PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the American Burying Beetle (*Nicrophorus americanus*) in Canada

American Burying Beetle

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

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[1] 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 SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the American Burying Beetle and has prepared this strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the province of Ontario as per section 39(1) of SARA.

It was determined that the recovery of the American Burying Beetle in Canada is not technically or biologically feasible. The species still may benefit from general conservation programs in the same geographic area and will receive protection through SARA and other federal, and provincial or territorial, legislation, policies, and programs.

The feasibility determination will be re-evaluated as part of the report on implementation of the recovery strategy, or as warranted in response to changing conditions and/or knowledge.

Under SARA, a recovery strategy sets the strategic direction to support recovery 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 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*.

[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.

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.

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

The initial draft of this document was prepared by Holly Bickerton (Consulting Ecologist) Additional preparation and literature review was completed by Laura Timms (Consulting Ecologist). This recovery strategy was drafted by Juliana Galvis-Amaya (formerly ECCC-CWS), Christina Rohe, Elisabeth Shapiro, Rachel DeCatanzaro (Environment and Climate Change Canada, Canadian Wildlife Service (ECCC-CWS) – Ontario), and Emma Hawley-Yan (formerly ECCC-CWS – Ontario). Judith Girard, Ken Tuininga, Krista Holmes (ECCC-CWS - Ontario), Marianne Gagnon (ECCC-CWS – Quebec), Jennifer De Almeida (Insectarium de Montréal), Carling Dewar and Lucy Ellis (Ministry of the Environment, Conservation and Parks) provided comments, advice and input during the development of this document.

Acknowledgment and thanks is given to all other parties that provided advice and input used to help inform the development of this recovery strategy.

Executive Summary

The American Burying Beetle (*Nicrophorus americanus*) is a large and conspicuous insect in the family Silphidae (carrion beetles). Formerly widespread over much of eastern North America, the beetle has declined dramatically throughout its range over the past century, and now occupies only a fraction of its former range extent. In Canada, the American Burying Beetle has been documented from eight locations in Ontario, with the most recent collection in 1972. Due to the length of time since the last observation, and multiple unsuccessful attempts to locate the species within its former Canadian range, the American Burying Beetle was assessed as extirpated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2011.

The American Burying Beetle is listed as Extirpated on Schedule 1 of the federal *Species at Risk Act* (SARA) and in Ontario under the *Endangered Species Act, 2007* (ESA). Reports also exist from Quebec, Nova Scotia and Manitoba, but these are considered unconfirmed, erroneous, and unsubstantiated, respectively. The species' current distribution includes three widely distributed populations in the United States.

The habitat requirements of this species in Canada are unknown. In the United States, it has been found in a variety of vegetated and open habitats, including deciduous and coniferous forest, tallgrass prairie, shrub thicket, mown fields and grazed pasture. There are likely several habitat requirements for the American Burying Beetle, including soil conditions required to undertake successful reproduction, a sufficient supply of suitably-sized carrion, limited abundance of predators, and minimal competition for carcasses. Predominant threats, including those that may have contributed to the species' extirpation from Canada, likely include habitat loss and fragmentation, a reduction in suitable carrion prey, and an increase in predation and competition.

Recovery in Canada for the American Burying Beetle is not considered to be biologically or technically feasible at this time. Because there are no known extant occurrences in Canada and all verified historical records occurred on land that is now heavily urbanized or agricultural, it is considered that sufficient suitable habitat is not currently available to support the species. Also, it is unknown if U.S. populations in the northern extent of the species current range are large enough to support reintroduction efforts or if the individuals are well-adapted to overwinter in Canada. The most considerable limitation for reintroduction into heavily-populated southwestern Ontario is a lack of sufficiently large contiguous habitat with diverse natural land cover to support the species' needs. The feasibility of recovery may be revised if population(s) are discovered in Canada, or if reintroduction from U.S. populations becomes appropriate.

Since there are currently no known populations in Canada and verified historical records provide no habitat information, critical habitat for the American Burying Beetle is not identified in this recovery strategy. A conservation approach addressing activities that may benefit the American Burying Beetle is presented in the Conservation Approach section (Section 6).

Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, the recovery of the American Burying Beetle has been determined not biologically or technically feasible at this time. Recovery is considered not feasible when the answer to any of the following questions is “no”.

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

   Unknown – The species has not been recorded in Canada since it was last collected in southern Ontario in 1972, and has been designated as extirpated from the country and as presumed/possibly extirpated from all states sharing the border with Canada (COSEWIC 2011).

   Although viable, natural populations exist in the U.S. and well-established captive populations could provide breeding and release stock, it is suspected that the origin of the captive population may influence its ability to adapt to the local conditions (e.g., varying climate regime) (U.S. Fish and Wildlife Service 2019). As such, it is unknown whether captive-bred beetles originating from the U.S. would be well-adapted to survive overwintering in Canada. While reintroduction efforts have made moderate progress in the U.S., intense management effort such as the continual stocking and ongoing provisioning of carrion resources (e.g., carcass of a small mammal or bird) is required. Additionally, it is yet to be determined whether or not a self-sustaining reintroduced population can be achieved (McKenna-Foster et al. 2016; USFWS 2019; Merz, B. pers. comm. 2019).

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

   No – The Canadian portion of the historical range likely included only southern Ontario. Records have also been reported from Nova Scotia and Quebec, but these reports have been investigated but remain unconfirmed. The reported presence of the species in Manitoba remains unsubstantiated (COSEWIC 2011).

   Due to the lack of information about suitable habitat requirements in Canada, and the low likelihood that it could be restored in a timely manner, it is considered that sufficient suitable habitat is not currently available, nor can it be made available in a reasonable timeframe to support the recovery of the American Burying Beetle in Canada.

   The specific habitat that the American Burying Beetle used in Canada is unknown, as there is no habitat information associated with any of the records from the eight reported locations (COSEWIC 2011). Based on extant populations in the U.S., the American Burying Beetle requires large, contiguous habitat with diverse natural land

cover to support a suitable carrion prey population, soil conditions suitable for excavation, and limited predator abundance and competition from scavengers (COSEWIC 2011). Since all verified historical occurrences of the species in Canada occurred on land that is now heavily urbanized or agricultural, it is unlikely that sufficient suitable habitat is available to support the American Burying Beetle at this time.

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

   Unknown – The primary threats for the decline of the American Burying Beetle across its North American range likely include reduced availability of suitable carrion for reproduction, and habitat loss and fragmentation (COSEWIC 2011). The extinction of the Passenger Pigeon (which provided an abundance of carrion) and significant declines in other formerly abundant, large avifauna (e.g., Greater Prairie Chicken, Northern Bobwhite) have been suggested as an important factor in the decline of the American Burying Beetle (Raithel 1991; COSEWIC 2011). Currently, there is insufficient information regarding whether a suitable carrion prey base exists or could be supported in southern Ontario to sustain a resilient[4] and redundant[5] population of American Burying Beetle.

   Much of the species' historical range in Canada has since been developed or modified for agricultural and urban land-use, and the effects associated with a heavily modified landscape would be difficult to mitigate in southern Ontario. More specifically, native and invasive species (e.g. coyotes, raccoons, domestic dogs and cats) can act both as predators of American Burying Beetle and competitors for carcass resources, which when combined lead to lower success of the American Burying Beetle (Trumbo and Bloch 2000; Prugh et al. 2009; Ritchie and Johnson 2009). This threat is increased in fragmented, urbanized and agricultural landscapes that support high numbers of these animals. Further, invasive species such as Garlic Mustard and European earthworms have heavily modified the soil and understory conditions in many Ontario forests, thereby decreasing the availability of soil that meets the requirements of the species (COSEWIC 2011).

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

   Unknown – Captive breeding and release programs have been ongoing in the U.S. for over two decades, and population monitoring and survey methods are well-established (USFWS 2019; Merz, B. pers. comm. 2019). Reintroduction efforts

[4] Resilience: a species that has large enough population size(s) to rebound from periodic disturbance and avoid demographic and genetic collapse is more likely to survive over the long-term

[5] Redundance: a species that has multiple (sub) populations or locations, or a distribution that is very widespread, is more likely to survive over the long term because of reduced risk of catastrophic loss or extirpation from a single, local event

have occurred in Massachusetts, Missouri, and Ohio (USFWS 2019). With the initial provisioning of carrion resources, the best results occurred in Missouri where reintroduced individuals have successfully overwintered and the population is closely monitored throughout the summer months using baited pitfall-traps (USFWS 2019; Merz, B. pers. comm. 2019). Although captive breeding and reintroduction efforts are underway and show promise in the U.S., at least 25 years of data is needed to document that a reintroduced population is self-sustaining (Merz, B. pers. comm. 2019). As of yet, it is unknown if American Burying Beetles from U.S. populations or reintroduction techniques are well suited to the Canadian environment. Research related to limiting factors and threats such as genetics, carrion resources, and competition would have to be completed for any potential reintroduction site (USFWS 2019).

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2011

Common Name (population): American Burying Beetle

Scientific Name: *Nicrophorus americanus*

COSEWIC Status: Extirpated

Reason for Designation: There is sufficient information to document that no individuals of the wildlife species remain alive in Canada. This includes that it: (1) is a large distinctive and conspicuous insect not seen for 39 generations; (2) has not been seen despite a tenfold increase in the number of field entomologists and an estimated 300,000 general trap nights of which at least some should have resulted in capture of this species, as well as studies of carrion-feeding beetles that did not reveal it; (3) comes to lights yet still not seen in thousands of light traps; and (4) a recent directed search in the general area where last seen 60 and 39 years ago that failed to find this species.

Canadian Occurrence: Ontario, Quebec

COSEWIC Status History: Designated Extirpated in November 2011

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

2. Species Status Information

The American Burying Beetle is listed as Extirpated[6] on Schedule 1 of the *Species at Risk Act* (SARA) (S.C. 2002, c.29). In Ontario, the species is listed as Extirpated[7] under the *Endangered Species Act*, 2007 (ESA) (S.O. 2007, c. 6). Under the ESA, Extirpated species receive protection, as does their habitat if prescribed in regulation. In Canada, the status of the American Burying Beetle is listed as Possibly Extirpated (NH) on a national scale and provincially as Possibly Extirpated (SH) in Ontario and Quebec (NatureServe 2021; Appendix B). However, reports of the American Burying Beetle in provinces outside of Ontario are considered to be unconfirmed (COSEWIC 2011). In the United States, the status of the American Burying Beetle is listed as Imperiled/Vulnerable (N2N3) on a national scale and as Presumed Extirpated (SX),

[6] Extirpated (SARA): a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
[7] Extirpated (ESA): a species that lives somewhere in the world, lived at one time in the wild in Ontario, but no longer lives in the wild in Ontario.

Possibly Extirpated (SH), Critically Imperiled (S1) or Vulnerable (S3) in 32 states (NatureServe 2021) (Appendix B). However, in 2020, the species was reclassified (downlisted) under the U.S. Endangered Species Act from Endangered to a Threatened; Experimental population, non-essential status (USFWS 2020). The International Union for Conservation of Nature (IUCN) lists the species as Critically Endangered (CR-A1c) indicating that more than 80% of the global population has disappeared and the species has experienced a decline in area of occupancy, extent of occurrence and/or habitat quality (World Conservation Monitoring Centre 1996; NatureServe 2021).

3. Species Information

3.1 Species Description

The American Burying Beetle is a terrestrial insect that passes through four distinct life stages: egg, larva, pupa and adult. It is a large, distinctive member of the Silphidae family of carrion beetles. Measuring between 25 and 35 mm in length, it is the largest of the 15 species in the *Nicrophorus* genus (carrion-feeding or sexton beetles) in North America. Its large size and bright orange markings distinguish it from other *Nicrophorus* species. The American Burying Beetle is ebony in colour, with pumpkin orange markings covering the elytra[8], pronotum[9], back of the head, and top of the antennae (COSEWIC 2011). Only the shape of the orange patch on the on the clypeus[10] at the front of the head head can differentiate females and males: females have a small, triangular marking and males have a large, rectangular marking (COSEWIC 2011). There are no proposed subspecies or species forms.

The vermiform (worm or caterpillar-like) larvae are white with sparse orange markings at the top of each segment (COSEWIC 2011). The average life span of the American Burying Beetle is approximately one year and it generally breeds only once. Age of adults is determined by the intensity of colour and the overall condition of the body and appendages (USFWS 2019). Adults are nocturnal and spend the day at rest in the leaf litter or burrowed into the soil (Bedick et al. 1999; Willemssens 2015).

3.2 Species Population and Distribution

The American Burying Beetle is found only in North America. The historical range of the species included most of temperate northeastern North America, from South Dakota in

[8] Hardened front wings which form a dorsal shell when retracted
[9] Large plate just behind the head and before the elytra
[10] A broad plate at the front of an insect's head

the west to Massachusetts in the east, and Michigan in the north to southern Texas in the south (USFWS 2019). Although the American Burying Beetle has been reported from Manitoba, Quebec, and Nova Scotia, it is likely the Canadian portion of the historical range included only southern Ontario. In 2010, multiple targeted surveys within its historical Canadian range resulted in no observations, and non-targeted surveys in Ontario have also resulted in no observations of the American Burying Beetle. As such, more than four decades (over 40 generations of the species) have passed since it was last observed in 1972, and there is no evidence that the species was ever widespread or abundant in Canada (COSEWIC 2011).

In Canada, there are records from eight locations across southern Ontario (Figure 1): Toronto (1896), St. Thomas (1925), Guelph (1930), Chatham (1930, 1936), Strathroy (1934), Harrow (1951, 1972), Hamilton (no date) and Port Sydney (no date). In Quebec, reports of the species are considered unconfirmed due to a lack in documentation of the specimen, and doubt in the location information provided by the collector (COSEWIC 2011). The report from Manitoba is unsubstantiated and the Nova Scotia report is considered to have been erroneously included in some databases (COSEWIC 2011).

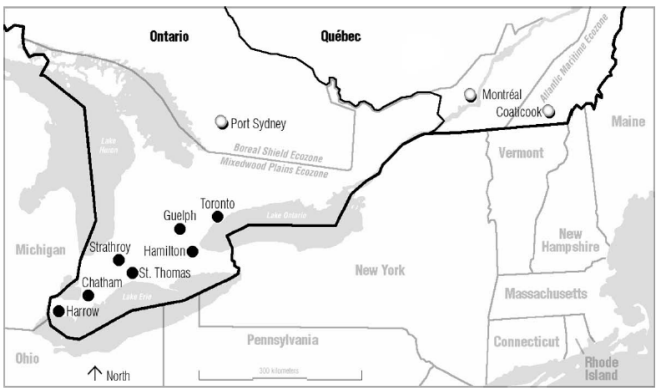

Figure 1. Historic Canadian range of the American Burying Beetle (filled black circles) and questionable records (open circles) (retrieved from COSEWIC 2011).

In the United States, the American Burying Beetle's historic range covered much of the Midwestern and eastern U.S., but now the species is restricted to an estimated 10% of this area, and is believed to be extirpated from all states neighbouring Canada (COSEWIC 2011). The species current distribution in the U.S. occurs in three rather distinct regions of the country (Figure 2). On Block Island off the southern coast of Rhode Island, in central Nebraska and a small area of adjacent South Dakota, in Eastern Oklahoma and areas of Kansas to the North, Arkansas to the east, and the northeastern edge of Texas to the south (USFWS 2019). A potential report of an

occurrence in Michigan in 2017 was investigated in 2018 but failed to confirm the species presence at this location; additional surveys are planned (USFWS 2019).

Reintroduction has occurred in four parts of the U.S., with varying success. On Penikese Island, Massachusetts, reintroduction efforts between 1990 and 1993 were initially successful, but the population collapsed after about eight years (Amaral et al. 1997; USFWS 2019). A reintroduction in Nantucket was initiated in 1993, but persisted only while carcasses were provided (Mckenna-Foster et al. 2016; USFWS 2019). Reintroduction in Missouri was initiated in 2011 and current survey results show strong evidence that the individuals released are successfully reproducing and overwintering; though it will be many more years of continued monitoring efforts before this population can be considered self-sustaining (USFWS 2019; Merz, B. pers. comms. 2019). Lastly, reintroduction efforts in Ohio were initiated in 1998 and have resulted in breeding success. However, monitoring efforts have yet to find evidence of any American Burying Beetles successfully overwintering (USFWS 2019).

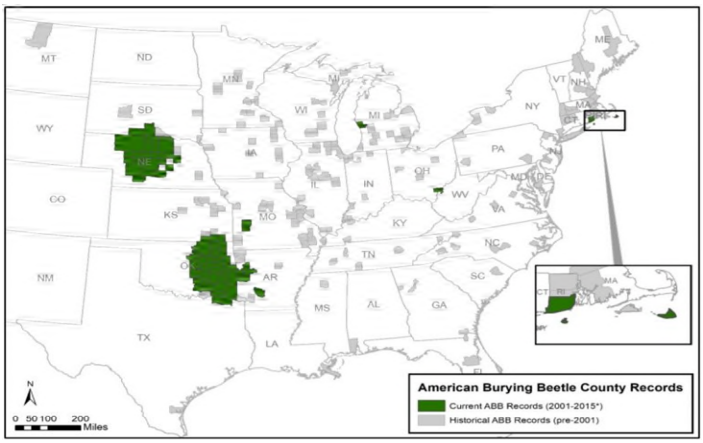

Figure 2. North American distribution of the American Burying Beetle from 1870 to 2015 (*2017 Michigan occurrence not included). Reintroductions have occurred in Missouri, Ohio, and Massachusetts on Penikese Island and Nantucket Island (retrieved from USFWS 2019).

3.3 Needs of the American Burying Beetle

The American Burying Beetle occurred in Canada in the Mixedwood Plains Ecozone, and possibly, in the southernmost part of the Boreal Shield Ecozone (COSEWIC 2011). However, because there are no Canadian records detailing precise habitat descriptions where the beetles were found, the best estimations of this species' needs are based on observations made of U.S. populations.

The American Burying Beetle occupies a variety of landforms and habitats in the United States (e.g., deciduous and coniferous forest, shrub thicket, tallgrass prairie, mown

fields and lightly grazed pasture), suggesting that it is a habitat generalist (USFWS 2019). As such, the predominant habitat requirements for this species are based not on any particular vegetation community, but on a combination of other factors, including availability of carrion, soil conditions, absence of predators and limited competition from scavengers (Sikes and Raithel 2002).

Life Cycle and Reproduction

Adults typically emerge from their overwintering sites and begin their active seasonal activities when temperatures exceed 15^{o}C (i.e., ~April in areas relevant to Canadian climate) (COSEWIC 2011). At this time, males may broadcast pheromones to attract a mate if a suitable carcass is found (see Availability of Carrion below) (Raithel 1991). The breeding pair will then move the carcass (i.e., carrying on their backs if feasible) until the soil is suitable for excavation / burial (see Soil Condition below) (COSEWIC 2011). A brood chamber is then excavated with a restricted exit tunnel to the surface and the carcass is prepared (i.e., fur or feathers removed and treated with anal and oral secretions to reduce both decay and invasion from other carrion-brooding insects (e.g., fly maggots) (Raithel 1991; COSEWIC 2011). Females lay eggs in the exit tunnel and after a couple of days, the larvae hatch. The adults (at least the female) will remain in the brood chamber to help protect the brood and carcass from competitors and to continue to tend to the carcass (i.e., remove fungi and continue to coat with secretions to control bacterial growth) (COSEWIC 2011). The adults will feed regurgitated food to the larvae until they can feed from the carcass themselves (COSEWIC 2011). Larvae pupate in soil near the brood chamber and emerge 48 to 60 days later as adults (Raithel 1991). Adult American Burying Beetle typically live for only 12 months.

Availability of Carrion

Like other beetles in the carrion beetle family (Silphidae), the American Burying Beetle is dependent on vertebrate carcasses for both adult and larval food. While captive-bred adults will consume mealworms (Jurzenski 2012), the availability of appropriately-sized carcasses is an important requirement for successful reproduction of this species (Sikes and Raithel 2002).

Adult beetles may feed on carcasses of any size, but the optimum size for reproduction is approximately 100 – 250 grams or a medium-sized rat (Kozol et al. 1988; Trumbo 1992; COSEWIC 2011). American Burying Beetles can use smaller carcasses for reproduction, however these typically support fewer larvae, and are more quickly consumed by scavengers (Kozol et al. 1988; USFWS 2019). Alternatively, carcasses larger than the optimum size may prove difficult to bury and maintain for reproduction (USFWS 2019). Varieties of carrion species have been documented to be used,

however, the most commonly used carcasses include those of small mammals and birds (COSEWIC 2011). Notably, the extinction of the Passenger Pigeon (*Ectopistes migratorius*) is considered to have contributed to the decline of the American Burying Beetle as this was once an abundant species of the optimal size that would have been a consistent source of carrion (Sikes and Raithel 2002). The reduction in range of the Greater Prairie Chicken (*Tympanuchus cupido*) and Northern Bobwhite (*Colinus virginianus*), both of which were abundant species in the 19th century, could also have contributed to the decline of the American Burying Beetle (Sikes and Raithel 2002). Finally, the now discontinued practice of fertilizing agricultural fields with fish carcasses and human middens[11] may have historically provided a source of brood carcass for the American Burying Beetle (Raithel 1991; COSEWIC 2011).

Soil Condition

Soil plays an important role in supporting the American Burying Beetle's life cycle processes (see COSEWIC 2011 – Life cycle and reproduction). The soil must be loose and moist for digging, well drained so it does not flood, and with enough structural integrity to prevent brood chamber collapse (USFWS 1991); in eastern North America, soils of this type occur mainly in undisturbed deciduous forest (COSEWIC 2011). Adults burrow into the soil during periods of inactivity, such as during the day, to avoid desiccation and predation (Willemssens 2015). Immature adults and aging beetles also burrow into the soil to overwinter (USFWS 2019).

Soil moisture and compaction are particularly important factors, as it appears that American Burying Beetles consistently show a preference for easily compressible soils with a high moisture content (Jurzenski 2012; Willemssens 2015). These preferred characteristics allow individuals to bury carrion efficiently to avoid competition for carcasses and prevent desiccation (Bedick et al. 2006; Willemssens 2015). In Arkansas, trapping success for American Burying Beetle increased in soils with more than 40% sand, and below 50% silt and 20% clay (Lomolino et al. 1995). Similarly, loamy sands[12] were a significant predictor of American Burying Beetle presence in a habitat suitability model for the Nebraska Sandhills regions (Jurzenski et al. 2014), as well as in a model of the southern portion of the species' continental distribution (Leasure and Hoback 2017). The American Burying Beetle does not have strict vegetation requirements, however, the presence of a loose organic litter layer (e.g., decaying leaves) could be important for efficient carrion burial, as indicated by the

[11] A heap of dung or refuse
[12] Soils made up of mostly sand with varying amounts of silt and clay

greater breeding success in forests as compared to grasslands (Lomolino and Creighton 1996; Willemssens 2015).

Absence of predators

The habitats most likely to support American Burying Beetle are those with an abundance in bird and mammal species, and low numbers of wild and domestic predators (COSEWIC 2011). The naturally occurring population of American Burying Beetle on Block Island is thought to be advantaged by a lack of predatory mammals such as the Coyote (*Canis latrans*) and Virginia Opossum (*Didelphis virginiana*) (Raithel 1991) which are presumably direct predators of American Burying Beetle and of suitable carrion species (small mammals and birds) (COSEWIC 2011; USFWS 2019). Raccoons (*Procyon lotor*) and domestic dogs (*Canus lupis familiaris*) and cats (*Felis catus*) are also known to prey on adult beetles and are able to efficiently detect and disturb buried carcasses (COSEWIC 2011).

Limited competition for carrion

The American Burying Beetle must compete with other species for carrion resources. Opportunistic scavengers (feed on any dead animal) such as crows, raccoons, opossums, and coyotes reduce the number of carcasses available for food and reproduction (COSEWIC 2011; USFWS 2019). In addition, reduced populations of species that act as sources of carcasses increases competition amongst carrion-feeding species (See COSEWIC 2011 – Reduction of carcass resources).

4. Threats

4.1 Threat Assessment

The American Burying Beetle threat assessment is based on the IUCN-CMP (International Union for Conservation of Nature - Conservation Measures Partnership) unified threats classification system (IUCN-CMP 2016). 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) (Salafsky et al. 2008). Limiting factors are not considered during this process.

A threat assessment[13] is not presented for the American Burying Beetle as no extant locations[14] are known for this species in Canada, and therefore, threats cannot be scored for scope[15] or severity[16] to determine individual threat impacts[17]; nor is it possible to estimate the overall threat impact[18] at this time.

Historical threats, indirect or cumulative effects of the threats, as well as threats that can be hypothesized to affect future reintroduced populations (based on threats affecting naturally occurring and reintroduced populations in the U.S.) are presented in the Description of Threats section.

4.2 Description of Threats

The primary causes of the species global decline and regional extirpation in Canada are largely uncertain. However, the conversion and fragmentation of habitat are considered likely factors that not only decreased the availability of suitable areas, but contributed to multiple other associated pressures (e.g., increase of direct predators to adult beetles and/or larvae through the predation of excavated carrion; reduced availability and increased competition for suitable carrion host species; road mortalities; and spread of invasive species) (Dobbyn et al. 1994; Cadman et al. 2007; COSEWIC 2011). Many of these threats continue to pose a risk to remnant and reintroduced populations in the

[13] Threat assessments presented in Recovery Strategies are based on the IUCN-CMP (World Conservation Union – Conservation Measures Partnership) unified threats classification system.
[14] The term 'location' in relation to the IUCN-CMP, defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations.
[15] **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%).
[16] **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%).
[17] **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 neutral or potential benefit.
[18] The overall threat impact is calculated following Master et al (2012) using the number of Level 1 Threats assigned to this species. The overall threat considers the cumulative impacts of multiple threats.

U.S. and selection of habitat for any future reintroduction of the species should take these into account.

Threats are discussed below under the Threat Level 1 headings which are listed here in numerical order.

IUCN Threat #1. Residential & commercial development

1.1 Housing & urban areas; 1.2 Commercial & industrial areas

The American Burying Beetle's historical range in Canada likely included only southern Ontario, where approximately 36% of the country's human population is found (Statistics Canada 2017). The conversion of forest woodlots and grasslands into residential and commercial lands results in the loss and fragmentation of the American Burying Beetle's habitat, two stresses that have greatly contributed to the species' extirpation primarily due to the indirect effects development has had on the availability of suitable carrion, predator abundance, and competition (see IUCN Threat 8) (Dobbyn et al. 1994; Cadman et al. 2007). Trumbo and Bloch (2000) found a lower relative success of four *Nicrophorus* species in smaller woodlands over larger woodlands, which is attributed in part to a reduced number of carcasses available to meet the species' needs. The rapid rate at which available carcasses are found and consumed in fragmented landscapes is likely due to an increased number of access points for predators and competitors and the reduced search area for carrion, caused by sparse distribution of habitat (USFWS 2019).

As most extant U.S. populations of American Burying Beetle occur in relatively remote and lightless areas, the increased use of artificial lighting in developed areas during the late 1800s has been suggested as a factor in the decline of the species (i.e., potential negative impacts of night-flying insects attraction to fluoresecent lights and/or related land-use changes and fragmentation associated with the artificial lighting) (Sikes and Raithel 2002; USFWS 2019). However, this constitutes a minor threat, due to the apparent lack of impact on other light-attracted *Nicrophorus* species (see COSEWIC 2011- Direct impacts).

IUCN Threat #2. Agriculture & aquaculture

2.1 Annual & perennial non-timber crops

The conversion of forests and grasslands into agricultural lands poses a particularly important threat to the species in eastern North America. A range-wide model of

continental American Burying Beetle distribution in relation to environmental variables found that throughout its current range, this species is negatively associated with cultivated croplands (Leasure and Hoback 2017). Generally, plant monocultures and cropland influence the abundance and composition of carrion resources (Jurzenski 2012) and species that thrive in agricultural landscapes are not suitable carrion to support American Burying Beetle (Holloway and Schnell 1997). For example, in agricultural landscapes in the southern U.S., populations of unsuitable carrion species such as the Deer Mouse (*Peromyscus maniculatus*) increased in grazed and moderately overgrazed pastures, while suitable potential carrion species such as the Hispid Cotton Rat (*Sigmodon hispidus*) decreased in abundance (Holloway and Schnell 1997). Similarly, the decline of grassland birds and other ground nesting species due to conversion to croplands may be particularly significant to the American Burying Beetle, because birds such at the Passenger Pigeon and Greater Prairie Chicken provided an abundant source of carcasses suitable for American Burying Beetle feeding and reproduction (COSEWIC 2011).

The use of insecticides, particularly DDT, was initially considered a factor in the decline of American Burying Beetle (USFWS 1991). However, its widespread use occurred more than two decades after the major American Burying Beetle decline and it is unlikely to have been the only cause due to the lack of impact seen in other *Nicrophorus* species populations (Kozol et al. 1988; Raithel 1991; Sikes and Raithel 2002).

While the conversion of land to agriculture in southern Ontario has decreased, verified records of American Burying Beetle occurred on lands that are now highly fragmented agricultural landscapes, making it a current and ongoing threat for consideration should American Burying Beetle be reintroduced in Canada (Jalava et al. 2015).

IUCN Threat #4. Transportation & service corridors

4.1 Roads & railroads

The American Burying Beetle may travel more than 1 km in search of suitable carrion (Creighton and Schnell 1998; Bedick et al. 1999). Increased road density in southern Ontario may pose a direct threat to the American Burying Beetle through road mortality and increased presence of suitable carrion on roadsides (roadkill) where little appropriate burying habitat exists (See COSEWIC 2011- Direct impacts).

IUCN Threat #7. Natural system modifications

7.3 Other ecosystem modifications

In many Ontario forests, invasive species such as European earthworm (*Lumbricidae*), Garlic Mustard (*Alliaria petiolata*) and Buckthorn (*Rhamnus cathartica*) have modified the soil and understory conditions (Stinson et al. 2006; Knight et al. 2007; Craven et al. 2016). Heavily altered soil that cannot be easily excavated or proves unsuitable for the formation of brood chambers leaves adult beetles vulnerable to predation and increases the likelihood of carcass detection by scavengers (Gibbs and Stanton 2001; COSEWIC 2011). Soil compaction also prevents young from emerging the following spring and reduces water infiltration, increasing the risk of desiccation during periods of inactivity (Lomolino and Creighton 1996; Meadows et al. 2008; USFWS 2019). Additionally, cascading effects caused by these invasive species have had impacts on populations of suitable carrion hosts such as the negative relationship observed between introduced earthworms and some ground nesting birds (Loss et al. 2012).

IUCN Threat #8. Invasive & other problematic species & genes

8.1 Invasive non-native/alien species/diseases

Invasive species may prey upon American Burying Beetle or compete for carrion resources. In southern Ontario, the European Fire Ant (*Myrmica rubra*) is known to form large colonies that can displace other arthropods, competes for carcasses, and could predate American Burying Beetles when they co-occur at a food or reproductive source (Scott et al. 1987; USFWS 2019). Similarly, free-ranging domestic dogs and cats likely prey upon adult American Burying Beetles and disturb larvae-bearing carcasses (Raithel 1991; COSEWIC 2011).

The presence of a disease or pathogen specific to American Burying Beetle has been hypothesized to account for the pattern of decline not exhibited by other *Nicrophorus* species in North America. However, no evidence of such species-specific disease is available to verify this hypothesis (Sikes and Raithel 2002; USFWS 2019).

8.2 Problematic native species

An increase in direct predation and competition for carrion are likely the major contributing factors to the American Burying Beetle’s extirpation from many regions (Sikes and Raithel 2002; COSEWIC 2011). Vertebrates such as the Coyote, Virginia

Opossum, Striped Skunk (*Mephitis mephitis*), American Crow (*Corvus brachyrhynchos*), Raccoon, and Red Fox (*Vulpes vulpes*) are suspected predators of adult American Burying Beetles and larvae-bearing carcasses (Raithel 1991; COSEWIC 2011). Additionally, the availability of suitable carrion decreases with an increase in vertebrate scavengers as most are also carrion eaters (Jurzenski & Hoback, 2011; Jurzenski et al., 2014). Several of theses species have increased substantially in both abundance and range over the last century (Garrot et al. 1993, Sikes and Raithel 2002) due to the low density or absence of top predators and increased food availability from human sources (e.g. food handouts, garbage, crops) (Mitchell and Klemens 2000), coinciding with the period of major decline in the American Burying Beetle's range.

5. Critical Habitat

5.1 Identification of the Species' Critical Habitat

Section 41(2) of SARA requires that if the recovery of a listed wildlife species is not feasible, the recovery strategy must include an identification of the species' critical habitat to the extent possible. Under SARA, critical habitat is "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

Critical habitat for the American Burying Beetle in Canada is not identified in this federal recovery strategy due to the need to confirm the geographic location(s) and specific biophysical attributes of critical habitat at Canadian locations. Despite targeted searches in potentially suitable habitat in southern Ontario, no individuals have been found since 1972; the American Burying Beetle has been designated as extirpated from the country as well as from all states sharing the border with Canada (COSEWIC 2011).

Given the existing knowledge gaps regarding the historical condition of American Burying Beetle in Ontario, and the lack of information on the attributes of suitable habitat for this species in Canada, it is unlikely that sufficient habitat could be made available to support a resilient and redundant Canadian population in a reasonable timeframe. Most significantly, the historically known Canadian range is now heavily urbanized or agricultural, and therefore no longer likely to provide suitable habitat for the species.

6. Conservation Approach

The recovery of the American Burying Beetle in Canada is not considered technically and biologically feasible at the present time. Recovery of the species may become feasible if a population is found in Canada and/or if reintroduction from an external

source is deemed feasible and appropriate. The conservation approach table (Table 1) provides guidance on activities that would be beneficial for the species in Canada. The IUCN's Guidelines for Reintroductions and Other Conservation Translocations (IUCN 2013) should be used to assess the feasibility of population restoration and the associated risks, along with information available from reintroduction efforts already underway in the United States (see section 3.2).

685
686 Table 1. Conservation approach for American Burying Beetle in Canada.

Conservation Measure Category*	Description of Activity	Rationale
10.3.2 Alliance & Partnership Development – Knowledge Generation & Sharing	Raise awareness of the American Burying Beetle with key focal groups (e.g., entomological societies, environmental consultants, conservation authorities)	Recovery of the species may become feasible if a population is found in Canada. Nicrophorus species are often discarded from traps during entomological (insect) surveys as they are considered nuisances.
8.1.1 Research & Monitoring – Basic Research & Status Monitoring	Determine if reintroduction is feasible and appropriate: - Conduct a detailed habitat assessment based upon known habitat attributes in the beetle's current range - Identify a source population that could support harvesting for reintroduction purposes and meets the climate requirements to ensure survival in Canada. - Conduct a risk assessment considering the benefits and the potential negative impacts related to ecological aspects of a reintroduction (e.g., risks to source populations or ecosystems).	The primary limitation to reintroducing the American Burying Beetle in Canada is thought to be a lack of suitably large areas of habitat, where factors identified as a threat to the species are either minimal, or can be controlled. An assessment of available habitat would thoroughly evaluate a number of candidate natural areas in southern Ontario. The climate at an identified destination site should be suitable for the current and future climate requirements of the American Burying Beetle.Therefore, founder beetles should originate from habitats that are similar to the destination as these may be more genetically suited to destination conditions. Consequences affecting both the translocated species and other species or ecological processes in the destination community must be understood and addressed prior to deciding whether or not a reintroduction programme should be established.
10.3.1 Alliance & Partnership Development – Coordinating Conservation Implementation	If reintroduction is determined to be feasible and appropriate, investigate the potential for building partnerships between U.S. and Canadian zoos and universities to support a reintroduction program.	Collaboration with experts conducting reintroductions in other jurisdictions would be beneficial to making best use of resources. These partnerships would be necessary for the planning and provisioning of American Burying Beetle individuals and the overall success of reintroduction efforts.

8.1.1 Basic Research & Status Monitoiring – Biological Targets	Conduct species monitoring and follow-up work (e.g. confirmation) on American Burying Beetle observations should the species be discovered or rediscovered by individuals during surveys done for other species in Ontario and Quebec.	Confirm presence and distribution of the species and its suitable habitat in Canada.

687 * Based on the IUCN-CMP (International Union for Conservation of Nature - Conservation Measures Partnership) conservation actions classification system
688 (IUCN-CMP 2016).

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[19]. 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[20] (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.

Should a population of American Burying Beetle be discovered and/or reintroduction of the species be considered, recovery planning impacts on non-target species in southern Ontario will need to be taken into account. Any recovery planning activities for the American Burying Beetle will be implemented with consideration of all co-occurring species at risk, such that there are no negative impacts to these species or their habitats.

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

Appendix B: Conservation Status Ranks of the American Burying Beetle (*Nicrophorus americanus*)

Table B-1. Conservation ranks of the American Burying Beetle (*Nicrophorus americanus*)

American Burying Beetle (*Nicrophorus americanus*)				
Global (G) Rank	**National (N) Rank (Canada)**	**Subnational (S) Rank (Canada)**	**National (N) Rank (United States)**	**Subnational (S) Rank (United States)**
G2G3	NH	Ontario (SH) Quebec (SH) Manitoba (SH)	N2N3	Alabama (SH), Arkansas (S1), Connecticut (SX), Delaware (SX), Florida (SH), Georgia (SX), Illinois (SH), Indiana (SX), Kansas (S1), Kentucky (SX), Louisiana (SH), Maine (SX), Maryland (SX), Massachusetts (S1), Michigan (SH), Minnesota (SX), Mississippi (SX), Missouri (SH), Nebraska (S3?), New Jersey (S1), New York (SH), North Carolina (SH), Ohio (SX), Oklahoma (S1), Pennsylvania (SH), Rhode Island (S1), South Carolina (SH), South Dakota (S1), Tennessee (SH), Texas (S1), Virginia (SH), Wisconsin (SX)

Source: NatureServe 2021

Table B-2. Definitions Global (G), National (N) and Subnational (S) Conservation Status Ranks (Master et al. 2012).

Rank	Definition
S1	Critically Imperiled— At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
G2 N2	Imperiled— At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3 N3	Vulnerable— At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G#G# N#N#	Range Rank— A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
NH SH	Possibly Extirpated— Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
SU	Unrankable— Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SX	Presumed Extirpated—Species or community is believed to be extirpated from the nation or state/province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.