the colonycycle. See Threat 7.3 for the impact of this Threat on the host species.
1.2	Commercial & industrial areas	Negligible	Negligible	Slight	High	As above.
1.3	Tourism & recreation areas	Negligible	Negligible	Negligible	High	Some types of recreational development could cause important elements of habitat to be lost, though other developments can be beneficial to pollinators.

Threat	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
2	Agriculture & aquaculture	Negligible	Negligible	Slight	High	Habitat loss as a result of agricultural expansion and intensification. Certain types of development can have positive effects, but although there are agricultural crops where bees are abundant and widespread (e.g. flowering berries and tree fruits), these maynot support bumble bees through the season without surrounding diverse hedgerows and meadows. See Threat 7.3 for the impact of this Threat on the host species.
2.1	Annual & perennial non-timber crops	Negligible	Negligible	Slight	High	See Threat 7.3 for the impact of this Threat on the host species. Cropland in Canada has increased overall, and the increased reliance on intensive agriculture (decreased 'edge meadows' around planted fields) over the past few decades has reduced foraging habitat for bumble bees. Small parts of the Canadian range of Gypsy Cuckoo Bumble Bee (although potentiallythe most suitable) contain some of the most intensivelyfarmed regions of Canada.
3	Energy production & mining	Negligible	Negligible	Extreme	High	See 3.1
3.1	Oil & gas drilling	Negligible	Negligible	Extreme	High	Large-scale extraction in oil sands of northern Alberta destroys habitat, but is negligible in scope relative to this species' Canadian range.
4	Transportation & service corridors	Negligible	Negligible	Negligible	High	Large portions of this species' range are relatively undisturbed, where road building and utility/service lines are not planned. In many cases transportation corridors mayimprove habitat for bees.
4.1	Roads & railroads	Negligible	Negligible	Negliglible	High	Increased direct mortalitydue to bee collisions with cars, but potential benefit from increased production of roadside weeds.
6	Human intrusions & disturbance	Negligible	Negligible	Negligible	High	Large portions of the species' range are relatively undisturbed.
6.1	Recreational activities	Negligible	Negligible	Negligible	High	Some recreational activies mayreduce floral resources.

Threat	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
7	Natural system modifications	Medium	Restricted	Extreme	High	The primarythreat to this species is the human-caused, continued decline of host species in southern portion of range.
7.1	Fire & fire suppression	Negligible	Small	Negligible	High	The impacts of fire on bee abundance can be detrimental in short term but opening of habitat can be beneficial in medium-longer term. Fire suppression can be detrimental in longer term.
7.3	Other ecosystem modifications	Medium	Restricted	Extreme	High	Host bees are declining in the southern portion of their ranges, or approximately one-third of the Canadian range of Gypsy Cuckoo Bumble Bee. These declines are the direct and cumulative result of a number of threats, including Threats 1.1, 1.2, 2.1, 8.1, 8.2, and 9.3.See the Description of Threats section for further details.
8	Invasive & other problematic species & genes	Unknown	Restricted	Unknown	High	Perhaps primarilya threat to hosts; unknown severity for Gypsy Cuckoo Bumble Bee.
8.1	Invasive non-native/alien species	Unknown	Restricted	Unknown	High	These threats impact the Gypsy Cuckoo Bumble Bee largely through declines in host species. See Threat 7.3 for the impact of this Threat on the host species. Unknown direct impact for Gypsy Cuckoo Bumble Bee; however, the use of managed bumble bee colonies for pollination services in greenhouses results in the transfer of novel (introduced) pathogens and/or increased loads of native pathogens to host species, which carry particularlyhigh pathogen loads. In western Canada, the Common Eastern Bumble Bee has escaped its greenhouse colonies and established wild populations, competing with native bee species for nesting habitat or forage resources. Honey Bees compete directlywith bumble bees for scarce pollen and nectar resources, and also transfer pathogens to bumble bees.
8.2	Problematic native species	Unknown	Restricted	Unknown	High	Managed Common Eastern Bumble Bee colonies in the east can result in transfer of native pathogens to wild bees (see above).

Threat	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
9	Pollution	Low	Small	Moderate	High	See Threat 7.3 for the impact of this Threat on the host species. See below.
9.3	Agricultural & forestry effluents	Low	Small	Moderate	High	Insecticides can be directlydetrimental. Herbicides reduce floral resources for all bees. Fungicide effects unknown, but implicated in increasing susceptibilityof host bumble bees to pathogens. Gypsy Cuckoo Bumble Bee is primarilyimpacted by this threat through declines in hosts. See Threat 7.3 for the impact of this Threat on the host species.
11	Climate change & severe weather	Medium-Low	Restricted-Small	Extreme-Moderate	High	Primarilya decline in climate envelope along southern edge of its range.
11.1	Habitat shifting & alteration	Medium-Low	Restricted-Small	Extreme-Moderate	High	The Gypsy Cuckoo Bumble Bee faces challenges to shifting climatic regimes, but also is vulnerable to the effects of shifting climatic regimes on its host species and their nest timing.
11.2	Droughts	Unknown	Unknown	Moderate-Slight	High	Drought affects timing and availability of floral resources.
11.3	Temperature extremes	Low	Restricted-Small	Slight	High	Bumble bees are very susceptible to the effects of extreme summer heat.
11.4	Storms & flooding	Unknown	Unknown	Unknown	Unknown	Increased spring storms are predicted in some climate change scenarios, and these maylocally prevent host queens from establishing colonies.

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2 Description of Threats

Gypsy Cuckoo Bumble Bee is thought to be impacted by four primary threats (Table 4 above): natural system modifications (host bee declines), climate change and severe weather (habitat shifting and alteration, temperature extremes), pollution (agricultural and silvicultural pesticides), and invasive non-native/alien species (pathogen spillover from greenhouse bumble bees, and probably to a lesser extent, competition with introduced bumble bees and Honey Bees).

It is important to note that although indirect threats are not normally highlighted in recovery strategies, the threats to the Gypsy Cuckoo Bumble Bee's host species are essential to consider when planning for its recovery. The declines in host species are the cumulative result of several threats, which are accounted for in the "Natural System Modifications" (the host bee declines) section below, but detailed in the following sections (Threats 8 and 9). These two threats are central to the definition of "activities likely to result in destruction" of Critical Habitat (Section 7.3), so are presented above Threat 11 (Climate Change and Severe Weather).

It should also be emphasized that because the impacts of some of these threats vary greatly across the range of this widely-distributed bee, and because the assessment is made at a range-wide scale, the impacts can be significantly higher in some regions than the overall assessment indicates.

Natural System Modifications (Threat 7)

Other ecosystem modifications (7.3)

The most significant, direct threat to the Gypsy Cuckoo Bumble Bee is the continuing decline of three of its host bumble bee species: the Rusty-patched Bumble Bee (listed as Endangered under the *Species at Risk Act*), the Yellow-banded Bumble Bee (listed as Special Concern), and the Western Bumble Bee (not yet listed; the southern subspecies *B. o. occidentalis* assessed as Threatened; the northwestern subspecies *B. o. mckayi* assessed as Special Concern) (COSEWIC 2010; 2014b; 2015). The Cryptic Bumble Bee has not been assessed by COSEWIC but showns no apparent decline (Owen *et al*. 2012) and has a national conservation status ranking of Secure (Canadian Endangered Species Conservation Council 2016).

In North America, the rapid decline of members of the subgenus *Bombus* appears to have begun in the early to mid-1990s (National Research Council [NRC] 2007, COSEWIC 2010, 2014b, 2015).

Host bumble bee declines in North America have occurred in approximately one-third of the Canadian range of Gypsy Cuckoo Bumble Bee (COSEWIC 2014b; COSEWIC 2015); local Gypsy Cuckoo Bumble Bee extirpations in southern areas of its range are associated with declining host bumble bee densities (COSEWIC 2014a; Colla 2017). Conversely, the Gypsy Cuckoo Bumble Bee is still present in areas of western Canada where its host species are still relatively common.

Invasive and Other Problematic Species and Genes (Threat 8)

Invasive non-native/alien species (8.1) and Problematic native species (8.2)

The introduction and/or spread of pathogens from commercially-raised bumble bees and Honey Bees, and the accidental release of non-native bumble bees are direct, serious threats to the hosts of the Gypsy Cuckoo Bumble Bee. However, their direct effects on the Gypsy Cuckoo Bumble Bee are unknown.

Parasites and pathogens of bumble bees

The prevalence of the microsporidian[4] pathogen *Nosema bombi* in North American bumble bees increased dramatically from low detectable frequency in the 1980s to significantly higher frequency in the mid- to late-1990s, corresponding to a period of reported massive infectious outbreak of *N. bombi* in commercial bumble bee rearing stocks in North America (Cameron *et al.* 2016). Although *N. bombi* is native to North America, it has been postulated that a novel strain was imported from Europe about this time; however genetic evidence to date does not support this (Cameron *et al.* 2016; Brown 2017).

Studies have shown the parasites *Crithidia bombi* and *N. bombi* can have a potentially devastating effect on bumble bee colonies (Brown *et al.* 2000, 2003; Otterstatter *et al.* 2005; Otti and Schmid-Hempel 2007, 2008; van der Steen 2008). These parasites are found in a variety of bumble bee species (Macfarlane 1974; Macfarlane *et al.* 1995; Colla *et al.* 2006). However, microsporidian infection rates and intensities were significantly higher in declining populations of the Gypsy Cuckoo Bumble Bee's hosts than they were in bumble bees with stable populations (Cameron *et al*. 2011). A recent genetic study of the host Yellow-banded Bumble Bee revealed gene activation that indicated possible "novel pathogen pressures" (Kent *et al.* 2018).

Three factors—the rapid rise microsporidian infection in commercial bumble bees, the coincident decline in the hosts of the Gypsy Cuckoo Bumble Bee, and the fact that these pathogens are more prevalent in these hosts relative to species that are not declining—have together caused pathogen spillover to be cited as one of the primary causes of the declines of the hosts of the Gypsy Cuckoo Bumble Bee (Thorp and Shepherd 2005; COSEWIC 2010; Cameron *et al.* 2011; Szabo *et al.* 2012; Graystock *et al.* 2016; all cited in Colla 2017; Arbetman *et al.* 2017). Pathogen spillover occurs when managed populations of bees introduce pathogens to wild populations or amplify pathogens (spillback) that may have been naturally in lower abundances (Power and Mitchell 2004; Graystock *et al.* 2016). The use of infected commercial bumble bees in Canada for greenhouse pollination is known to cause pathogen spillover into populations of wild bumble bees foraging nearby (Colla *et al.* 2006; Otterstatter and Thomson 2008).There are no data, however, on the direct effects of pathogen spillover on cuckoo bumble bees.

[4] Microsporidia are unicellular parasites, now considered to be fungi or closely related to fungi.

Honey Bees as vectors of pathogens and viruses

Honey Bees appear to be another vector for the transmission of pathogens to wild bumble bees. Graystock *et al.* (2014) showed that, in Great Britain, the prevalence of *C. bombi* was 18% greater in bumble bees near an apiary than in those farther away from it. There is also increasing evidence that a number of Honey Bee pathogens are transferable to bumble bees (Plischuk *et al*. 2009; Meeus *et al.* 2011; Peng *et al.* 2011; Graystock *et al.* 2013). Under controlled conditions, *N. ceranae*, a common parasite of Honey Bees, produced fewer spores in bumble bees than in Honey Bees but exhibited greater virulence, reducing survival by 48% and having negative effects on behaviour (Graystock *et al*. 2013). The potential impact of Honey Bees as vectors is unknown in Canada.

Honey Bees that are infected with *Deformed wing virus* through the Varroa Mite (*Varroa destructor)* during pupal stages develop into adults showing wing and other morphological deformities. Researchers in Germany and the United Kingdom have found this Honey Bee virus in deformed individuals of *Bombus terrestris* and *B. pascuorum* (Genersch *et al.* 2005; Fürst *et al.* 2014) and further work has shown that the Varroa Mite drives *Deformed wing virus* infection intensity in Honey Bees and sympatric bumble bees (Manley *et al.* 2019). Because *V. destructor* is widespread in Canada (Ontario Ministry of Agriculture, Food and Rural Affairs 2019), this disease therefore poses a serious potential threat to bumble bee populations there.

Competition with Honey Bees

Honey Bees also compete directly with bumble bees for scarce pollen and nectar resources. Pollen can be a limiting resource; in the absence of Honey Bees, native bees can remove 97-99% of the available pollen daily (Schlindwein *et al.* 2005, Larsson and Franzen 2007). One standard apiary of 40 Honey Bee colonies can remove 400 kg of pollen during three summer months in wildlands (Winston 1987; Seeley 1995; Cane and Tepedino 2016). Cane and Tepedino (2016) point out that this amount of pollen would produce 4 million (range 3.7-12 million) individuals of an average leafcutter bee (*Megachile rotunda*). Henry and Rodet (2018) found that high-density beekeeping (greater than 14 colonies/km^2) triggers foraging competition that depresses both the occurrence (−55%) and nectar foraging success (−50%) of local wild bees. However, Mallinger *et al.* (2018) caution that more competition studies that include measures of wild bee reproductive success are needed to quantify ongoing effects.

Competition with exotic bumble bees

The introduction and use of the Common Eastern Bumble Bee (*B. impatiens*) for pollination services in Canada may further impact declining host populations of Western Bumble Bee and Yellow-banded Bumble Bee in the southern parts of their range. The Common Eastern Bumble Bee may out-compete some native bee species for nesting habitat or forage resources, and may serve as a source for pathogens or diseases. The establishment of wild populations of Common Eastern Bumble Bee in western Canada has likely had a negative impact on native species, as has been documented in other parts of the world (Williams and Osborne 2009). It is now believed to be established in Greater Vancouver and the Fraser Valley of British Columbia (C. Sheffield, pers. comm.

2018); there are numerous photographic records from that region (including a mating pair) on Bumble Bee Watch (2018) and on iNaturalist (2020).

Pollution (Threat 9)

Agricultural and forestry effluents (9.3)

It has long been known that pesticides can have negative impacts on bees (e.g., Johansen and Mayer 1990; NRC 2007). Although the recent focus has largely been on neonicotinoid insecticides, other insecticides, herbicides and fungicides have also been tied to bumble bee declines (see more detailed discussion below). The queens and workers of the hosts of Gypsy Cuckoo Bumble Bees are exposed to pesticides while they forage and while they burrow into the soil to expand nest sites. Cuckoo bumble bees have less exposure to pesticides than do their hosts, but would still contact them during foraging, nest searching, and hibernation.

Neonicotinoid insecticides

Around the time when the declines of bumble bees in the subgenus *Bombus* were observed in North America, the neonicotinoid insecticide imidacloprid was registered for use in the United States and Canada (1994 and 1995 respectively: Cox 2001). Neonicotinoids can pose a particularly severe threat to bees because they can be harmful even at concentrations in the parts-per-billion (ppb) range (Marletto *et al.* 2003). These pesticides are systemic, travelling throughout plant tissues and integrating with pollen and nectar. They are routinely used on golf courses and agricultural lands (Sur and Stork 2003). They are also used prophylactically; that is, they are being applied even if there is no apparent insect outbreak needing attention (van der Sluijs *et al*. 2014). Recent research in Quebec showed that prophylactic neonicotinoid seed treatments in field crops are useful in less than 5% of cases, and that integrated pest management solutions would be much more effective tools for producers (Labrie *et al.* 2020). In 2012 in the Canadian Prairie Provinces, neonicotinoids were applied on about 11 million hectares (44% of the cropland). At present, most application is via a seed coating, but application on foliage also occurs.

The effects of imidacloprid are not lethal to individual bumble bees when used as directed (e.g., Tasei *et al.* 2001), and this allowed them to be registered for use. But colonial insects such as bumble bees can be negatively impacted by cumulative sublethal effects of this and other pesticides. In fact, recent studies have shown that chronic (i.e. 1-4 weeks) exposure to neonicotinoid pesticides can have significant sub-lethal effects on bumble bees at field-realistic exposure levels (Pisa *et al.* 2014; van der Sluijs *et al*. 2014; Crall *et al*. 2018; Raine 2018): bees suffered impaired learning and short-term memory (Stanley *et al.* 2015a); decreased foraging performance (Mommaerts *et al.* 2010; Feltham *et al.* 2014; Gill and Raine 2014; Stanley *et al.* 2015b; Stanley *et al.* 2016;); reduced queen production (Whitehorn *et al.* 2012); and ultimately, colony failure (Bryden *et al.* 2013).

Other neonicotinoids such as thiamethoxam and clothianidin also have effects on bumble bees, although these effects are not identical. Moffat *et al.* (2016) found that

both thiamethoxam and imidacloprid reduced “colony strength” (number of live bees, number of brood cells), but clothiandin did not. However, although Arce *et al*. (2017) found only subtle effects by clothianidin on worker behaviour, they did find reduced numbers of adult bees at colonies exposed to the insecticide.

One would expect that host bumble bees (both queens and workers) would be more affected through chronic exposure than cuckoo bumble bees, but there has been no research on cuckoo bumble bees in this regard.

Neonicotinoid exposure in concert with other threats can also have significant deleterious results. In a study on *Bombus impatiens*, imidacloprid exposure followed by an immune challenge significantly decreased survival probability relative to control bees (Czerwinski and Sadd 2017).

The effects of neonicotinoids on pollinators have been reviewed by Health Canada’s Pest Management Regulatory Agency (PMRA) and three re-evaluation decisions for thimethoxam, clothianidin, and imidacloprid were released in April 2019 (Health Canada 2019a, 2019b, 2019c); the detailed regulation changes can be found in the cited documents. A summary is provided as well (Health Canada 2020). In general, application of these neonicotinoids will be cancelled or restricted for certain uses, especially those related to foliar or soil applications on fruits, nuts, ornamentals, and outdoor-grown fruiting vegetables; cereal and legume seed-treatment uses will receive additional label instructions only. The required mitigation measures must be implemented on all product labels no later than 11 April 2021 (Health Canada 2020). Further regulation changes were made in re-evaluation decisions made in the spring of 2021 (Health Canada 2021a, 2021b, 2021c). In general, application of these neonicotinoids will be cancelled or restricted for certain uses, especially those related to foliar or soil applications on fruits, nuts, ornamentals, and outdoor-grown fruiting vegetables; and some corn and legume seed-treatments. Other uses will receive additional label instructions. The changes made in the 2021 re-evaluations will take effect in the spring of 2023.

These new regulations from PMRA will thus reduce, but not end the use of neonicotinoid pesticides (and their threats to bumble bees) in Canada.
In 2015, Ontario brought in new regulations designed to reduce the acreage planted with neonicotinoid-treated corn and soybean seed by 80% by 2017. By 2018, however, reductions of only 37.5% relative to 2014 had been achieved (Ont ario Ministry of the Environment, Conservation and Parks 2019; Raine, pers. comm. 2019).

Other insecticides
Sulfoxamine-based insecticides are the most likely successors to neonicotinoids, but there are few studies into their sub-lethal effects on pollinators. A recent study, however, found that bumble bee colonies exposed to sulfoxaflor produced significantly fewer workers than unexposed controls, and ultimately produced fewer reproductive offspring (Siviter *et al.* 2018).

Chlorantraniliprole is another insecticide recently approved for use in Canada as a seed treatment of corn that will at least partially replace the use of neonicotinoid insecticides. Although Health Canada (2016) determined that as a seed coat it presented a "negligible risk to … bees," research has shown that low-level, chronic oral exposure via pollen induced lethargic behaviour in bumble bee workers and drones (Smagghe *et al.* 2013).

Tebufenozide is an insect growth regulator insecticide used for spruce budworm control in eastern Canada. Studies on Honey Bees found that those treated with field-realistic dosages of tebufenozide did not learn as well as untreated bees (Abramson *et al.* 2004). However, Smagghe *et al.* (2007) found no negative effects of tebufenozide on adult survival, nest reproduction, and larval growth in *Bombus terrestris*.

Herbicides

The use of glyphosate as a broad-spectrum, systemic herbicide has increased 15-fold since the mid-1990s, when genetically-engineered herbicide-tolerant crops were introduced (Benbrook 2016). In Canada, the great majority of canola, soybean, and corn crops are now planted with genetically-engineered herbicide-tolerant varieties (Wilson 2012). Generally considered to have low toxicity to terrestrial insects, there are indications that glyphosate may have sub-lethal effects on bees (Helmer *et al.* 2014; Herbert *et al.* 2014; Balbuena *et al*. 2015; Vázquez 2018) and may increase susceptibility to infection by pathogens (Motta *et al*. 2018).

More importantly, however, the intensive and extensive use of glyphosate and other herbicides has resulted in a great reduction in floral resources in treated landscapes (Boutin *et al.* 2014; Bohnenblust *et al.* 2016), and has thus likely contributed to reduced bumble bee colony and reproductive success. In the prairie provinces, over 30% of agricultural land was treated with herbicides in 2011 (Agriculture and Agri-foods Canada 2016). Because of increased genetic resistance to glyphosate and the lack of new herbicides, Health Canada and the Canadian Food Inspection Agency have recently approved new genetically engineered crops that are resistant to other herbicides already in use: for example, 2,4-D and dicamba (Canadian Biotechnology Action Network 2018).

In Canada, an average of 116,000 hectares of publicly-owned forest lands are treated with glyphosate herbicides annually; when the area of privately-owned forest lands are considered, the total area treated may be closer to 150,000 ha/yr, about one-third of the area cut (ForestInfo.ca 2018). Quebec banned the use of herbicides in forests in 2001. The use of glyphosate in Alberta silviculture has been increasing (Thompson and Pitt 2011). There is no use of herbicides for forestry north of 60°N (National Forestry Database 2019).

Fungicides

There is increasing evidence suggesting that fungicides may have detrimental effects on bees. Pettis *et al.* (2013) found that 100% of Honey Bee-collected pollen in agricultural landscapes contained fungicide residue, and Bernauer *et al.* (2015)

demonstrated that colonies of the Common Eastern Bumble Bee (*Bombus impatiens*) produced fewer workers, less bee biomass, and had smaller mother queens following exposure to chlorothalonil, a widely used fungicide on crop and ornamental plants. Fungicides also interact with other bumble bee threats; in fact, a study by McArt *et al.* (2017) found that greater use of chlorothalonil in the landscape was the strongest predictor of the prevalence of the pathogen *Nosema bombi* in four declining bumble bee species, including the Yellow-banded Bumble Bee.

Climate Change and Severe Weather (Threat 11)

Climate change is a threat to bumble bees worldwide (Williams and Osborne 2009). Bumble bee species with narrow climatic tolerances are shown to be more vulnerable to extrinsic threats (Williams *et al.* 2009). Although the Gypsy Cuckoo Bumble Bee is the most common cuckoo bumble bee in Europe, climate change scenarios modelled by Rasmont *et al.* (2015b) predict that its climatic niche there will decline by 45 to 79% by the end of this century. Rasmont *et al.* (2015b) also note that it is a specialized nest parasite of hosts that have apparently low dispersal ability.

In general, bumble bees are cool-adapted species that live in temperate areas. Kerr *et al.* (2015) assembled long-term bumble bee data for Europe and North America and showed that, as climate warms, bumble bees are disappearing from the southern edges of their ranges but not correspondingly shifting northward at the northern edges. These effects were independent of changing land uses or pesticide applications. Across a range of climate change scenarios and assumptions about the capacities of bumble bees to disperse into new areas, range declines are expected to continue and even to accelerate among North American bumble bees (Sirois-Delisle and Kerr 2018). Rasmont and Iserbyt (2012) attribute some declines in European bumble bees to increasing occurrences of extreme heat waves.

In general, female cuckoo bumble bees emerge approximately one month after the queens of their host species (Plath 1934) so that they can take over host colonies with workers already in place, but it is unknown if emergence synchrony of host/parasite will be affected by climate change. If it is, this could have a major impact on the Gypsy Cuckoo Bumble Bee; if it emerges too early, it won't find appropriate nests and if it emerges too late, it won't be able to successfully take over the host colonies.

Although one might think that longer growing seasons might be beneficial to bumble bees, this is not necessarily the case. Ogilvie *et al.* (2017) studied the effects of growing season length in the U.S. Rocky Mountains, and found that longer seasons had a negative effect of interannual abundance of three species of bumble bees. This result was attributed to more days of low flower availability within the longer growing season.

Climate change can also disrupt the phenology of bumble bees during the winter. In areas of moderate winters (e.g. southern England), host bumble bees can become winter-active, especially if autumn temperatures are above normal (Owen *et al.* 2013). Although *Bombus terrestris* (a close relative of the Yellow-banded Bumble Bee) workers

can rapidly adapt to cold winter temperatures while active, they will die if they remain outside the colony overnight when the temperatures fall to about -10°C. This is not anticipated to be a major threat to Gypsy Cuckoo Bumble Bees in Canada, since they are not present in areas with moderate winters (such as the southwest coast of British Columbia).

Negligible Threats

Housing and urban areas (IUCN-CMP Threat #1.1), IUCN-CMP #1.2 Commercial and industrial areas (IUCN-CMP Threat #1.2), and Annual and perennial non-timber crops (IUCN-CMP Threat #2.1).

These threats are scored as negligible only because they occur primarily in a relatively small portion of this species' large range. Habitat loss as a result of urbanization, agricultural expansion, and reduction of non-crop habitats in farmland is a serious threat in parts of southern Canada. Both the Gypsy Cuckoo Bumble Bee and (especially) its host species require large amounts of nectar and pollen over the entire flight season. Over the past few decades, the increasing practice of planting crops to edge of fields, with little or no hedgerows or meadows has resulted in decreased quality foraging habitat for bumble bees globally (e.g., Kosior *et al.* 2007), and probably has had similar impact in Canada, as much of the area traditionally occupied by Gypsy Cuckoo Bumble Bee and its hosts in Canada has changed significantly (Grant and Javorek 2011). Even where intensive crops support bees (e.g. blueberries), these crops generally bloom only for a short time, and bumble bees cannot thrive without a diversity of plants in surrounding areas that bloom through the growing season. The part of the Canadian range of the Gypsy Cuckoo Bumble Bee adjacent to the southern international border contains some of the most highly urbanized and intensively farmed regions of Canada (e.g., southern regions of Ontario, Quebec, Saskatchewan and Manitoba).

Cropland in Canada has increased 6.9% to 93.4 million acres 2011-2016 (roughly 10% of the Canadian range of the Gypsy Cuckoo Bumble Bee (Statistics Canada 2017).

Limiting Factors

Populations of Gypsy Cuckoo Bumble Bees are naturally limited by the density of their hosts. The decline of their hosts is treated above as a threat (Threat 7).

Bumble bees require a constant suite of floral resources to support colony growth: pollen and nectar needs to be available throughout the growing season (Goulson 2010). However, an historical analysis of pollen on host Rusty-patched Bumble Bee specimens suggests that this species' decline was "unlikely to have been driven by spatial or temporal limitations of specific floral species" (Simanonok *et al.* 2020). But without these resources, emerging queens, workers and colony growth (future queen production) are limited. Only mated queens overwinter, so lack of abundant early season floral resources will cause colonies to die, or newly emerged queens to disperse. Abundant food resources throughout the colony growth period ensure that local populations will

thrive. However, food resources are probably not limiting in southern regions where Gypsy Cuckoo Bumble Bee populations have undergone serious declines (because of the effects of pathogens and pesticides on their hosts).

Intrinsic factors triggered by an increasingly small and fragmented population may lead to local extirpation because of the haplodiploid reproductive system of bumble bees. In practical terms, if a bee population decreases to a few reproducing individuals, inbreeding will quickly contribute to further, more rapid declines and the species is certain to become locally extirpated even under stable environmental conditions. (Zayed and Packer 2005; COSEWIC 2014a). A genetic study of the Yellow-banded Bumble Bee in southeastern Canada has shown that it is experiencing inbreeding where its populations have declined, and this may contribute to further declines (Kent *et al.* 2018).

5. Population and Distribution Objectives

Population and Distribution Objective:

- Maintain a stable or increasing population of the Gypsy Cuckoo Bumble Bee within its current range; and

- Restore the Gypsy Cuckoo Bumble Bee within its former range in Canada by regaining its representation in different national ecozones[5], to the extent possible.

Short-term statement toward meeting Population and Distribution Objective:

- Maintain or increase densities of host bumble bees within the current and former range of the Gypsy Cuckoo Bumble Bee by reducing threats to the hosts and by maintaining or increasing current levels of suitable habitat for them.

- Determine the necessity and feasibility of restoring host populations in the Mixedwood Plains Ecozone (e.g., one or more sites in extreme southern Ontario).

Rationale:

The Gypsy Cuckoo Bumble Bee was, until the turn of the last century, a commonly-encountered bee across its wide range (the 'former' range mentioned in the second objective above) in Canada (see Section 3.2 and Figure 2). It is now apparently extirpated or extremely rare in southeastern Canada but still occurs, possibly even at historical abundance, in northwestern Canada. It has been found recently in southern British Columbia and western and central Alberta, but its relative abundance there is low. Its status in the boreal forests of Quebec, Ontario, and the eastern portion of the Prairie Provinces is uncertain because of lack of recent collection data. It may still be extant in some parts of Quebec (where it was collected in the early 2000s and photographed in 2020) and in northwestern New Brunswick (adjacent to recent records

[5] See national ecozone map at: https://biodivcanada.chm-cbd.net/ecosystem-status-trends-2010/technical-report-1?lang=En&n=64217e8d-1#_03_1

from northern Maine). In Southern Ontario, however, high search effort over the past decade has found none.

The Gypsy Cuckoo Bumble Bee was assessed by COSEWIC (in 2014) as Endangered on the basis of an inferred reduction in the total number of mature individuals of greater than 50% over the last 10 years; the reduction and its causes are not clearly understood or known to be reversible[6]. These precipitous declines are primarily attributed to large declines in its host bumble bee species in the south (in particular, Rusty-patched, Yellow-banded, and Western Bumble Bees). Although the precise causes of these declines are not clearly understood, best available information suggests that they resulted from the cumulative effects of a number of factors, including new pathogens and pathogen spillover from managed bumble bees in greenhouses, greatly increased use of pesticides (including new systemic insecticides, herbicides, and fungicides), the effects of climate change, as well as direct loss and degradation of habitat.

For Gypsy Cuckoo Bumble Bee to no longer be at significant risk of extirpation or extinction (on the basis of its assessed COSEWIC criteria), the reduction in total number of mature individuals would need to be stabilized, with no greater than 30% loss over 10 years (based on an index of abundance over its entire Canadian range). This stabilization can be achieved simply by maintaining current levels of available, suitable, habitat in the Yukon, Northwest Territories, and the boreal/montane regions of provinces from Quebec to British Columbia. Maintaining healthy habitat in these areas requires preventing the northward spread of threats, in particular those that impact host bumble bee species (as explained above). There are, however, significant knowledge gaps relating to the current distributions of Gypsy Cuckoo Bumble Bee, as well as its host bumble bee species. It is important to note that the short-term goals will focus on maintaining (or promoting increase) of host bumble bees both in areas where Gypsy Cuckoo Bumble Bee is known or presumed to be extant, and in areas where it is presumed to be extirpated.

In the Objective above, the “current range” refers to the actual range of this species at the present time, even though this is imperfectly known. The current range is a subset of the full range depicted in Figure 2, but it cannot be mapped at this time because the status of the species at the sites represented by white dots is unknown. The population and distribution objective aims to maintain the current representation of Gypsy Cuckoo Bumble Bee within different ecozones in Canada, and where feasible and to the extent possible regain its presence in ecozones in Canada where it is known or suspected to have been lost. It is unlikely that this species will ever be re-established throughout its historic range; the intention here is to regain at least one or more populations in each ecozone that it formerly inhabited. Losses to ecosystem representation are particularly evident in southeastern Canada, where populations are presumed to be extirpated (for example, despite intensive inventory efforts in the vicinity of historical sites in southern Ontario in recent years, no occurrences have been relocated since 2008).

[6] Applicability of COSEWIC Criteria: meets Endangered A2abce (for further details on criteria guidelines refer to https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife/wildlife-species-assessment-process-categories-guidelines/quantitative-criteria.html)

There are, however, significant uncertainties regarding the feasibility of regaining representation in these areas. It is unknown whether improvements to local habitat quality (e.g., through control of managed bumble bees in greenhouses and the reduction in use of pesticides), and/or habitat availability (e.g., through restoration in suburban or rural areas) will lead to the natural re-establishment and recovery of host populations, and it is unknown whether Gypsy Cuckoo Bumble Bee individuals originating from the remaining extant populations in northern ecoregions would be successful in southern re-introduction efforts. Short term efforts to regain representation in southeastern Canada should aim to reduce this uncertainty by

a. continuing to intensively monitor habitats in the vicinity of historical sites; and
b. where host bumble bees are successfully located in sufficient numbers, and where Gypsy Cuckoo Bumble Bees are apparently absent from the surrounding region, determine one or more appropriate areas for trial restoration and reintroduction; and
c. determine whether or not source populations are appropriate to move to target area.

It is important to emphasize that bumble bees should not be reintroduced to areas within their former range unless all of these steps have been taken. Note that deliberately re-introducing Gypsy Cuckoo Bumble Bee into areas of Alberta, British Columbia, Northwest Territories or Yukon where it is not currently known or presumed extant is not a short-term objective for this species.

6. Broad Strategies and General Approaches to Meet Objectives

The broad strategies are listed in Table 5, and discussed in section 6.3. The most important strategies are the strengthening of policies and regulations around pesticide (insecticide, herbicide, and fungicide) use, and the use of imported bumble bees in greenhouse pollination.

6.1 Actions Already Completed or Currently Underway

Actions contributing to Gypsy Cuckoo Bumble Bee recovery have been implemented by various government agencies, academic institutions, non-profit groups, and citizens within Canada (Table 5).

1123 **Table 5.** Summary of recently completed or ongoing recovery-related Gypsy Cuckoo
1124 Bumble Bee work as of 2018. Many projects are ongoing throughout Canada; this is not
1125 intended to be an exhaustive list.

Purpose	Jurisdiction/ Organization	Recovery-related Action(s)
Surveying (extensive collection or photographic records meant to document species' presence)	Federal government, provinces and territories, Environmental Non-government Organizations (ENGOs), universities	• General bumble bee surveys being undertaken over much of populated Canada, for example: – Wildlife Preservation Canada (Guelph, Sudbury, Thunder Bay, Alberta, Ontario provincial parks) – York University (southern Ontario) – University of Calgary: south and central Alberta – University of Manitoba and Agriculture Canada, Brandon: Manitoba – Various provincial/territorial/federal government surveys (e.g. in British Columbia, Alberta, Saskatchewan, Northwest Territories). • Citizen Science initiatives, such as – Bumblebee Watch: https://www.bumblebeewatch.org/ and – iNaturalist: https://inaturalist.ca/home; – Bioblitzes: bioblitzcanada.ca
Monitoring (repeatable surveys designed to measure abundance or relative abundance, and population trends)	YT, ON, NS, AB, SK, MB	• Roadside monitoring: Ongoing surveys modelled after the Breeding Bird Survey (Droege 2009; McFarland et al. 2015): Underway in the Yukon (10-17 surveys in 2017-20), northwestern Ontario (29 in 2018), and Nova Scotia (2 in 2018). Surveys underway in Manitoba in 2019 (University of Manitoba). • Pollinator monitoring program underway (Ontario Ministry of Environment, Conservation and Parks) in southwestern Ontario • Blue vane trap monitoring of pollinators in Peterborough, ON area (Ontario Ministry of Natural Resources and Forestry) • Alberta bumble bee survey (2018, and every 5 years following) (Alberta Native Bee Council). • Saskatchewan: long-term blue vane trapping program begun in Provincial Parks
Habitat restoration	Wildlife Preservation Canada	• Nest box program in Ontario
Stewardship	• Health Canada	• Policy review regarding neonicotinoid pesticides and effects on pollinators recently completed (Health Canada 2019 a,b,c). Certain uses of neonicotinoid pesticides now banned, and other uses more strictly regulated. Policy review on effects on aquatic invertebrates still underway, and further restrictions based on this review

Purpose	Jurisdiction/ Organization	Recovery-related Action(s)
		will benefit bees as well.
	• ON	• Ontario pollinator health initiatives (Ontario Ministry of Environment, Conservation and Parks 2019). The coating of corn and soybean seeds with neonicotinoid insecticides is being regulated, which will reduce the amount of neonicotinoids taken up by flowering plants in agricultural areas and their watersheds in the future.
	• York University	• York University Native Pollinator Research Lab: writing a document to guide a national pollinator conservation strategy
	• City of Toronto	• Toronto Pollinator Protection Strategy: focuses on native bees.
Research	• Wildlife Preservation Canada • York University	• Conservation breeding research to develop techniques for possible bumble bee reintroductions, using Yellow-banded Bumble Bee in Ontario (Wildlife Preservation Canada and York University)
	• University of Guelph	• Sublethal effects of pesticides (e.g. University of Guelph: (Stanley *et al.* 2015a; Stanley *et al*. 2016; Stanley *et al*. 2015b; Gill and Raine 2014; Bryden *et al*. 2013). • Conservation genetics (York University, e.g. Kent *et al*. 2018). • Utility and quality of data from Bumble Bee Watch for long term monitoring (York University) • Forage and dispersal distance research using radio tracking (York University) • Using trained dogs to find nests for monitoring (York University) • Social dimensions of pollinator conservation in Canada (currently analyzing surveys of farmers, the public, stakeholder consultation documents, ENGO narratives, etc. (York University)
	• University of Ottawa	• Climate change and range loss in North American bumble bees (University of Ottawa)
Outreach	Government of Northwest Territories	• NWT has produced a pocket field guide to bumble bees, a bee colouring book, and photographic key: https://www.enr.gov.nt.ca/en/services/insects-and-spiders/bees
	Pollinator Partnership Canada (P2C)	• Pollinator Partnership Canada (P2C) has a number of education initiatives, including Bee City Canada, a bumble bee brochure, technical guides for land managers and ecoregional planting guides for the general public. https://pollinator.org/canada

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6.2 Strategic Direction for Recovery

Table 6. Recovery Planning Table

Recovery planning table for Gypsy Cuckoo Bumble Bee in Canada. Threats are according to the IUCN-CMP classification (refer to Table 4). The Broad Strategies to Recovery are from the Conservation Measures Partnership's (2016) Conservation Actions Classification v 2.0.

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
Invasive and other problematic species and genes; Agriculture and aquaculture	High	Land/Water Management: Site/Area Stewardship	• Mitigate stresses via ecological management of commercial bumble bee and Honey Bee populations to minimize transmission of pathogens and minimize competition with host bees. • Test for diseases in managed bees. • Promote and follow the Bumblebee Sector Guide to the National Bee Farm-level Biosecurity Standard (Canadian Food Inspection Agency 2013).
Pollution	High	Land/Water Management: Site/Area Stewardship	• Minimize use of pesticides; develop, promote and follow best practices in the application of pesticides (insecticides, fungicides, herbicides)
Residential and commercial development; Agriculture and aquaculture	High	Land/Water Management: Site/Area Stewardship	• Restore/enhance habitat and mitigate stresses through planting bee-friendly native flowering plants, ensuring blooming plants are available through the foraging season, etc.
All	High	Designation & Planning: Conservation Planning	• Plan for conserving and managing Gypsy Cuckoo Bumble Bee and its host bees by completing recovery documents and action plans for host species as appropriate
All	High	Legal & Policy Frameworks: Laws, Regulations & Codes; Policies & Guidelines	• Create, amend, or influence environment-related provincial/territorial and/or municipal laws and/or regulations, policies, and guidelines/best practices to benefit Gypsy Cuckoo Bumble Bee and its hosts (e.g. regarding transport and housing of bumble bees, disease testing of bumble bees and Honey Bees, pesticide regulation, slowing climate change, etc.)

Knowledge Gaps	High	Research & Monitoring: Basic Research & Status Monitoring	• Conduct research on Gypsy Cuckoo Bumble Bee and its relationship to host bees (e.g., confirmation of Western and Cryptic Bumble Bees as hosts, density of hosts needed to support Gypsy Cuckoo Bumble Bee, emergence timing, coordination with host nesting) • Conduct research on threats to the species, its host bees, and their habitats (e.g., pathogens, fungicides, insecticides, herbicides, loss of floral resources, competition with introduced Honey Bees and bumble bees, shift of climate envelopes, temperature extremes, droughts, and cumulative effects of threats).
Knowledge Gaps	High	Research & Monitoring: Basic Research & Status Monitoring	• Develop and implement national protocols and methods (including detailed study design) to inventory and monitor bumble bees (including Gypsy Cuckoo Bumble Bee and its hosts), and deposit data in a central repository. • Clarify identification issues with Suckley's Cuckoo Bumble Bee and address any identification errors in collections. • Conduct research on detailed genetic relationships among Gypsy Cuckoo Bumble Bees across their range
Knowledge Gaps	High	Research & Monitoring: Basic Research & Status Monitoring	• Conduct research and analysis to identify thresholds for altering the physical attributes of critical habitat
Conservation Capacity	High	Education & Training: Training & Individual Capacity Development	• Provide conservation capacity development through hands-on coaching & technical assistance and developing training materials (e.g., bee identification, monitoring protocols)
All	High	Awareness Raising: Outreach & communications	• Raise awareness of Gypsy Cuckoo Bumble Bee (e.g., species' needs, occurrences, direct threats) with relevant government agencies, land owners and managers, and public via reported media, social media, advertisements and marketing, displays, person-to person engagement, and experiential learning. • Promote restoration and creation of native foraging habitat for the Gypsy Cuckoo Bumble Bee and its hosts (i.e. flowers with short or open corollas, blooming through the active season).
Natural System Modifications	Medium	Species Management: Species Re-introduction & Translocation	• *If detailed, independently-reviewed studies show that it is feasible, appropriate and required to meet PDO*, facilitate reintroduction of Gypsy Cuckoo Bumble Bee and/or its host bees where they have been confirmed to be extirpated. Do not move bees without first referring to and following IUCN guidelines on translocation.

Natural System Modifications	Medium	Species Management: Ex-situ Conservation	• *If required, and if feasible to meet PDO*[b], develop methods and provide ex-situ protection via captive breeding of Gypsy Cuckoo Bumble Bee and its host species over generations
All threats to habitat	Medium	Conservation Designation & Planning: Easements & Resource Rights	• Promote habitat protection measures (such as conservation easements) to preserve and enhance bumble bee habitat.
Conservation Capacity	Medium	Institutional Development: Alliances & Partnership Development	• Create and maintain partnerships focused on coordinating conservation implementation, knowledge generation & sharing
All threats to habitat	Low	Conservation Designation & Planning: Protected Area Designation &/or Acquisition	• Establish or demarcate protected areas;

[a] Priority is characterized as High (essential: urgent and important, needs to start immediately), Medium (necessary: important but not urgent, action can start in 2–5 years); or Low (Beneficial: action would be beneficial at any time that it was feasible to start).

[b] It is important to consider a number of questions before captive breeding and re-introduction is considered as an option: Is it required? That is, have detailed and extensive surveys revealed that there are none left in an ecoregion and natural recolonization is unlikely? Or do surveys indicate that host populations are recovering on their own? And is it feasible? For example, have threats been eliminated? Has lab-rearing been mastered, and will enough individuals be available for release? Are the genetic considerations known and favourable to release?

6.3 Narrative to Support the Recovery Planning Table

6.3.1 High Priority (Essential):

Pathogens and pathogen spillover from managed bumble bee colonies are widely believed to be central threats to the hosts of Gypsy Cuckoo Bumble Bee, so the control of these pathogens and their carriers is key to the recovery of this species. More regulation and oversight of the managed Honey Bee and bumble bee industry is needed. It is important to know how many managed bees are being moved, and where they are being moved to. There should be regular testing for diseases within production facilities, and protocols to minimize disease spread to the wild (e.g. greenhouse vent covers, freezing of colonies before disposal, etc.). The “Bumblebee Sector Guide” to the National Bee Farm-level Biosecurity Standard (Canadian Food Inspection Agency 2013) should be updated and followed. Because it is impossible to prevent all escapes from greenhouses, there should be no shipment of managed bumble bees outside their natural ranges.

However, these organisms and their effects on these bumble bees are not well known. Important research questions include: What is the geographic origin of these pathogens; i.e. are they exotic or native? How are they transferred from bee to bee? Why is the prevalence of *Nosema* related to the concentration of fungicides in the environment?

There is now considerable evidence showing that neonicotinoid and other insecticides have serious sub-lethal effects on populations of wild bumble bees. Reduction and control of insecticide use through enforceable regulations and best practices is vital to the recovery of bumble bee populations in agricultural areas. The widespread use of herbicides in both agriculture and silviculture has undoubtedly greatly reduced the floral resources needed by host bumble bees; best practices need to be followed to minimize the destruction of bee forage. Particular attention needs to be paid to drift of herbicides beyond the crop boundaries (even by a few metres) during mechanical or aerial spraying.

Continued pesticide research is essential to the recovery of this and other bumble bee species, especially research into the sub-lethal effects of insecticides (including the relatively new insecticides that are being tapped to replace neonicotinoids), documentation of the effects of herbicides on pollinator forage resources, and the link between fungicides and bumble bee pathogens.

Completion of recovery strategies and management plans for the hosts of Gypsy Cuckoo Bumble Bee will be an important step in the recovery of this species as well.

Widespread inventory is needed to establish the true extent of the functional range of the Gypsy Cuckoo Bumble Bee (and other bumble bees) in Canada. This is true both in the southern areas in which it has declined, and in the more remote areas where it may still thrive, but inventory data are lacking. Inventories should be done late in the season

(mid-August for southern regions, late July for northern regions) in order to maximize the probability of encountering Gypsy Cuckoo Bumble Bees.

More intensive monitoring is needed to document ongoing trends. Monitoring in this plan means repeatable surveys at the appropriate time of year (see above) designed to measure an index of absolute abundance. These surveys would not only greatly enhance the re-assessment of the species, but are the only way of measuring progress in recovery efforts. Examples of monitoring include standardized roadside netting surveys, blue vane trap surveys, and pan trap surveys. Each method has its advantages and disadvantages; the key feature is that they can be repeated year after year and the results can be compared directly among years. It would be ideal if one or a handful of survey types would be used across Canada, so that results could be summarized and compared over wide areas, or even nation-wide. Data from the surveys should be kept in a central repository or repositories (for example, in provincial/territorial Conservation Data Centres).

Successful monitoring is dependent on investments in the training of paid and volunteer biologists and naturalists; including training in monitoring protocols, bumble bee identification, specimen preparation, and database entry. Because monitoring necessarily involves specimen capture, investments also must be made in regional natural history collections in order to safely store specimens collected.

Public education about the threats to bees and the enhancement of habitat for bees will support the broader recovery of bees in a number of ways. Raising awareness with relevant government agencies, land owners and managers is also essential. The engagement of interested people through citizen science programs such as Bumble Bee Watch and iNaturalist will help monitor and map bumble bees while recovery efforts take place.

The intensification of agriculture and general 'tidying' of the landscape in developed regions has resulted in a loss of bee habitat. Existing foraging and nesting habitat for host bumble bees needs to be maintained and enhanced if they are to return to viable numbers in more developed regions.

6.3.2 Medium Priority: Necessary

If Gypsy Cuckoo Bumble Bees are to return to parts of southeastern Canada (especially extreme southern Ontario), they may have to be re-introduced from other regions. Once threats to the hosts have been mitigated, the first step would be re-establishment of their hosts. Development and refinement of captive rearing techniques will be needed. Techniques would also have to be developed to rear nest parasites like Gypsy Cuckoo Bumble Bees in a managed setting.

In areas of extensive private land (e.g. southern Ontario), conservation easements could be a key strategy in the enhancement of habitat.

For this wide-ranging species with complex needs, partnerships focused on coordinating conservation implementation, knowledge generation and sharing will be necessary in recovery efforts.

6.3.3 Low Priority: Beneficial

Protected areas that are managed for pollinators could help establish populations in areas that are otherwise poor in appropriate habitat.

7. Critical Habitat

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

Critical habitat for Gypsy Cuckoo Bumble Bee in Canada is identified to the extent possible, to meet the species' needs described in Section 3.3. More precise boundaries may be mapped, and/or the criteria for identification may be refined if supported by additional research and/or new information.

Critical habitat identified in this document was assessed in relation to the population and distribution objective (Section 5). It has been determined that the critical habitat identified is insufficient to meet the population and distribution objectives owing to:

- Incomplete information about the current range and actual area of occupancy of Gypsy Cuckoo Bumble Bee and its host bumble bee species; and
- Insufficient certainty of the feasibility, and location of habitat necessary for restoring and regaining representation of Gypsy Cuckoo Bumble Bee in southeastern Canada (especially the Mixedwood Plains Ecozone).

A schedule of studies (Section 7.2, Table 7) has been developed to provide the information necessary to complete the identification of critical habitat required to support the population and distribution objective. The identification of critical habitat will be updated when this information becomes available, either in a revised recovery strategy or action plan(s).

7.1 Identification of the Species' Critical Habitat

7.1.1 Information and methods used to identify critical habitat

The location and spatial configuration of critical habitat is based on the principle of maintaining or increasing the densities of host bumble bees within the estimated maximum dispersal distance area where Gypsy Cuckoo Bumble Bee is known or presumed to be extant. To generate the geospatial delineation of areas containing ciritical habitat, a 10 km radius (based on research by Lepais *et al.* 2010) was applied to

all known or presumed extant site records as summarized in section 3.2, Table 2. These site records are all known to within 100 m, so the 10 km radius circles are precise to that level. The areas containing critical habitat for the Gypsy Cuckoo Bumble Bee are presented in Figures 4-26.

Gypsy Cuckoo Bumble Bee requires habitat for reproduction, foraging, mating and dispersal in order to complete its life functions. Host bumble bee nests and various types of open natural and human-modified habitat features possess the attributes required to support these functions. A description of the known biophysical features and attributes of the species' habitat that are required to support life-cycle processes (functions) are provided in Section 3.3 (Table 3). Within these geospatial polygons, critical habitat includes all biophysical features and attributes where they occur.

Within the mapped geospatial areas containing critical habitat only unsuitable areas that do not possess any of the features and attributes required by Gypsy Cuckoo Bumble Bee at any time are excluded from identification as critical habitat. Examples of excluded areas include: (i) existing permanent infrastructure (e.g. well-sealed buildings, extensive spans of artificial surfaces, the running surface of roads); (ii) aquatic areas including lakes and large, fast-flowing rivers (below the lowest water level); (iii) intensively managed landscapes lacking floral resources (eg. certain croplands); and (iv) true tundra above the shrub line.

7.1.2 Geospatial location of areas containing critical habitat

Critical habitat for Gypsy Cuckoo Bumble Bee is identified in four provinces and territories representing seven National Ecozones in Canada:

- Alberta: Figures 4-10
  - Boreal Plains National Ecozone
  - Prairies National Ecozone
- British Columbia: Figures 11-12
  - Montane Cordillera National Ecozone
  - Western Interior Basin National Ecozone
- Northwest Territories: Figures 13-14
  - Taiga Cordillera National Ecozone
  - Taiga Plains National Ecozone
- Yukon: Figures 15-26
  - Boreal Cordillera National Ecozone
  - Taiga Cordillera National Ecozone

The geospatial areas containing critical habitat include federal and non-federal land tenures; federal land tenures implicate one federal protected area, i.e., Kluane National Park and Reserve (Figure 21).

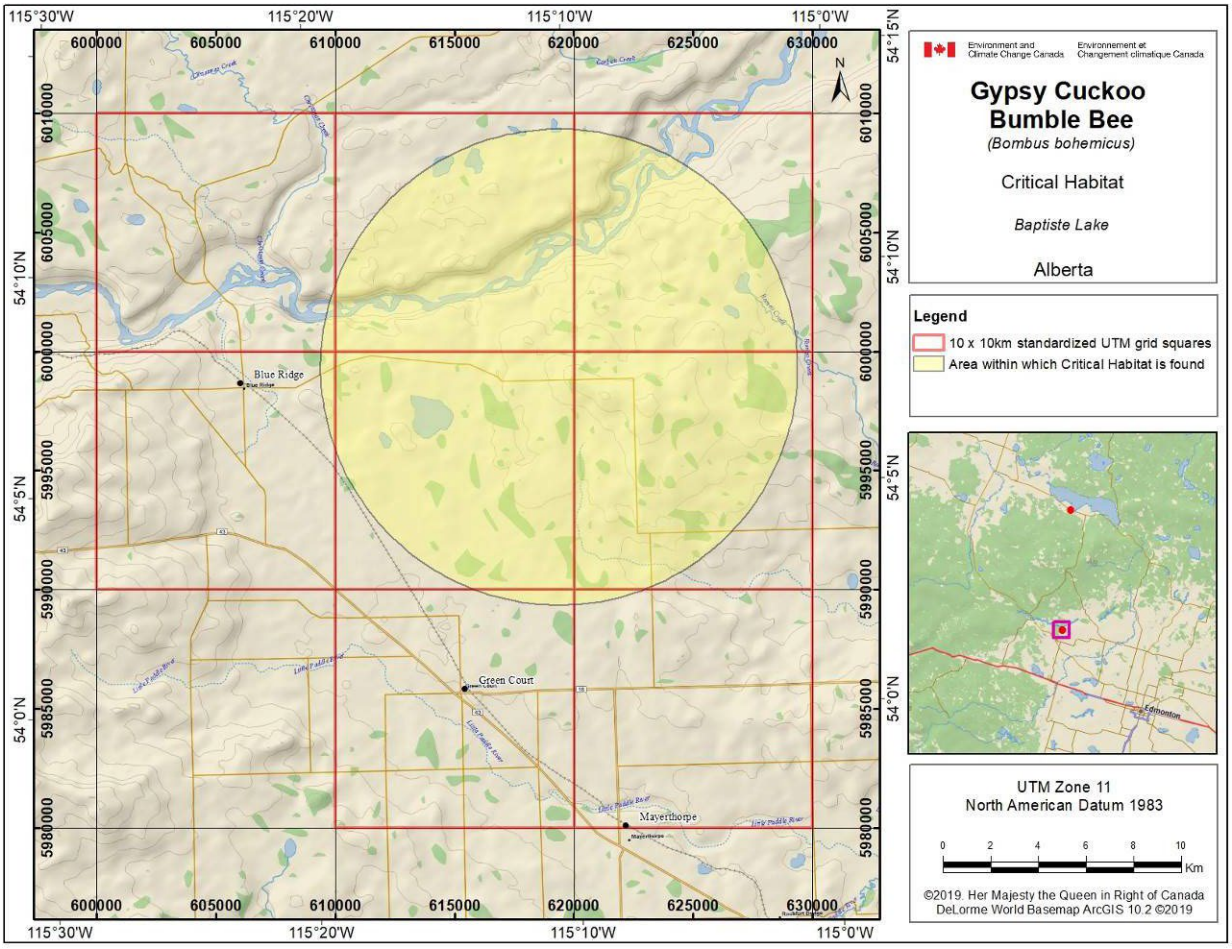

Figure 4. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Baptiste Lake, Alberta. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

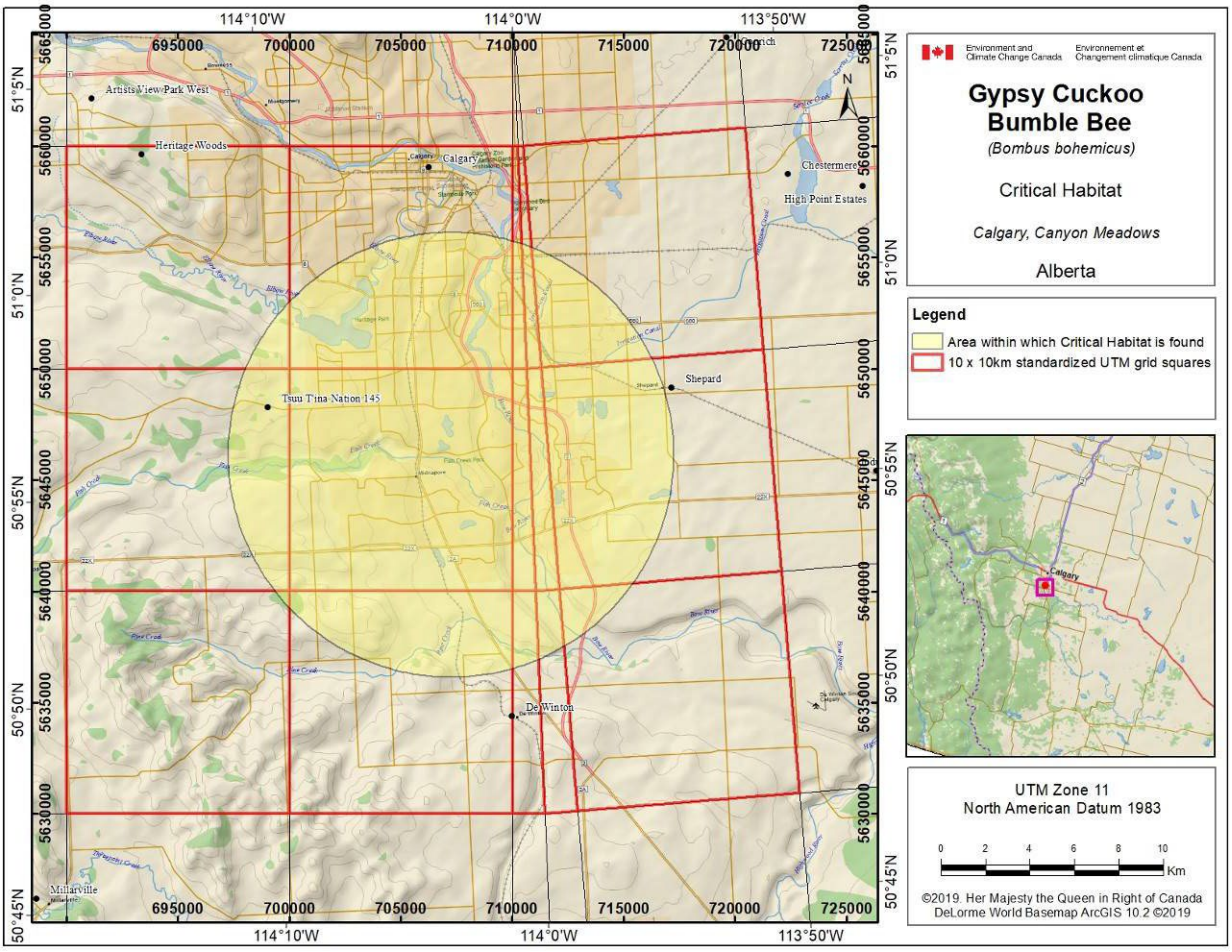

Figure 5. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Calgary, Canyon Meadows, Alberta. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

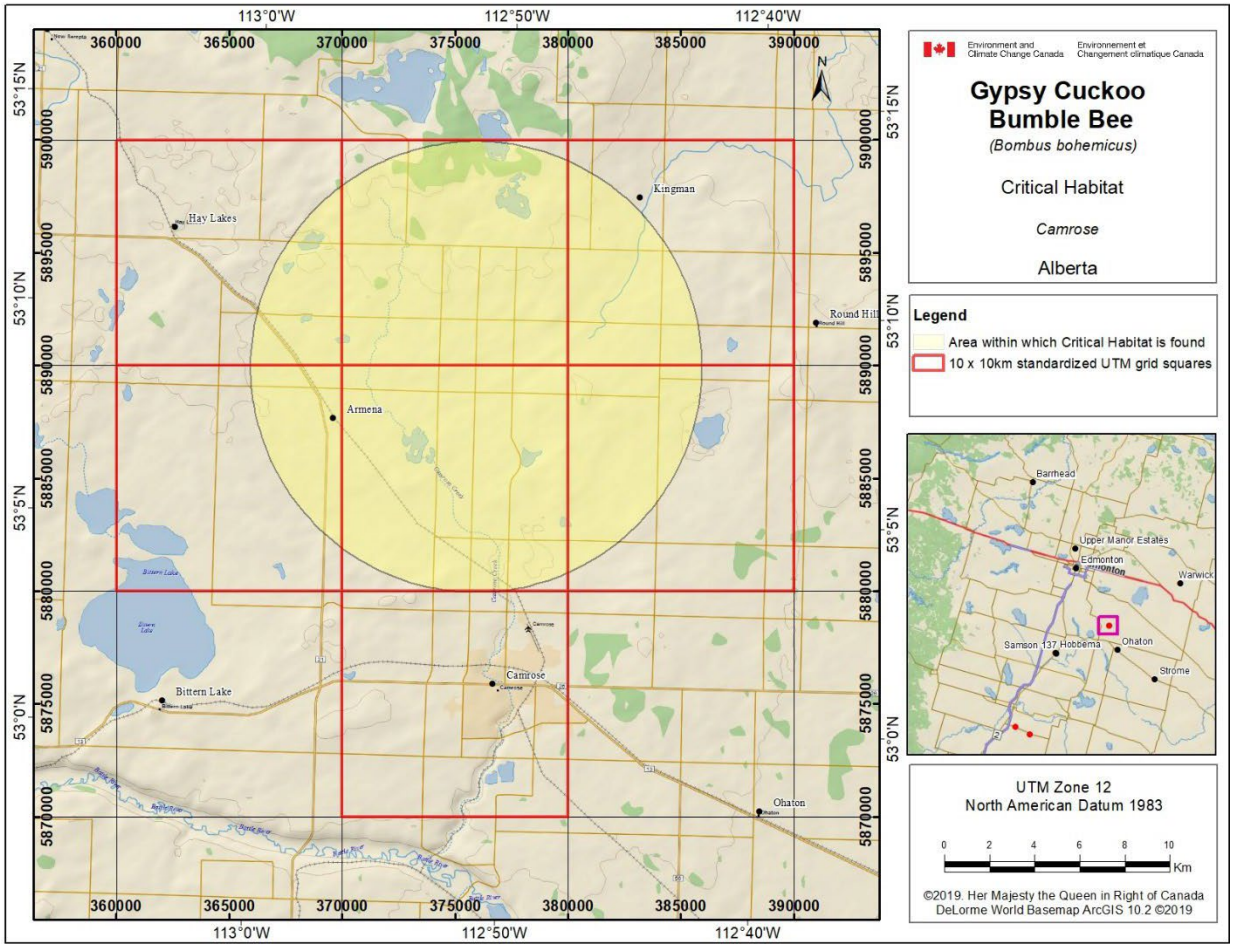

Figure 6. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Camrose, Alberta. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

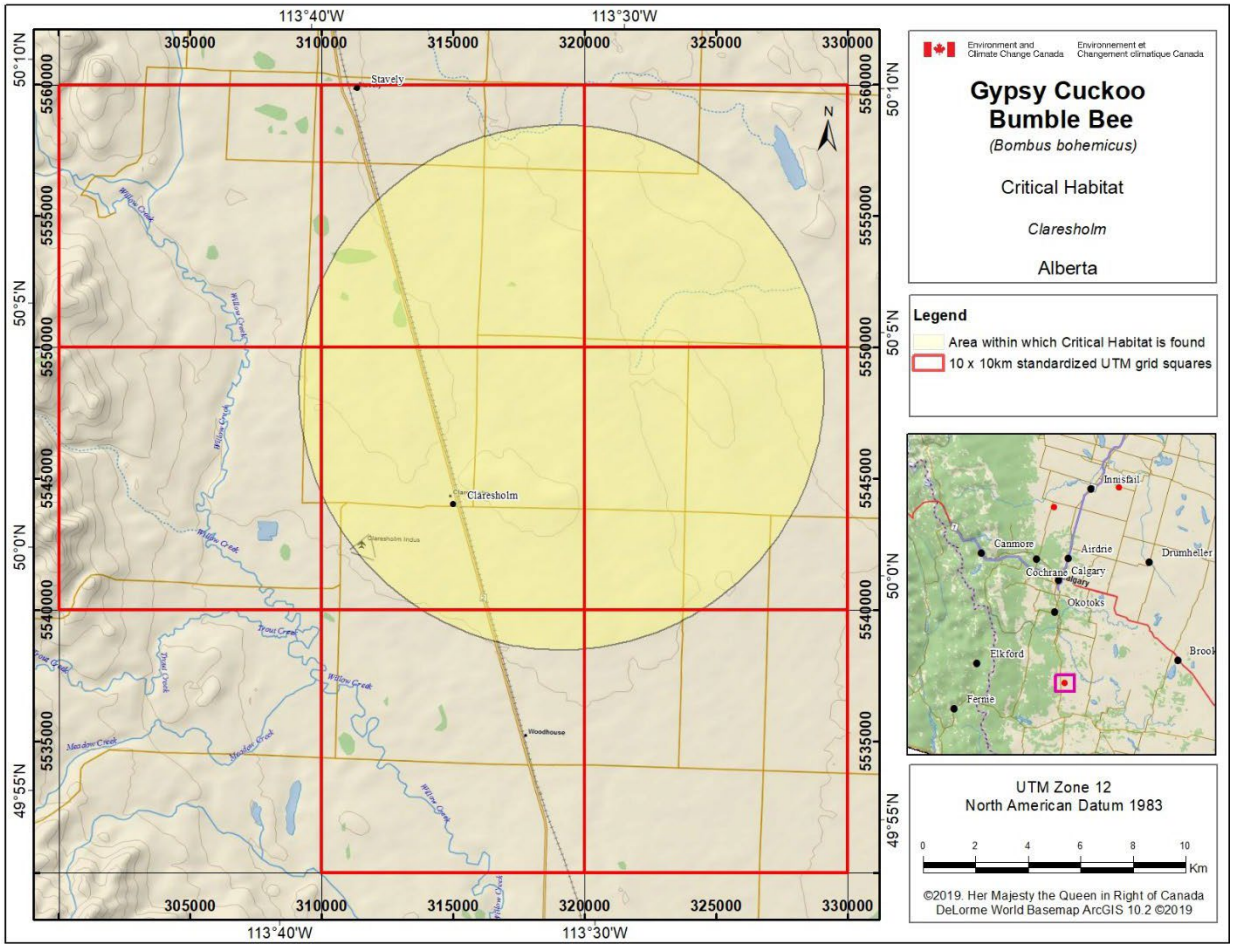

Figure 7. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Claresholm, Alberta. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

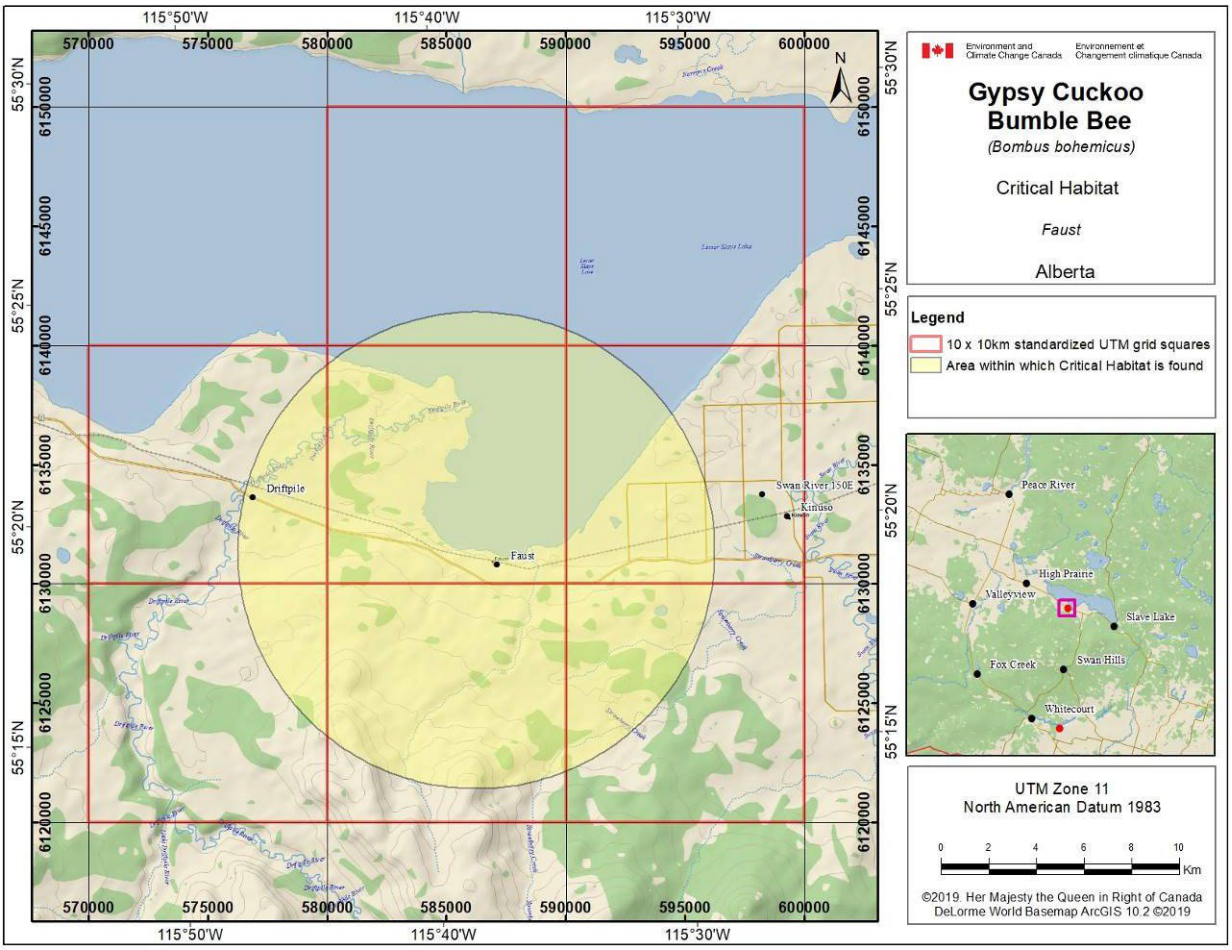

Figure 8. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Faust, Alberta. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

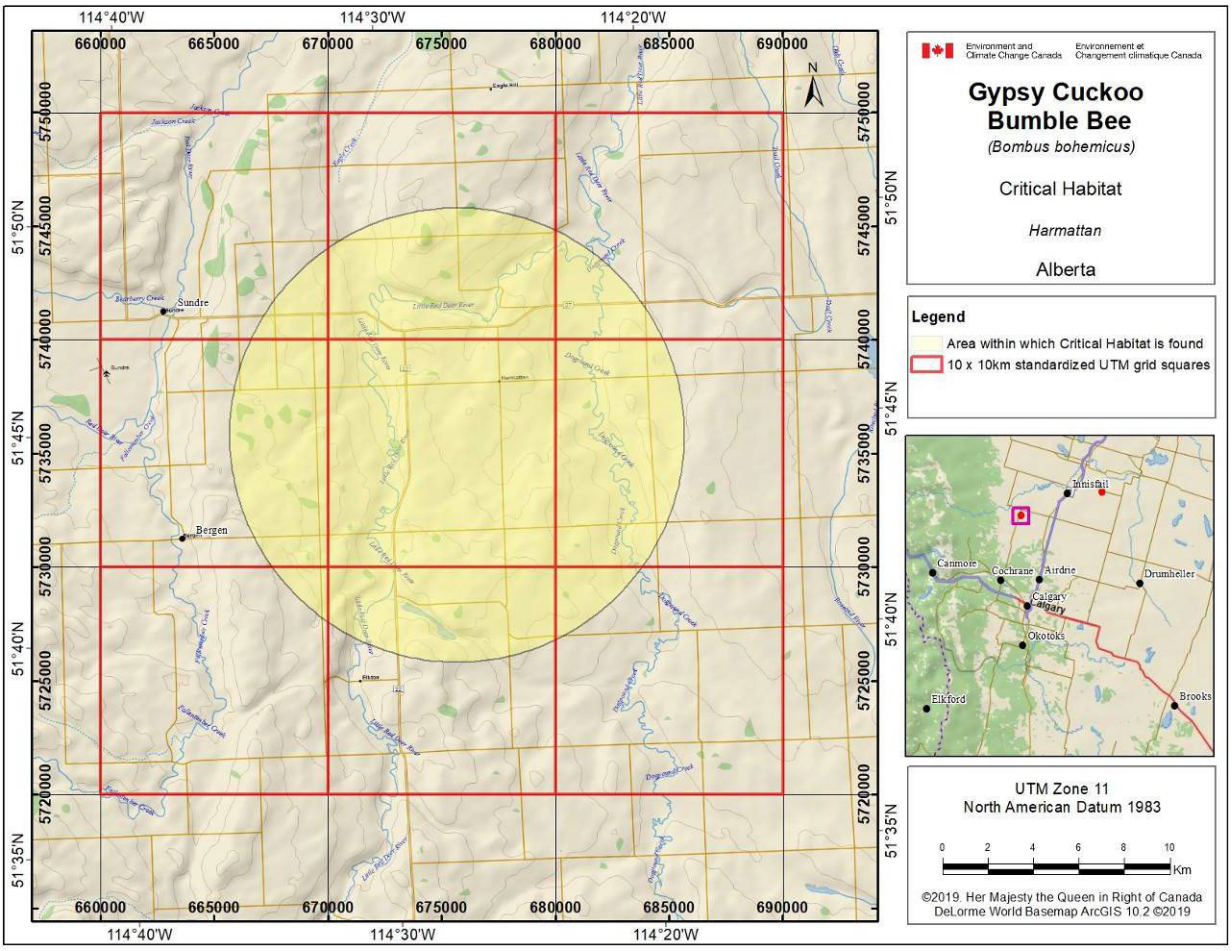

Figure 9. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Harmattan, Alberta. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

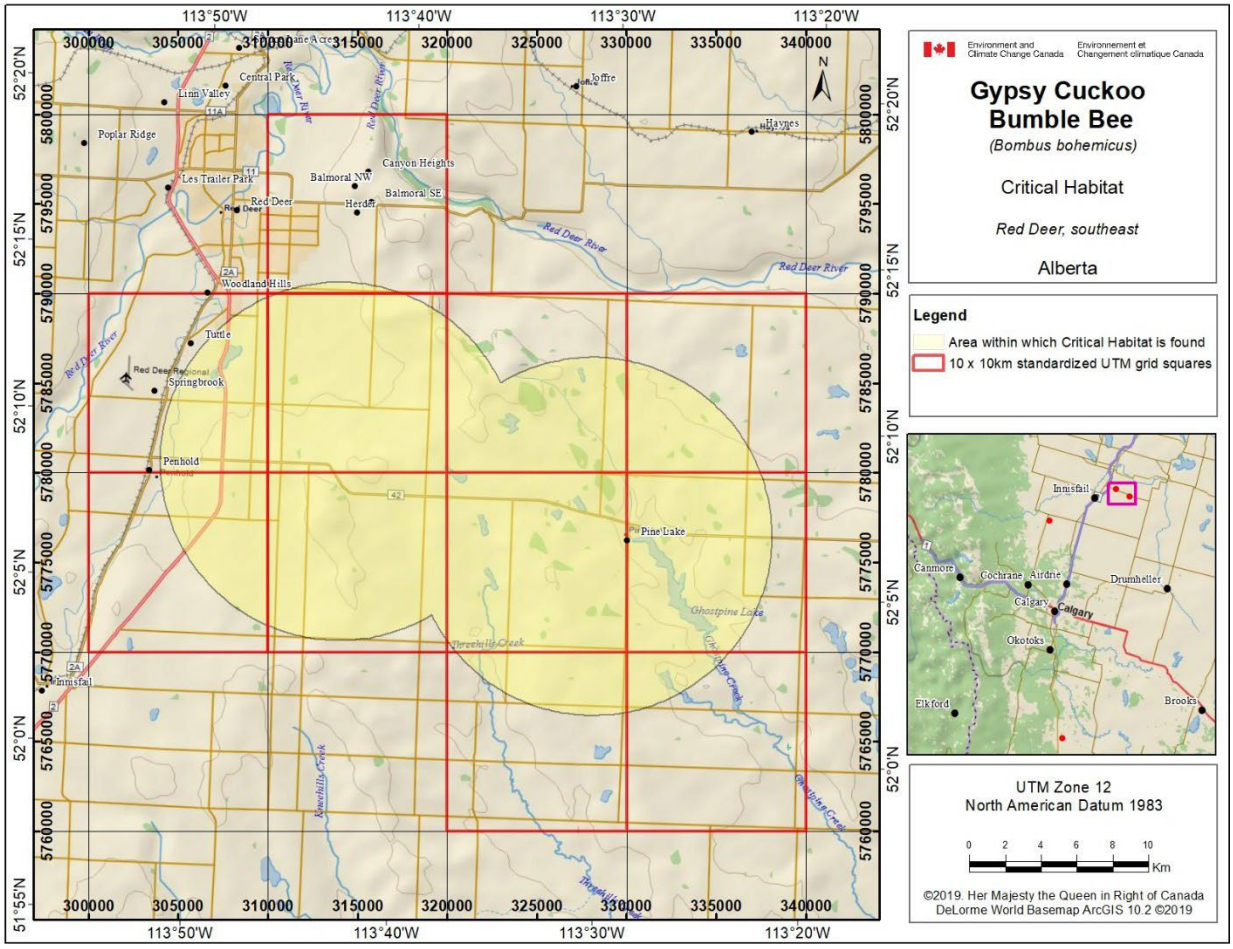

Figure 10. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Red Deer, southeast, Alberta. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

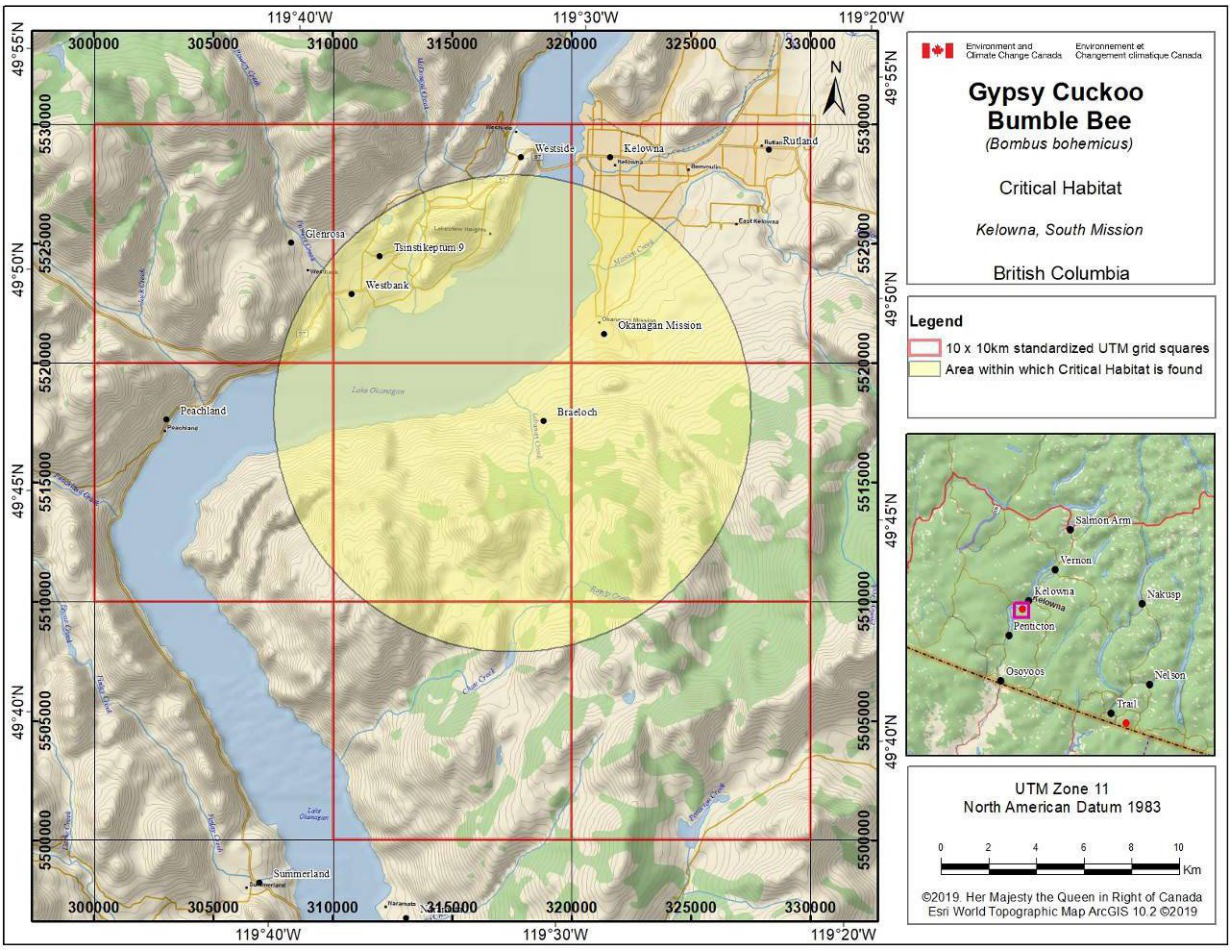

Figure 11. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Kelowna, South Mission, British Columbia. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

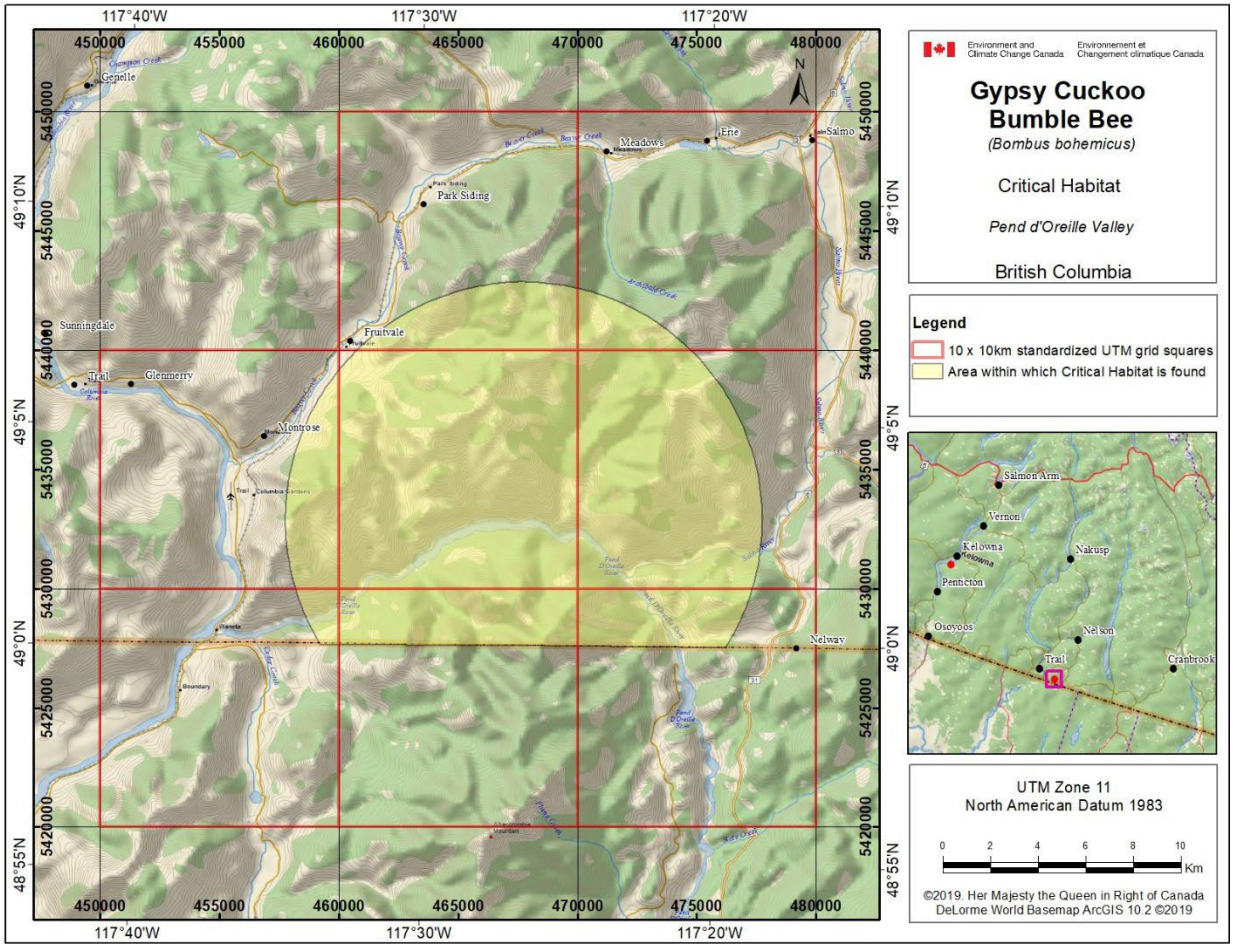

Figure 12. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Pend d'Oreille Valley, British Columbia. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

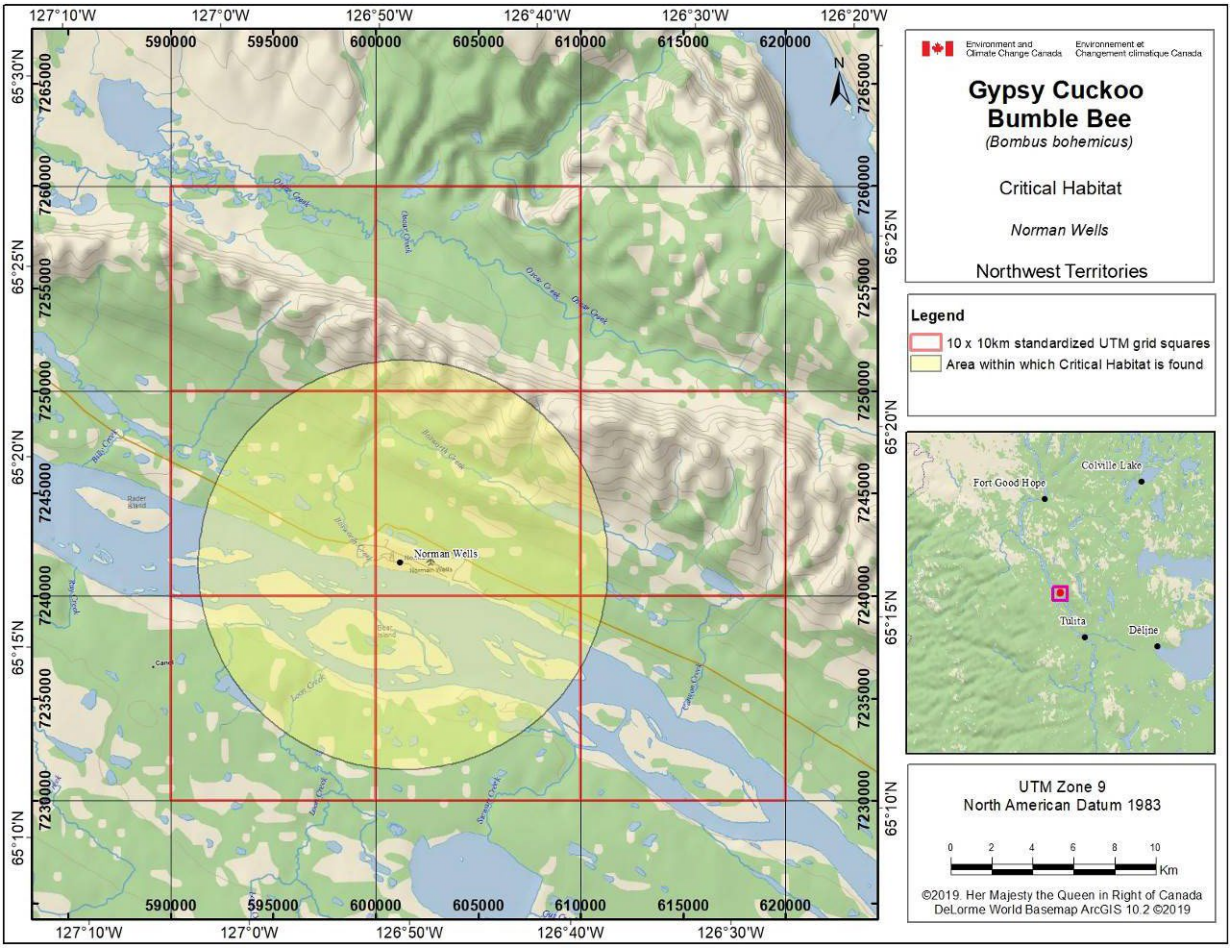

Figure 13. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Norman Wells, Northwest Territories. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

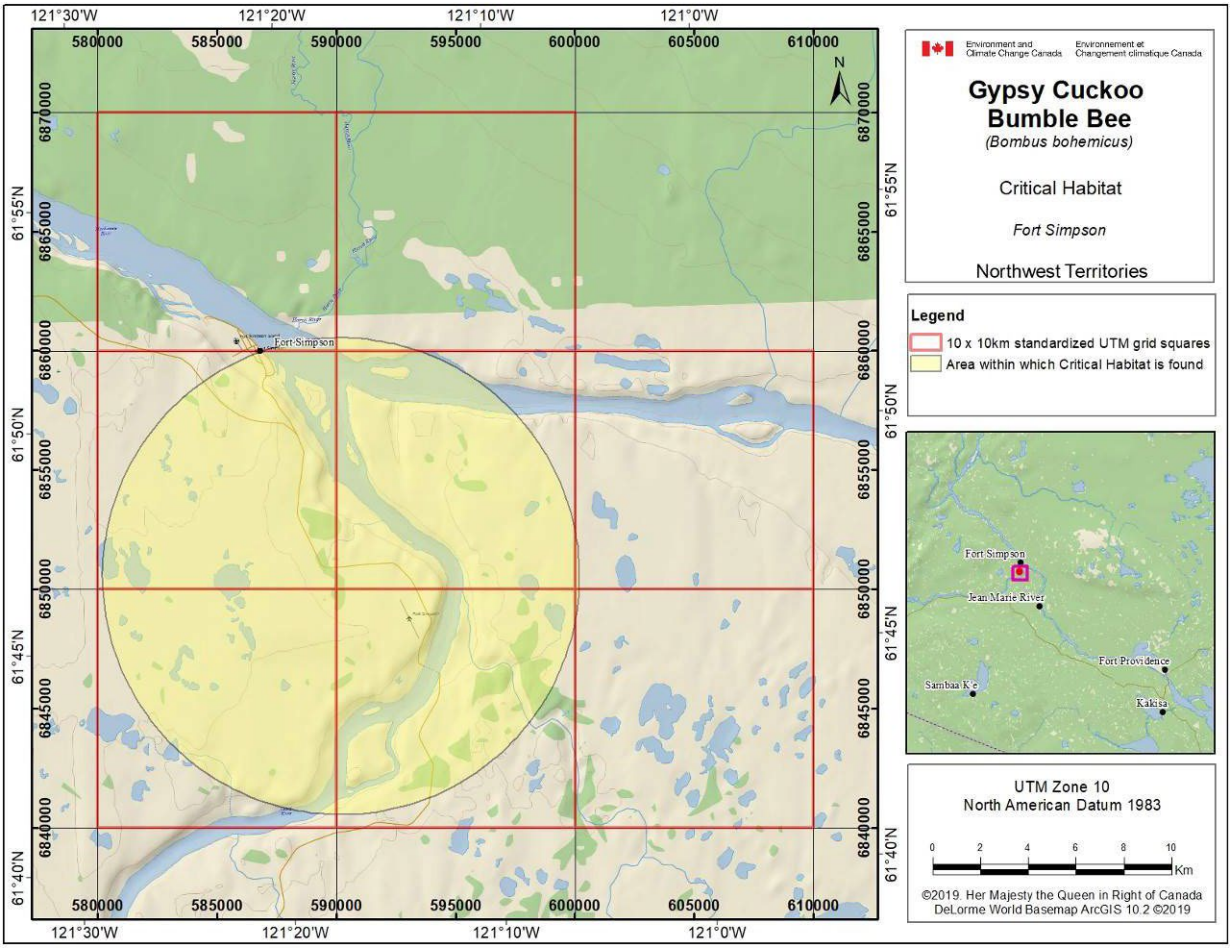

Figure 14. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Fort Simpson, Northwest Territories. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

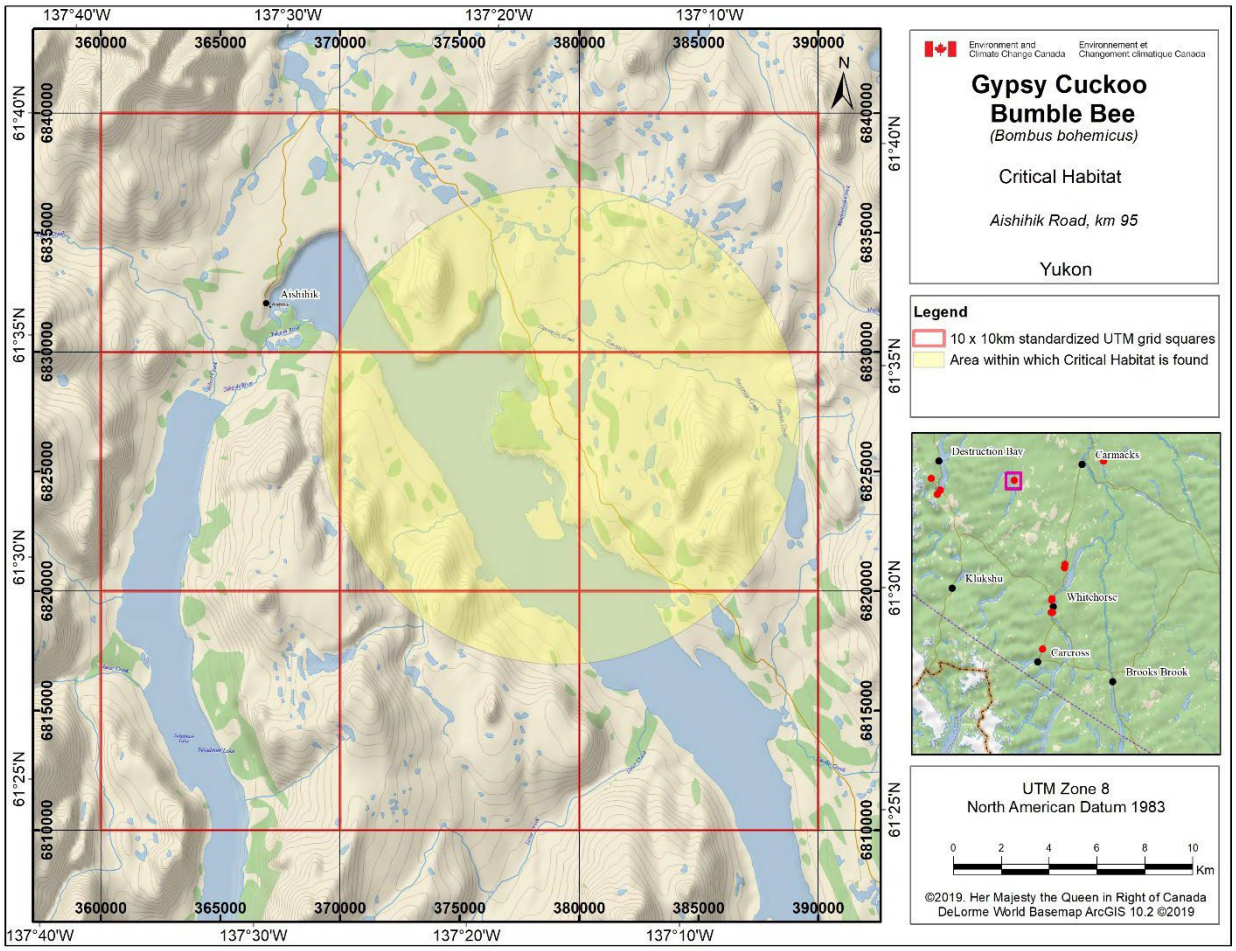

Figure 15. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Aishihik Road, km 95, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

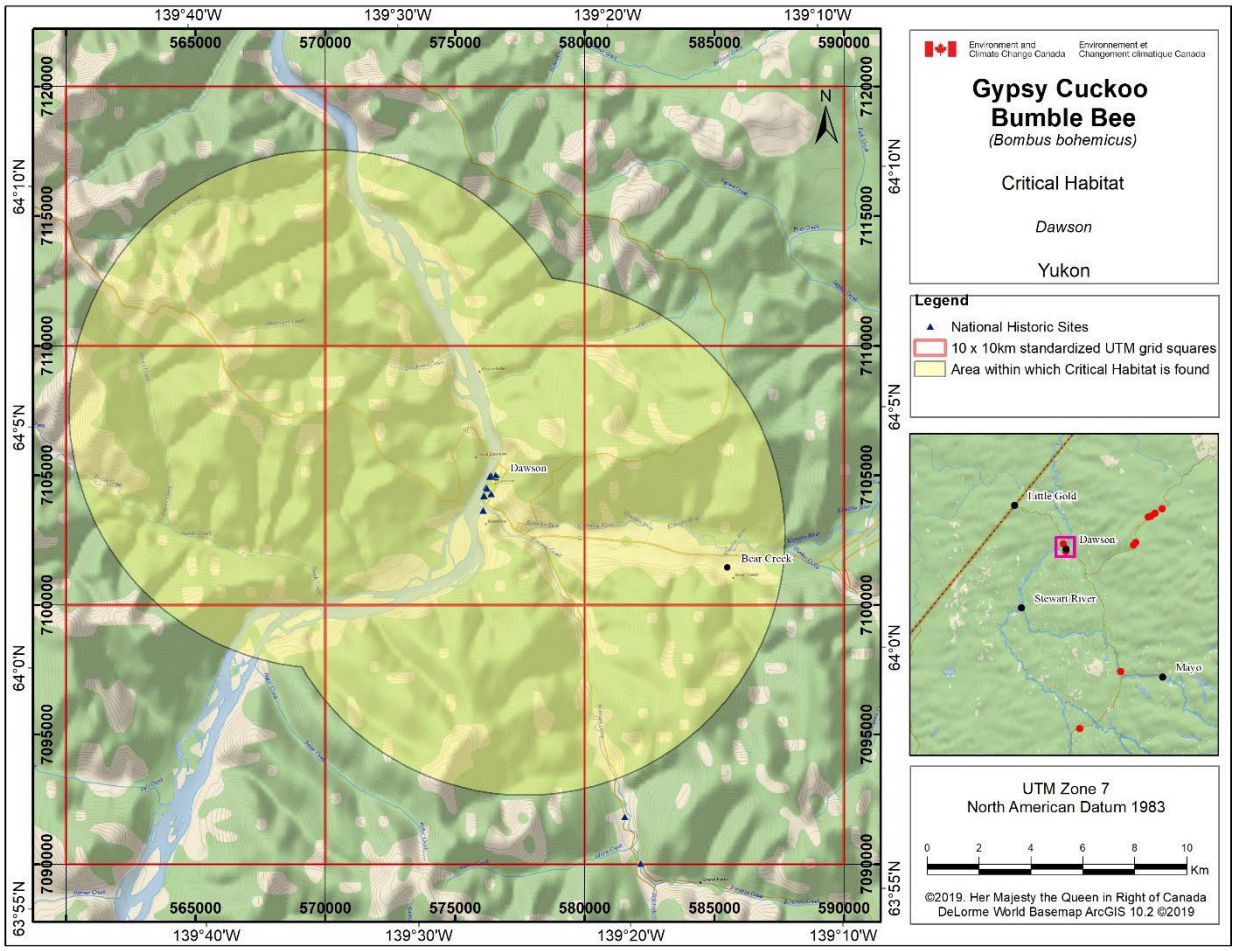

Figure 16. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Dawson, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

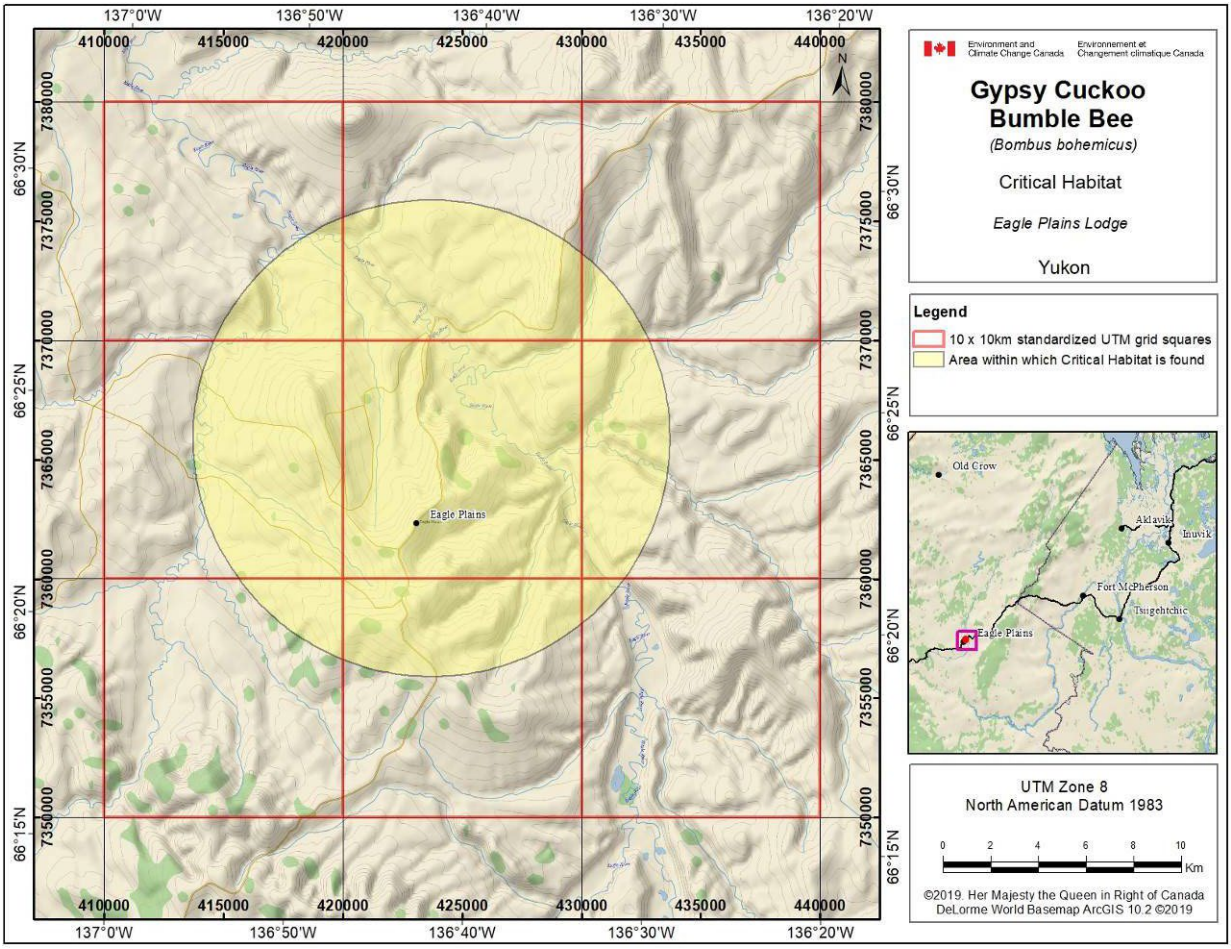

Figure 17. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Eagle Plains Lodge, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

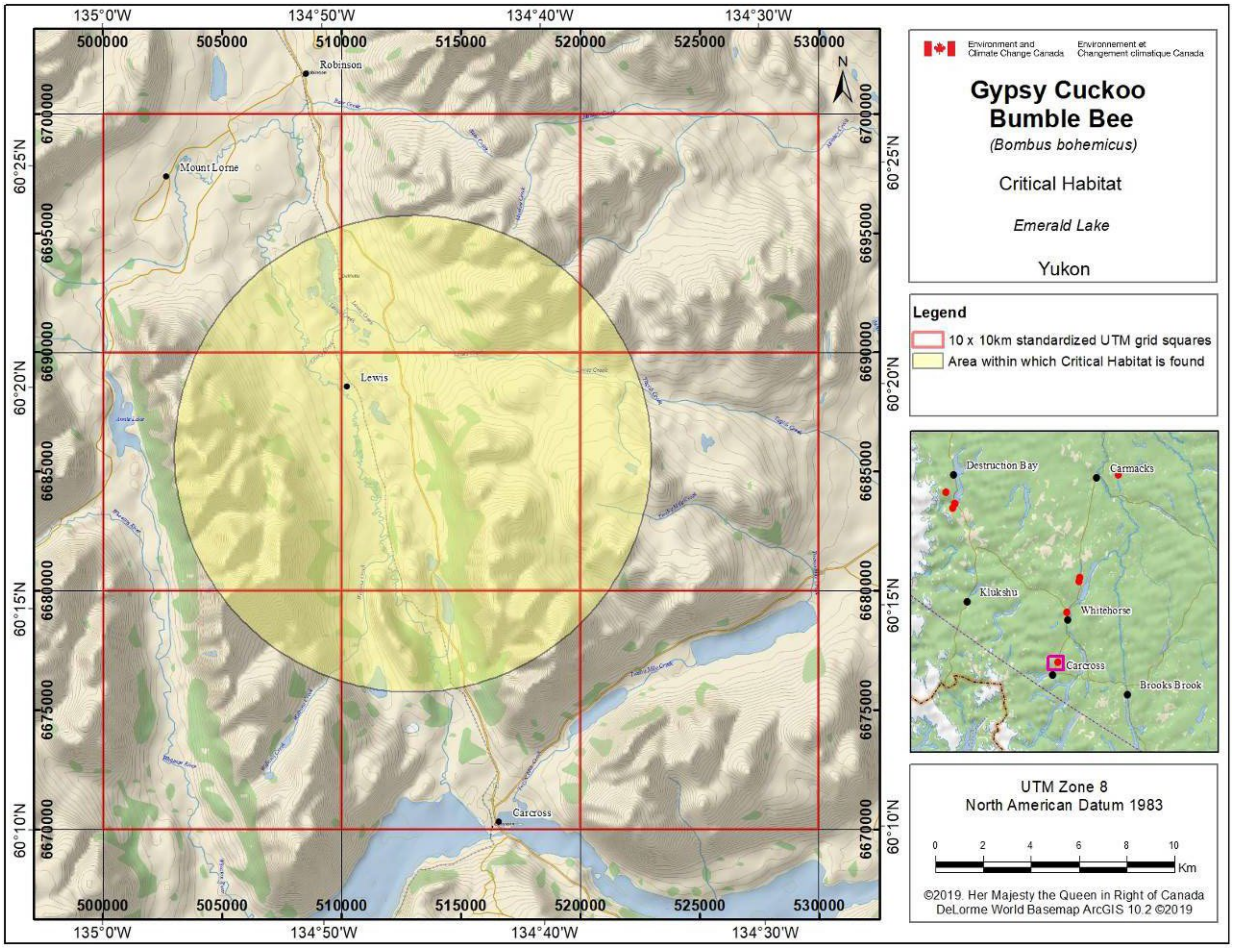

Figure 18. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Emerald Lake, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

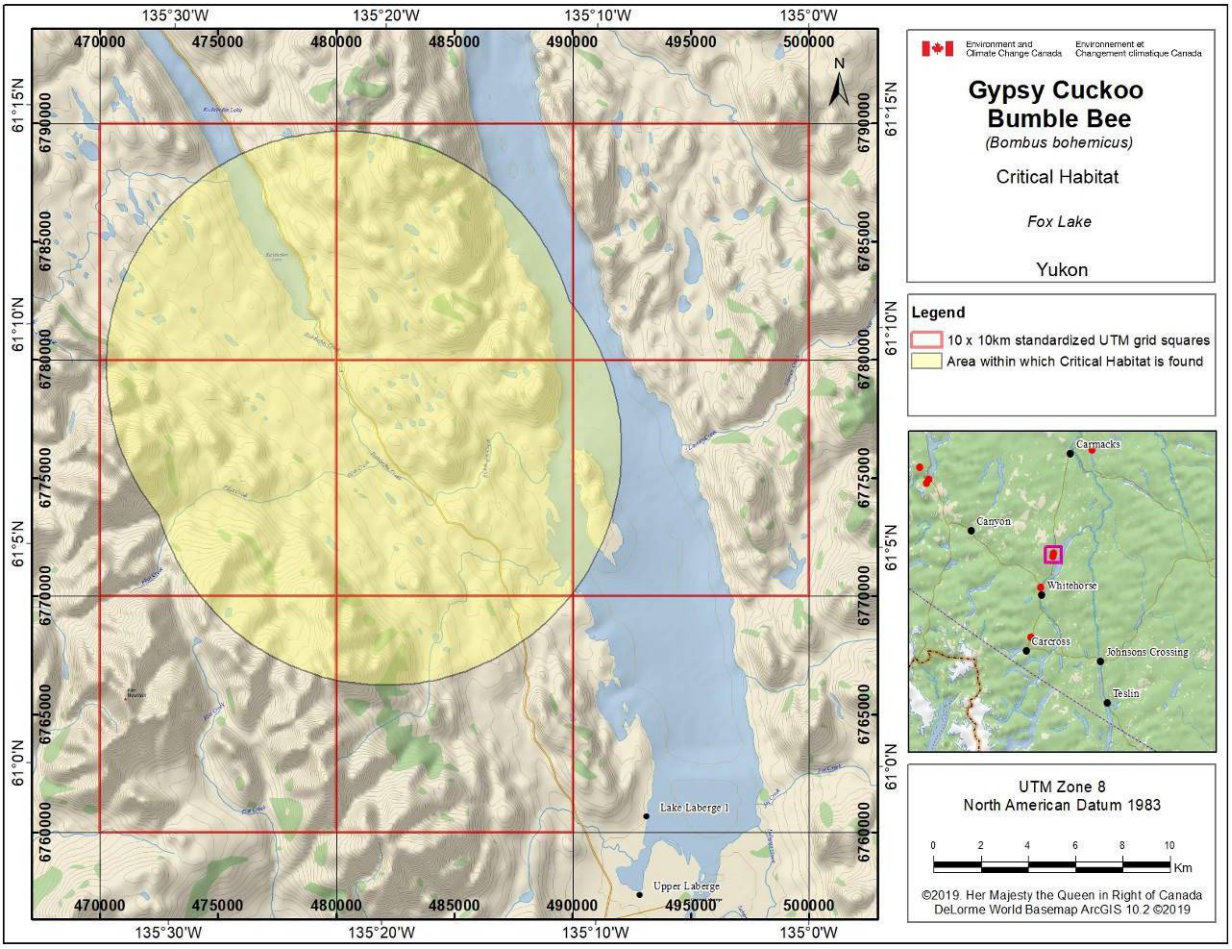

Figure 19. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Fox Lake, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

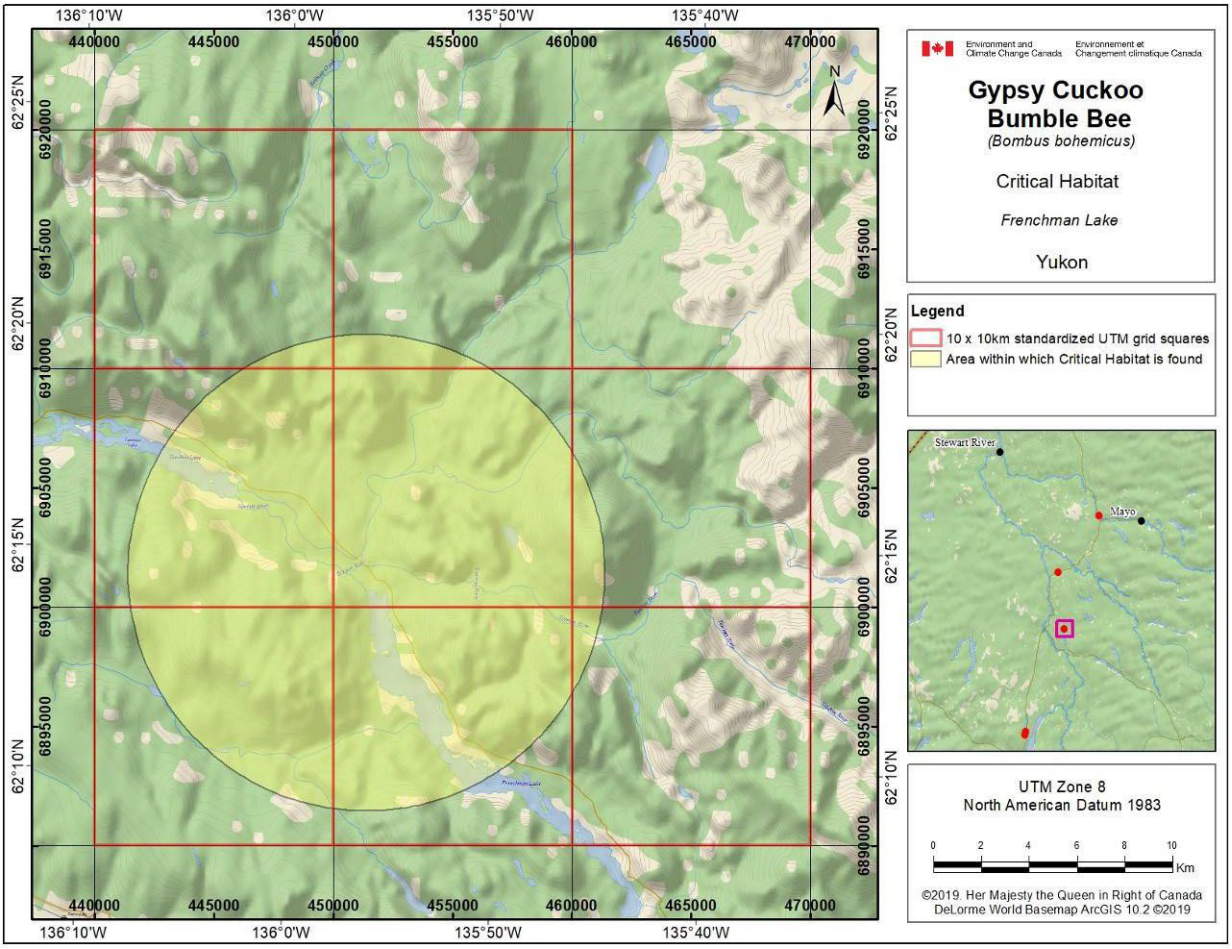

Figure 20. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Frenchman Lake, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found

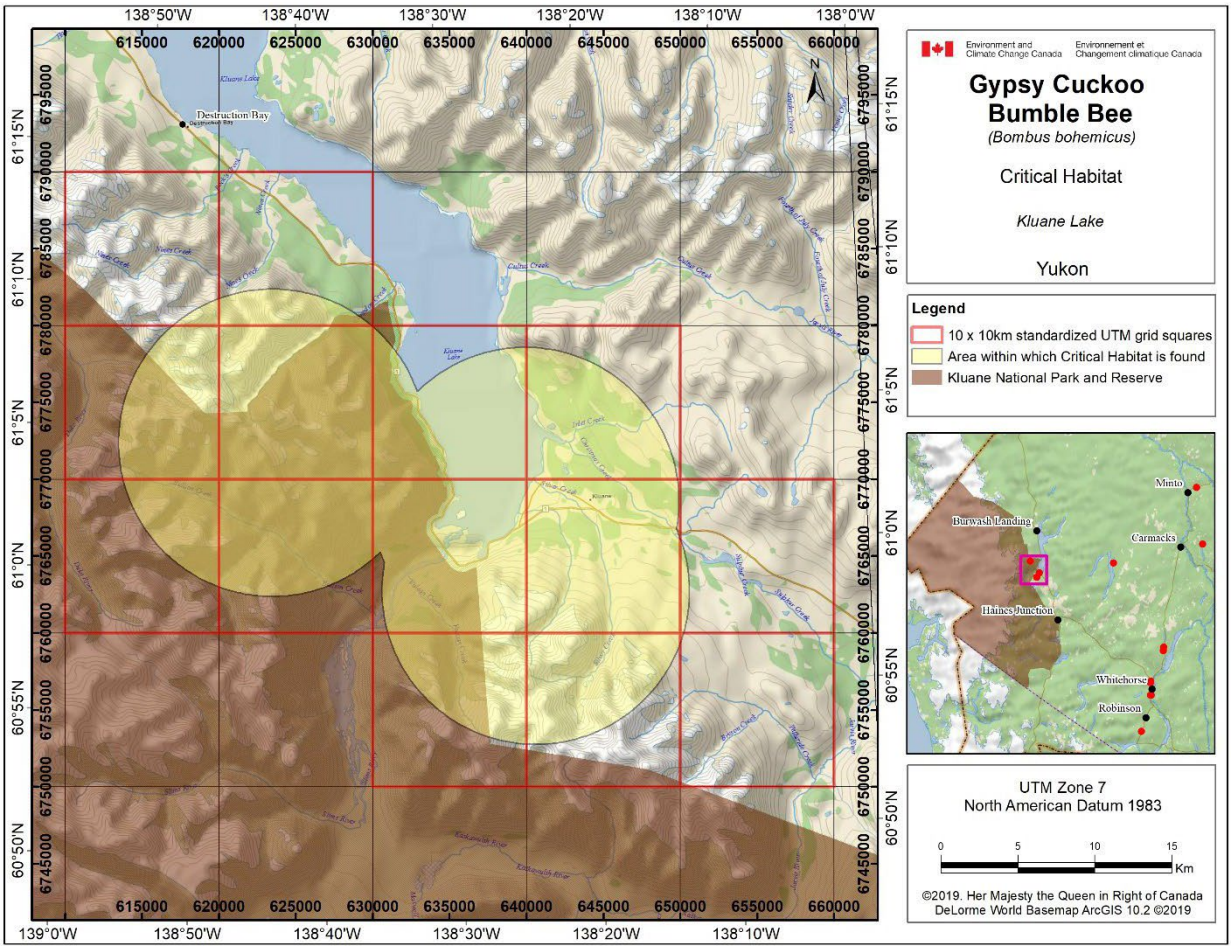

Figure 21. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Kluane Lake, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas containing critical habitat occur within the following federal protected area: Kluane National Park and Reserve.

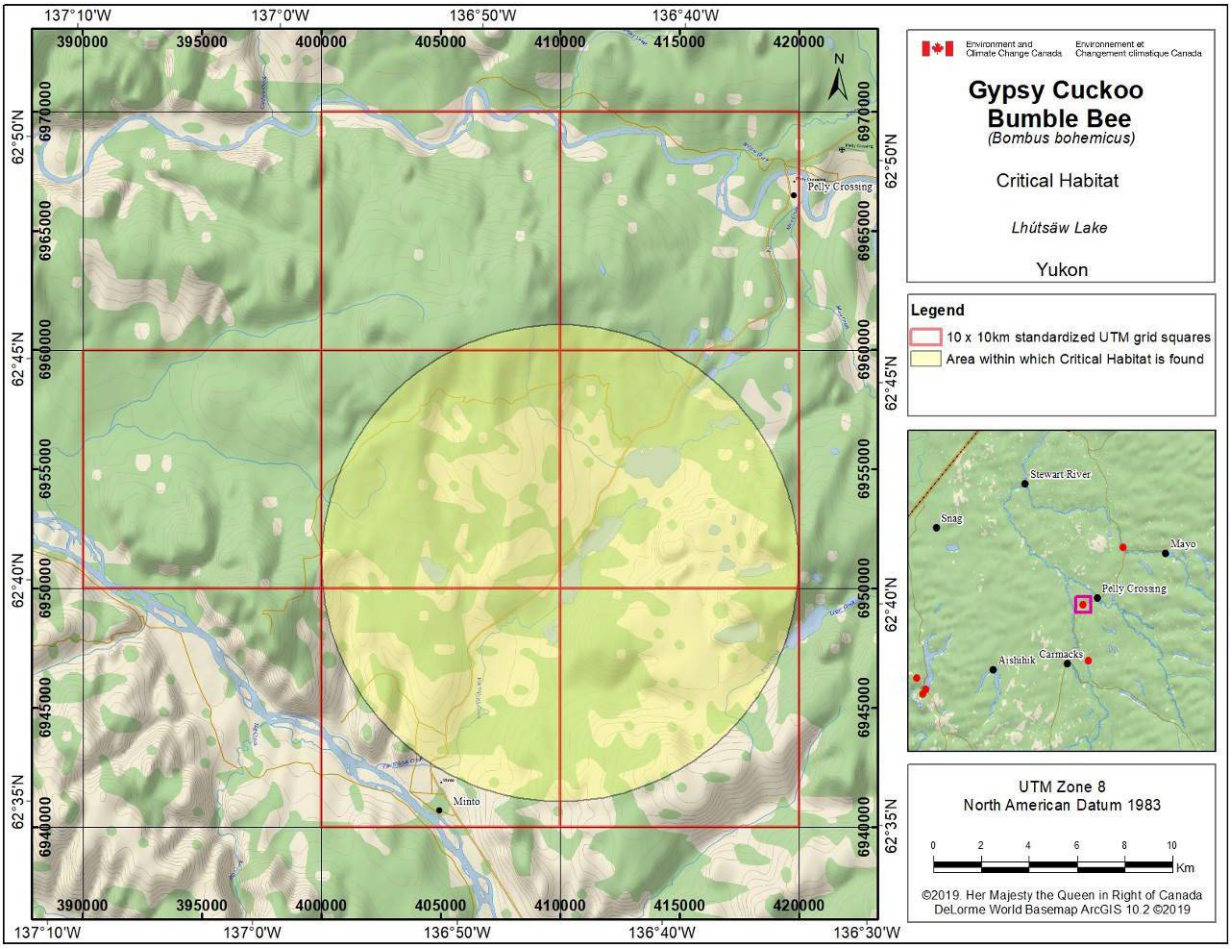

Figure 22. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Lhútsäw Lake, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

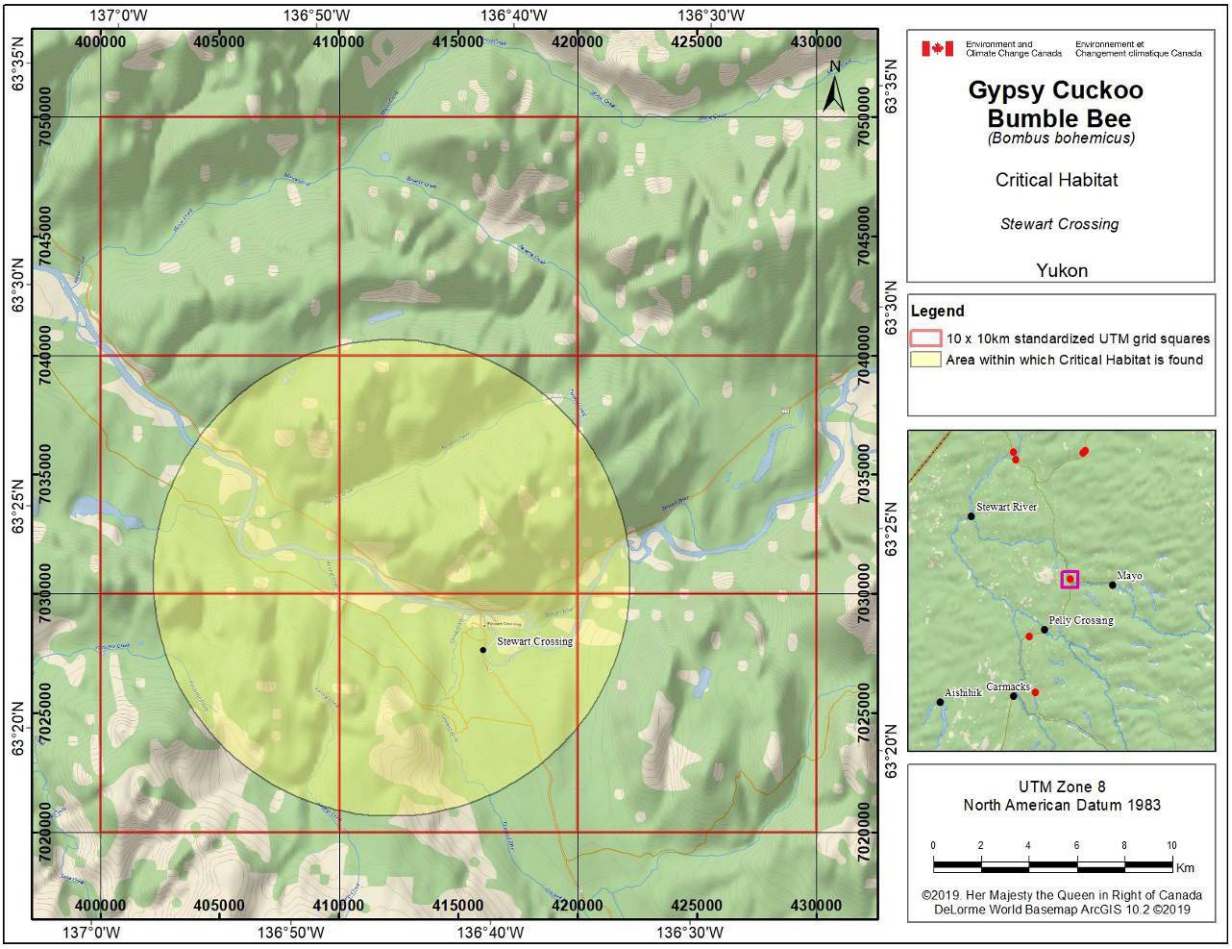

Figure 23. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Stewart Crossing, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

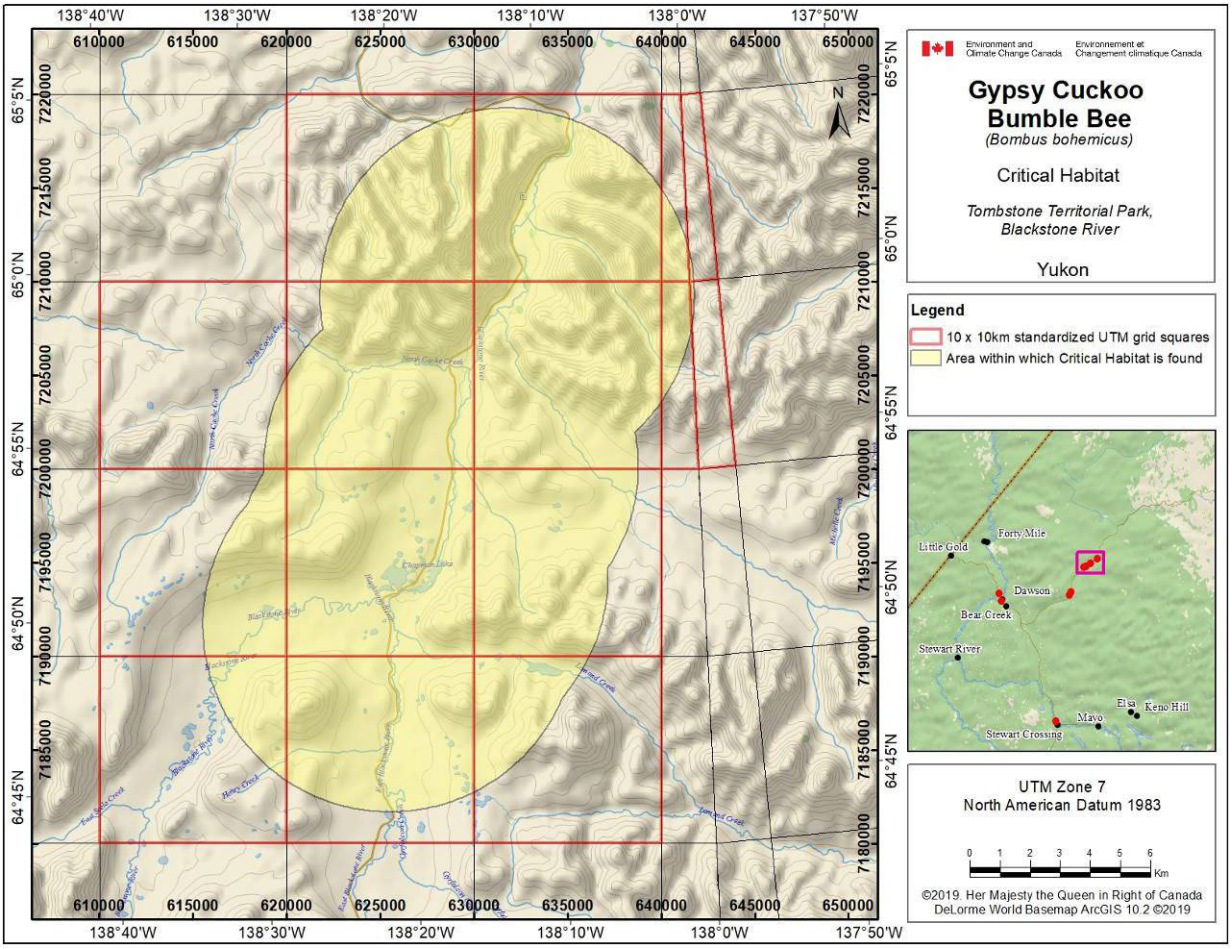

Figure 24. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Tombstone Territorial Park, Blackstone River, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

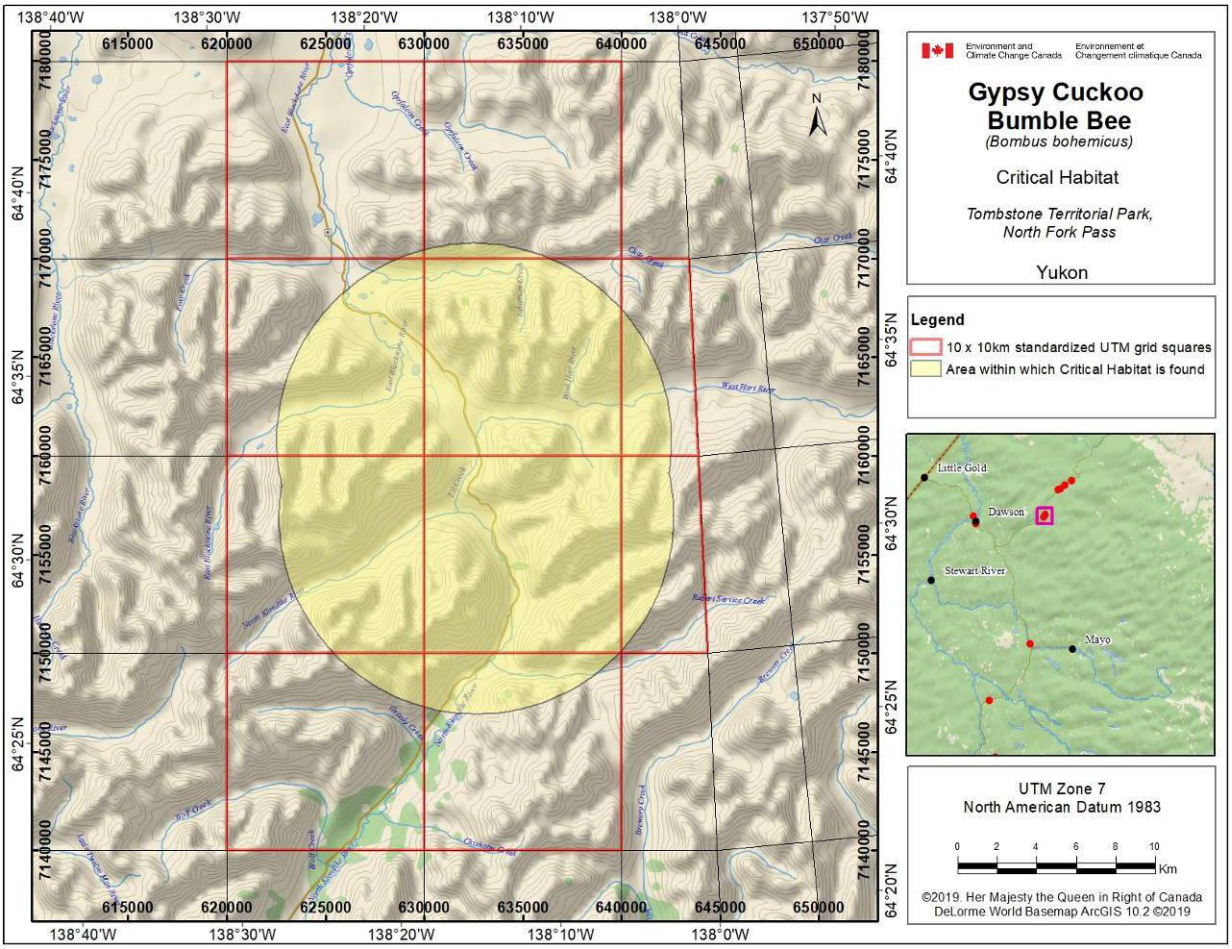

Figure 25. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Tombstone Territorial Park, North Fork Pass, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

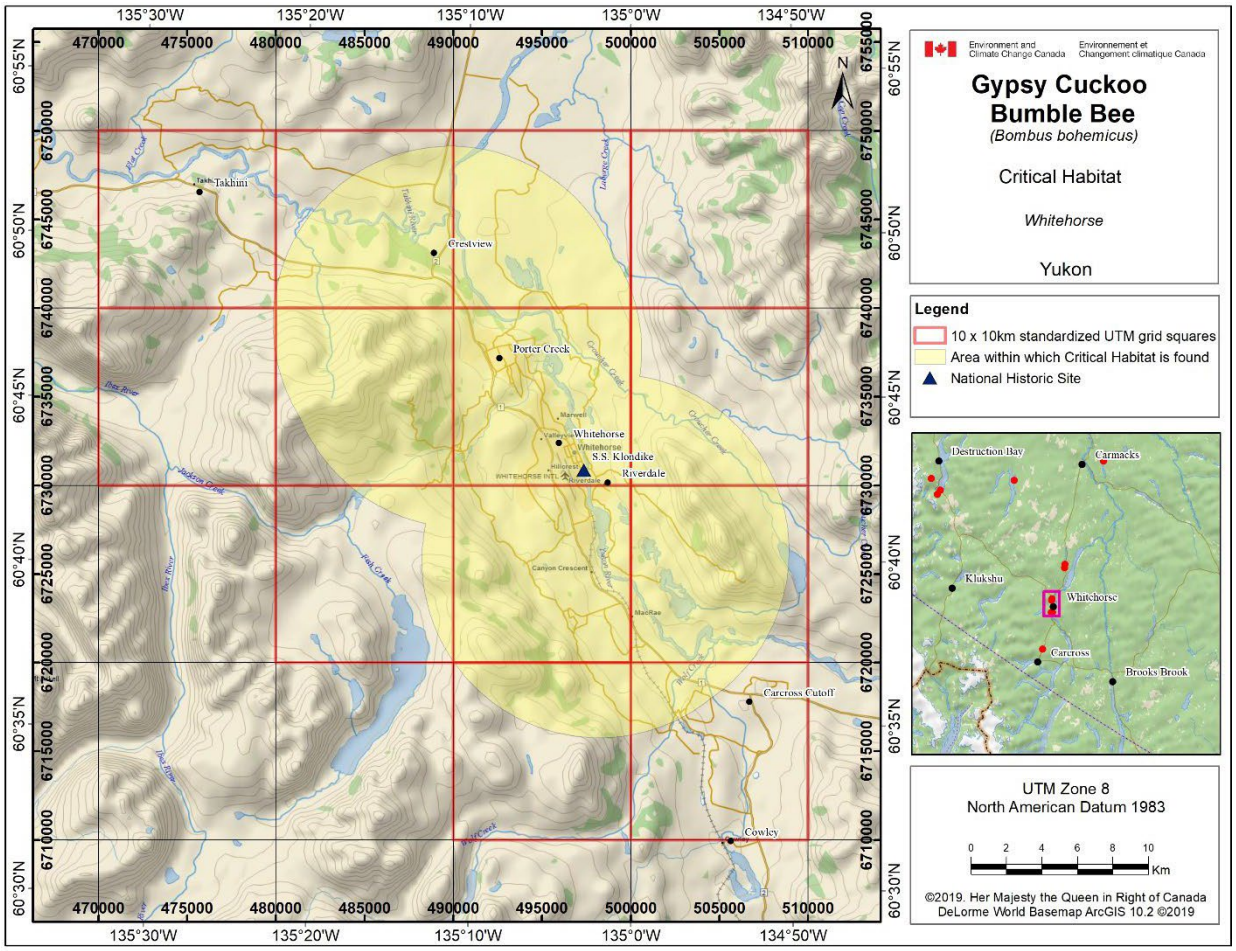

Figure 26. The area containing critical habitat for the Gypsy Cuckoo Bumble Bee in Canada – Whitehorse, Yukon. Critical habitat, as described in section 7.1.1, is found within the yellow shaded unit. The 10 km × 10 km UTM grid overlay (red outline) shown on this figure is a standardized national grid system used to indicate the general geographic area within which critical habitat is found.

7.2 Schedule of Studies to Identify Critical Habitat

Table 7. Schedule of studies to identify critical habitat.

Description of Activity	Rationale	Timeline
Inventory to identify the full extent of range and area of occupancy of Gypsy Cuckoo Bumble Bee and its presumed bumble bee hosts.	Critical habitat is currently identified for recently confirmed (presumed extant) populations of Gypsy Cuckoo Bumble Bee, which likely underestimates the full range that the species occupies in Canada, owing to insufficient survey information. Further inventory is required to complete the identification of critical habitat, particularly in parts of northern and eastern Canada where recent inventory information is unavailable or otherwise inadequate. There is also currently limited information on the biophysical attributes of breeding habitat, including availability of host bumble bee nests.	2022-2031
Repeated, intensive surveys in the vicinity of historic sites in southeastern Canada to determine appropriate areas (based on host densities) for trial restoration and/or reintroduction at one or more of these sites in Ontario, Quebec, and/or the Maritime provinces.	Regaining representation of Gypsy Cuckoo Bumble Bee in different ecozones in Canada will be important to long-term species' adaptability to environmental change. Currently there is inadequate certainty about the appropriate location of trial restoration sites, and to what extent reintroduction will be feasible, or even required.	2022-2031
Address key knowledge gaps and model habitat requirements for Gypsy Cuckoo Bumble Bee based on the landscape	Current information is inadequate to support a habitat-suitability approach to critical habitat identification, due to knowledge gaps including density of host bees needed to sustain a healthy population of Gypsy Cuckoo Bumble Bee on the landscape.	2022-2031

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time.

There are unknowns regarding the feasibility of recovery of Gypsy Cuckoo Bumble Bee. The primary, direct threats to the species are the loss of host bumble bee species and shifting climatic regimes caused by climate change. It is unknown whether the main human-caused threats to host bumble bee species (pathogen/disease spillover from bumble bees used in commercial greenhouse operations, use of systemic insecticides and other pesticides) can be avoided or mitigated to the extent that host populations can be re-established. Notwithstanding, if these human-related activities continue unchecked, the likelihood of restoring host populations will be significantly reduced, as will the likelihood that Gypsy Cuckoo Bumble Bee can be recovered.

Table 8 outlines human-related activities that are most likely to result in the destruction of critical habitat for Gypsy Cuckoo Bumble Bee. As noted in section 3.3, Gypsy Cuckoo Bumble Bee is dependent on healthy populations of hosts, which are in turn generalist, wide-ranging foragers in a variety of open habitats, and because the females of both host and parasite disperse every spring and fall to nesting and overwintering sites, this species has large-scale habitat needs that are only met at a scale of tens or hundreds of square kilometres, or more. Activities that would be likely to result in destruction of floral resources and availability of nesting habitat such that their availability becomes limiting at a local scale are not currently considered likely to occur, and therefore are not included in Table 8. The description of activities likely to result in destruction of critical habitat will be updated if/when there is relevant new information on threats to suggest that large-scale landscape conversion is likely to occur at a scale that would limit the survival or recovery of Gypsy Cuckoo Bumble Bee.

1564 **Table 8.** Activities likely to result in the destruction of Critical Habitat.

Description of Activity	Description of Effect	Details of Effect
Release/escape of managed bumble bees (such as the Common Eastern Bumble Bee) through non-adherence to the Bumblebee Sector Guide to the National Bee Farm-level Biosecurity Standard (Canadian Food Inspection Agency 2013).	Gypsy Cuckoo Bumble Bee and its bumble bee hosts are vulnerable to fungal and other pathogens, which are endemic within managed bumble bees that can escape from greenhouses. The hosts of Gypsy Cuckoo Bumble Bee are apparently particularly vulnerable to these pathogens. Thus, activities within or outside the area of critical habitat that cause wild bumble bees to interact with managed bumble bees can result in habitat that has a high pathogenic load and a long-term reduction in host bumble bee nests. Outside its native range (e.g. BC), the Common Eastern Bumble Bee can reduce foraging habitat availability for Gypsy Cuckoo Bumble Bee and (especially) its hosts through competitive use of floral resources.	IUCN-CMP Threat 8.1 Invasive non-native/alien species and Threat 8.2 Problematic native species Use of bumble bees (especially Common Eastern Bumble Bee) in commercial greenhouses is widespread. Because managed bees that escape greenhouses often travel at least 1.5 km to forage[7], this activity may cause destruction of critical habitat both within or outside the bounds of critical habitat. This activity could cause destruction during the active flying season for host bumble bees; that is, between May and September.
Applications of insecticides, herbicides, or fungicides that are not in accordance with latest Health Canada (PMRA) regulations.	Gypsy Cuckoo Bumble Bee and (especially) its bumble bee hosts are sensitive to insecticides; thus, activities within or outside the area of critical habitat can result in habitat toxicity and consequent reduction in successful host bumble bee nests. Large-scale application of herbicides can also destroy foraging habitat for Gypsy Cuckoo Bumble Bee and its bumble bee hosts because it has the potential to cause widespread reduction in the availability of suitable flowering plants used as nectar or pollen sources in and around area of application. Fungicides are correlated with increased pathogen levels in the hosts of Gypsy Cuckoo Bumble Bee.	Related to IUCN-CMP Threat 9.3. Use/application of pesticides causing toxicity to Gypsy Cuckoo Bumble Bee habitat (including, but not limited to neonicotinoid insecticides) is widespread, particularly in southern portions of the species' range. Effects can be direct or cumulative. The cumulative threat from pesticides is likely more serious where human developments are concentrated. This activity may occur within or outside the bounds of critical habitat to cause its destruction (e.g., through drift).

[7] Bumble bees have been recorded foraging up to 2.2 km from their home colony (Kreyer et al. 2004), and Walther-Hellwig and Frankl (2000) found 25% of resightings between 1.5 and 1.75 km from the colony.

High density beekeeping: cumulative effects of Honey Bee industry on pollen availability	At higher densities, Honey Bees can outcompete native bumble bees for pollen needed to rear young.	Related to IUCN-CMP Threat 8.1 Pollen availability can be a limiting factor for bees. If Honey Bees are placed at high enough densities (i.e. if apiaries are too large or too numerous) within or adjacent to critical habitat, they can outcompete the Gypsy Cuckoo Bumble Bee's host bees for pollen. It is not possible to determine thresholds at this time; however direct and cumulative effects are increasing. This activity may occur within or outside the bounds of critical habitat to cause its destruction (i.e. within foraging range of Honey Bees, about 2.5 km).
Introduction and spread of pathogens from Honey Bee colonies; allowing diseased Honey Bees to be present in colonies through failure to inspect and remove diseased bees.	Honey Bees carry diseases that can be transmitted to native bumble bees, and thus reduce the number of host nests available to Gypsy Cuckoo Bumble Bee	Viral diseases in Honey Bees such as *deformed wing virus* can be transmitted from Honey Bees to native bumble bees; this is a serious potential threat to the Gypsy Cuckoo Bumble Bee and its hosts. This activity may occur within or outside the bounds of critical habitat to cause its destruction (i.e. within foraging range of Honey Bees, about 2.5 km).

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.The performance indicators below reflect measurable variables in relation to the short-term statements toward meeting the population and distribution objective as outlined in section 5:

- There is no observed, estimated, inferred or suspected reduction in the number of mature individuals of Gypsy Cuckoo Bumble Bee and its host bumble bees.
- The range (extent of occurrence) of Gypsy Cuckoo Bumble Bee is stable or increasing, with no loss of current (in 2020) known range areas.
- Appropriate location(s) of restoration sites in southeastern Canada have been identified.

9. Statement on Action Plans

One or more action plans for Gypsy Cuckoo Bumble Bee will be completed within ten years of the final version of this recovery strategy being posted on the Species at Risk Public Registry.

10. References

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Appendix A: Plant food sources for the Gypsy Cuckoo Bumble Bee and its hosts.

Bumble bees are generalist feeders; these are a few examples of genera they forage on, given in Williams *et al*. 2014.

Gypsy Cuckoo Bumble Bee: *Cirsium, Melilotus, Rubus, Rudbeckia, Solidago, Symphyotrichum, Trifolium, Vaccinium*

Rusty-patched Bumble Bee: *Aesculus, Agastache, Dalea, Eupatorium, Helianthus, Impatiens, Lonicera, Monarda, Prunus, Solidago, Vaccinium*

Yellow-banded Bumble Bee: *Crocus, Eupatorium, Linaria, Melilotus, Monarda, Ribes, Rosa, Rubus, Spiraea, Taraxacum, Vaccinium, Vicia*

Western Bumble Bee: *Ceanothus, Centaurea, Chrysothamnus, Cirsium,Geranium, Grindelia, Lupinus, Melilotus, Monardella, Rubus, Solidago, Trifolium*

Cryptic Bumble Bee: *Chamaenerion, Melilotus, Potentilla, Senecio*

Appendix B: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[8]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[9] (FSDS) goals and targets.

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

The recovery of the Gypsy Cuckoo Bumble Bee is predicated on conserving and recovering the populations and habitat of its host bumble bees—the Rusty-patched Bumble Bee, Yellow-banded Bumble Bee, Western Bumble Bee (both *occidentalis* and *mckayi* subspecies), and Cryptic Bumble Bee. These conservation efforts should benefit all bumble bees, as well as other insect pollinators such as the Monarch (*Danaus plexippus*). The approaches presented in Table 5 will likely benefit these other species by reducing bee pathogen transmission, as well as pesticide use.

Bumble bees in general, are important pollinators of many native flowering plants and crops (COSEWIC 2010, 2014b, 2015). They have several characteristics that contribute to their effectiveness as pollinators of crop plant species (Corbet *et al.* 1993). For example, they are able to fly at lower temperatures than other bees, which allows for a longer work day and improves pollination of crops during inclement weather. They also have the capacity to "buzz pollinate," which can increase the rate of pollination of plants. Some cultivated plants, such as tomato, pepper, and blueberries, benefit from buzz pollination (Jepsen *et al.* 2013). Bumble bees are likely the primary pollinators for many ecologically and economically important plants, including apples, raspberries, cranberries, blueberries, and clovers. They are excellent pollinators of crops such as alfalfa and onion (COSEWIC 2010, 2014b, 2015). They play a vital role as generalist pollinators of native flowering plants, and their decline or loss could have far-ranging impacts (Jepsen *et al*. 2013). It has been shown that the loss of bumble bees would cause a greater number of plant extinctions than would the loss of specialist pollinators (Memmott *et al.* 2004).

[8] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[9] www.fsds-sfdd.ca/index.html#/en/goals/

The potential for this recovery strategy to inadvertently lead to adverse effects on other species was considered. None of the measures proposed include activities that would negatively affect other species. The SEA concluded that this strategy will clearly benefit the environment and will not entail significant adverse effects.