COSEWIC
Assessment and Status Report

on the

Hungerford's Crawling Water Beetle
Brychius hungerfordi

in Canada

ENDANGERED
2011

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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Hungerford's Crawling Water Beetle — Photo provided by S.A. Marshall, University of Guelph.

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COSEWIC
Assessment Summary

Assessment Summary – May 2011

Common name
Hungerford's Crawling Water Beetle

Scientific name
Brychius hungerfordi

Status
Endangered

Reason for designation
A probable early postglacial relict, this water beetle is endemic to the upper Great Lakes and is Endangered in the U.S. In Canada, it is restricted to a small area and is known from only 3 locations in Ontario. This species has declined and may be extirpated at the North Saugeen River. It is threatened by further planned developments at the North Saugeen and Saugeen River locations, by hydrological alterations at the Rankin River location, and by continuing declines in water quality due to events associated with increasing human population at all locations.

Occurrence
Ontario

Status history
Designated Endangered in May 2011.

COSEWIC
Executive Summary

Hungerford's Crawling Water Beetle
Brychius hungerfordi

Wildlife species description and significance

Brychius hungerfordi, or Hungerford's Crawling Water Beetle, is a small insect 3.7-4.4 mm long and yellowish-brown in colour with irregular dark stripes on the back. The larvae are long and slender with a distinctive curved hook at the tip of the abdomen.

Distribution

Hungerford's Crawling Water Beetle is endemic to the Great Lakes region with approximately 40% of its distribution in Canada. All Canadian populations are found within Ontario. The species is restricted to five streams in three counties (Emmet, Montmorency and Presque Isle) in northern Michigan and to three rivers (the Rankin, the North Saugeen and the Saugeen) in Bruce County, Ontario. Over the last 10 years the possible loss of one of three locations has been documented.

Habitat

Hungerford's Crawling Water Beetle is a specialist of small to medium-sized streams characterized by a moderate to fast flow, good stream aeration, cool temperatures (15°C to 25°C), inorganic substrate, and alkaline water conditions. Populations are often, but not always, found immediately downstream from culverts, beaver dams, and human-made dams. The presence of the alga *Dichotomosiphon* may be a critical component of the habitat because the beetle larvae appear to be very dependent upon it as a food source. Some areas within two watersheds (Saugeen and Grey-Sauble) containing Hungerford's Crawling Water Beetle are relatively pristine while others are very degraded. Poor agricultural practices, wetland degradation, impoundment and other watercourse alterations, and urban development are current threats in these watersheds. There is some evidence that the habitat at the location on the North Saugeen River has been impacted in such a way that may have led to a decline or loss of the Hungerford's Crawling Water Beetle population.

Biology

Hungerford's Crawling Water Beetle has four life stages: egg, larva, pupa and adult. The egg stage has not been described nor has egg-laying been observed for Hungerford's Crawling Water Beetle, but based upon studies of closely related species, females probably lay their eggs in spring or early summer on or in aquatic plants. The larvae are herbivorous and a recent study suggests that they may specialize upon the filamentous alga *Dichotomosiphon tuberosus*. The larvae probably feed and grow until the fall when they then move from the water to damp soil along the edge of the river where they probably remain over the winter. The following spring, they likely transform from larvae to adults before returning to the water. The adult beetles may live as long as 18 months.

Population sizes and trends

Population size at each of the three known locations in Canada is unknown. In Michigan, the population in a single pool was estimated to consist of approximately 1100 individuals. Over a three-year period the population size remained fairly constant. There are little data on year-to-year fluctuations or trends of Hungerford's Crawling Water Beetle populations in Canada. One of the Canadian populations has declined or is possibly extirpated.

Threats and limiting factors

Although the habitat requirements of Hungerford's Crawling Water Beetle are not fully understood, it is likely that threats to this species include any activities that degrade water quality or remove or disrupt the pools and riffle environment of streams in which this species lives. Such threats may include stream modification (e.g., channelization, dredging, bank stabilization, erosion control, and impoundment), pollution, impacts to the groundwater quality and quantity and invasive alien species.

Alternations to stream flow as a result of waterpower development, waterpower management regimes, permits to take water (either surface water directly from the stream or groundwater that may feed the stream), discharge of storm water and other activities may also impact Hungerford's Crawling Water Beetle populations by altering the hydrology, temperature, substrate and water chemistry of the stream. These activities all currently occur in the three Canadian watersheds where Hungerford's Crawling Water Beetles are found. Such activities and the resulting changes to stream flow could also impact the shoreline pupation sites of this beetle (e.g., through erosion and/or flooding).

One Canadian location is adjacent to lands where an expansion to a landfill site is proposed. Such an expansion could have impacts on groundwater quality which may result in negative direct or indirect effects upon the Hungerford's Crawling Water Beetle population at this location.

Protection, status, and ranks

Hungerford's Crawling Water Beetle is listed as endangered in the United States both federally and by the state of Michigan, the only state in which it occurs. It is not protected under any species at risk legislation in Canada.

None of the locations where Hungerford's Crawling Water Beetle are found are within provincial or federal parks. The Rankin River location is largely surrounded by Crown land and land managed by the Grey-Sauble Conservation authority and Bruce County.

This species receives some protection under the Ontario provincial *Planning Act*. Indirectly, it may receive some protection under other regulations and acts (e.g., locally under the *Development, Interference with Wetlands and Alteration to Shorelines and Watercourses Regulations*, provincially under the *Conservation Authorities Act, Lakes and Rivers Improvement Act, Nutrient Management Act, Environmental Assessment Act, Environmental Protection Act, Water Resources Act,* and *Source Water Protection Act* and federally under the *Fisheries Act*).

TECHNICAL SUMMARY

Brychius hungerfordi
Hungerford's Crawling Water Beetle — Haliplide de Hungerford
Range of occurrence in Canada: Ontario

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2008) is being used)	unknown but likely no more than 1.5 yrs as a larva
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	unknown, but may be extirpated at one location
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over the last 10 years, or 3 generations. *Although it may be extirpated at one location, the lack of information on population size and fluctuations makes make decline impossible to determine with accuracy.*	unknown
Projected or suspected percent reduction or increase in total number of mature individuals over the next 10 years, or 3 generations.	unknown
Inferred, or suspected percent reduction in total number of mature individuals over any 10 years period, over a time period including both the past and the future.	unknown
Are the causes of the decline clearly reversible and understood and ceased?	not applicable
Are there extreme fluctuations in number of mature individuals?	unknown

Extent and Occupancy Information

Estimated extent of occurrence	36 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value; other values may also be listed if they are clearly indicated (e.g.,, 1x1 grid, biological AO)).	12 km²
Is the total population severely fragmented? *Only 33% of 3 habitat patches may be too small to be viable.*	no
Number of "locations∗"	3 (but one has declined and may be extirpated)
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	yes, but not certain
Is there an inferred continuing decline in index of area of occupancy?	yes, but not certain
Is there an observed, inferred, or projected continuing decline in number of populations?	yes, but not certain
Is there an inferred continuing decline in number of locations?	yes, but not certain
Is there an inferred continuing decline in quality of habitat?	yes
Are there extreme fluctuations in number of populations?	no
Are there extreme fluctuations in number of locations∗?	no
Are there extreme fluctuations in extent of occurrence?	no
Are there extreme fluctuations in index of area of occupancy?	no

∗ See definition of location.

Number of Mature Individuals (in each population)

Population	N Mature Individuals
North Saugeen River	unknown
Saugeen River	unknown
Rankin River	unknown
Total	unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	n/a

Threats (actual or imminent, to populations or habitats)

Threats to this species include any activities that degrade water quality or remove or disrupt the pools and riffle environment of streams in which this species lives, or otherwise influence stream ecology. Such threats may include stream modification (e.g., channelization, dredging, bank stabilization, erosion control, and impoundment), pollution, and introduction of alien species.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Probably stable	
Is immigration known or possible?	possible but unlikely
Would immigrants be adapted to survive in Canada?	probably
Is there sufficient habitat for immigrants in Canada?	unknown
Is rescue from outside populations likely?	unknown

Current Status

COSEWIC: Designated as Endangered in May 2011

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ab(iii)+2ab(iii)

Reasons for designation:
A probable early postglacial relict, this water beetle is endemic to the upper Great Lakes and is Endangered in the U.S. In Canada, it is restricted to a small area and is known from only 3 locations in Ontario. This species has declined and may be extirpated at the North Saugeen River. It is threatened by further planned developments at the North Saugeen and Saugeen River locations, by hydrological alterations at the Rankin River location, and by continuing declines in water quality due to events associated with increasing human population at all locations.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable as the total number of mature individuals is unknown.

Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered under B1ab(iii)+2ab(iii) as the extent of occurrence (36km^2) and the index of area of occupancy (12km^2) are lower than the Endangered thresholds, there are fewer than 5 locations, and there is a continuing decline in the quality of habitat.

Criterion C (Small and Declining Number of Mature Individuals): Not applicable as the total number of mature individuals is unknown.

Criterion D (Very Small or Restricted Total Population): Meets Threatened under D2 as the index of area of occupancy (12 km^2) is small, there are only 2 or 3 locations, and there is evidence that human activities over the short time span of the past 10 years, and that are continuing, may have already resulted in the loss of one location and may affect another.

Criterion E (Quantitative Analysis): Not available.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2011)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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Hungerford's Crawling Water Beetle

Brychius hungerfordi

in Canada

2011

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Kingdom Animalia - Animal, animals, animaux
Phylum Arthropoda - arthropodes, arthropods, Artrópode
Subphylum Hexapoda - hexapods
Class Insecta - hexapoda, insectes, insects, inseto
Subclass Pterygota - insects ailés, winged insects
Infraclass Neoptera - modern, wing-folding insects
Order Coleoptera Linnaeus, 1758 - beetles, besouro, coléoptères
Suborder Adephaga Schellenberg, 1806
Family Haliplidae Aubé, 1836 - haliplids, crawling water beetles
Genus *Brychius* Thomson, 1859
Species *Brychius hungerfordi* Spangler, 1954 - Hungerford's Crawling Water Beetle, haliplide de Hungerford

Brychius hungerfordi Spangler, 1954, or Hungerford's Crawling Water Beetle is an insect of the order Coleoptera (beetles), and the family Haliplidae, (crawling water beetles or haliplids). Spangler (1954) described the species, based upon adult specimens. Many years later, Strand and Spangler (1994) described the larval stage.

The species is distinct and there are no subspecies or species forms.

Morphological description

Insects in the order Coleoptera (Beetles) are characterized by the hardened forewings or elytra that fold over the back enclosing and protecting the membranous hind wings underneath. The life history of beetles progresses through four stages of development: egg, larva, pupa and adult.

Hungerford's Crawling Water Beetle (Figure 1) is a small aquatic beetle in the family Haliplidae. All adult haliplid beetles are small, ranging from 1.5 - 5 mm in length (Roughley 2001) and can be distinguished from other small beetles by the extremely large coxal plates at the bases of the hind legs (Figure 2). There are three genera of haliplids in North America: *Brychius*, *Haliplus* and *Peltodytes* (Roughley 2001). All haliplids are yellowish to yellowish-brown in colour with the elytra usually exhibiting darkened spots or stripes, as well as longitudinally-oriented rows of punctures, darkened in most species (Matheson 1912, Roughley 2001).

Figure 1. Adult Hungerford's Crawling Water Beetle. The beetle is about 4 mm long from the tip of the head to the tip of the elytra. Photo provided by S.A. Marshall, University of Guelph.

Figure 2. Ventral view of an adult Hungerford's Crawling Water Beetle from the Saugeen River in 2008. Note the enlarged hind coxal plates, a key feature of the beetle family Haliplidae. Photo provided by S.A. Marshall, University of Guelph.

Adult *Brychius* (of which there are three species in North America) can be distinguished from other North American haliplid genera (*Haliplus* and *Peltodytes*) by their overall shape. The bodies of *Brychius* gradually taper toward the hind end and, as such, appear more elongate and torpedo-shaped, unlike the rounded shape of *Haliplus* and *Peltodytes*. Also, the sides of the pronotum (the dorsal plate between the head and the base of the wings) of *Brychius* are much more parallel-sided than in the other two genera creating a bell-shape (Roughley 2001). *Brychius* larvae have a distinctive curved urogomphus (a process on the final abdominal segment) (Figure 3), a feature that separates them from other aquatic beetle larvae (Mousseau and Roughley 2007).

Figure 3. Larval Hungerford's Crawling Water Beetle from the Rankin River in August 2008. Note the curved urogomphus at the tip of the abdomen. Photo by C.D. Jones.

Within the genus *Brychius,* adult *B. hungerfordi* can be distinguished from the other two species (*B. hornii* and *B. pacificus*) by the denticulate (finely toothed) margins of the elytra; by the presence of a thick black band on the basal margin of the pronotum; and by its larger average size. Adult *B. hungerfordi* have a total body length of 3.7 - 4.4 mm and a maximum body width of 1.90 - 2.25 mm (Mousseau and Roughley 2007). *Brychius hungerfordi* is the only *Brychius* species known or expected to occur in the Great Lakes region. *Brychius hornii* is a western species with a range extending east continuously to western Manitoba and with a currently disjunct and possibly questionable occurrence in the vicinity of Duparquet, in the Abitibi region of western Quebec. *Brychius pacificus* is a western species restricted to California and Oregon.

Keys to North American beetle families can be found in Arnett *et al.* (2002) and Marshall (2006). A key to the adult genera of Nearctic Haliplidae is found in Arnett and Thomas (2001). A key to adults of the three North American *Brychius* species can be found in Mousseau and Roughley (2007).

Population spatial structure and variability

There is little to no information available on population spatial structure and variability in Hungerford's Crawling Water Beetle. Some genetic studies have been initiated but are preliminary and currently only involve individuals from the Michigan locations (Vande Kopple, pers. comm. 2009). While population estimates do exist for the East Branch of the Maple River, Michigan (Grant *et al.* 2002), (see section on **Population Size and Trends** below) population estimates are not available for any other locations. In addition, "population demography" has not been examined at any location (USFWS 2009).

Designatable units

All Canadian populations are found in Ontario within the Great Lakes Upper St. Lawrence National Freshwater Biogeographic Zone (COSEWIC 2009). There are no known distinctions between the populations within this area that warrant consideration of designatable units below the species level.

Special significance

Hungerford's Crawling Water Beetle is a globally rare species with a very restricted range in North America. It is only known to occur in five rivers in northern Michigan and three rivers in Bruce County, Ontario. It is thought that Hungerford's Crawling Water Beetle is a probable glacial relict almost extirpated by natural causes in eastern North America (Roughley, pers. comm. 1989). Roughley suggests that the ancestor of Hungerford's Crawling Water Beetle became isolated in eastern North America during the pre-Pleistocene era. He also suggests that it was probably more common during glacial intervals because peri-glacial streams provided suitable habitat. As this habitat became limited in post-glacial times, through natural changes in streams, the beetle became increasingly rare to the point where it now only occurs in very limited, suitable

habitat. Hungerford's Crawling Water Beetle may also have remained isolated in the eastern region, following the Wisconsinan glaciation (approximately 12 thousand years ago), by being trapped by the formation of the Great Lakes (Mousseau and Roughley 2007).

DISTRIBUTION

Global range

Hungerford's Crawling Water Beetle is restricted to five streams in three counties (Emmet, Montmorency and Presque Isle) in northern Michigan and to three rivers in Bruce Co., Ontario (see Figure 4). The maximum global extent of occurrence encompasses 5,756 km^2. In the context of this report the terms "river" and "stream" are use interchangeably, as is often the case, although streams are sometimes taken to be smaller than rivers.

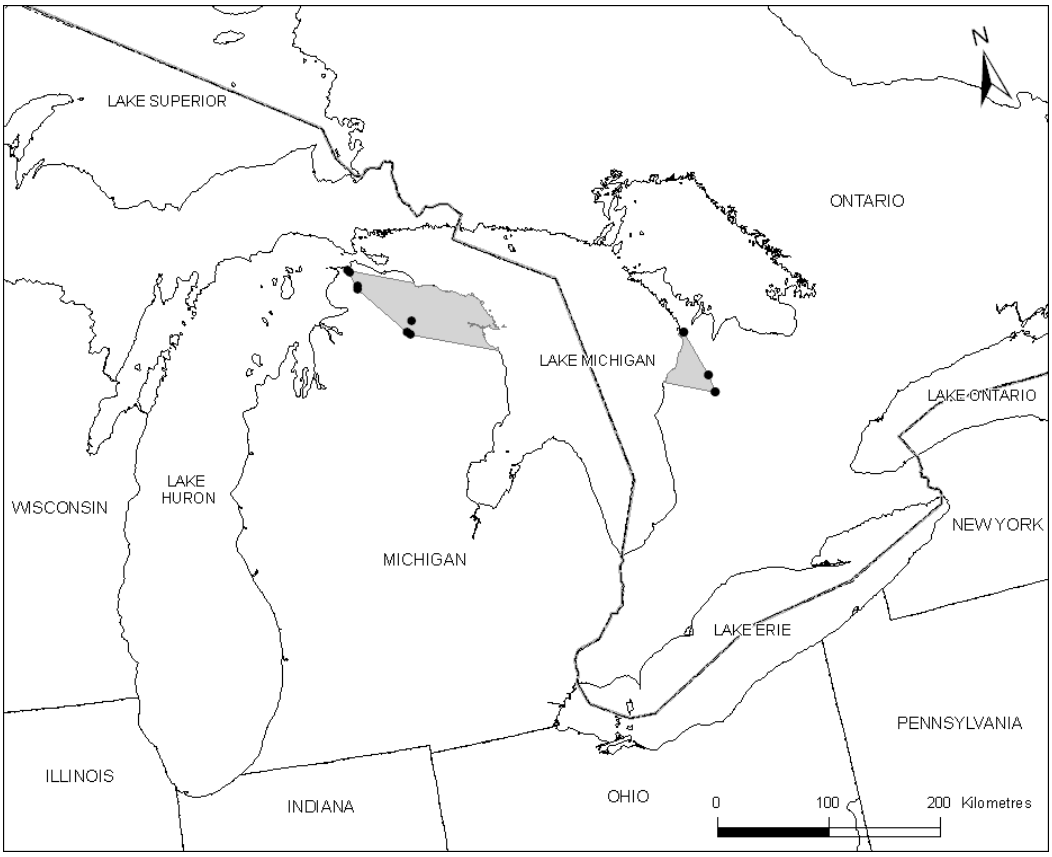

Figure 4. Global distribution of Hungerford's Crawling Water Beetle. The shaded area indicates the global extent of occurrence (EO) and the shaded area in Ontario suggests a possible region of occurrence but not the Canadian EO.

Canadian range

Within Canada, Hungerford's Crawling Water Beetle has a very restricted range, limited to three rivers in Bruce County, Ontario: the Rankin, the North Saugeen and the Saugeen (Figure 5). All of these rivers are found within the Mixedwoods Plain Ecozone (Environment Canada 2005) and two watersheds that drain to Lake Huron. The watersheds, Saugeen and Grey-Sauble, are well known management regions of Conservation Ontario. In the following text, a "location" refers to a section of river that has the same conditions and is subject to the same threats. A "site" is a point of occurrence.

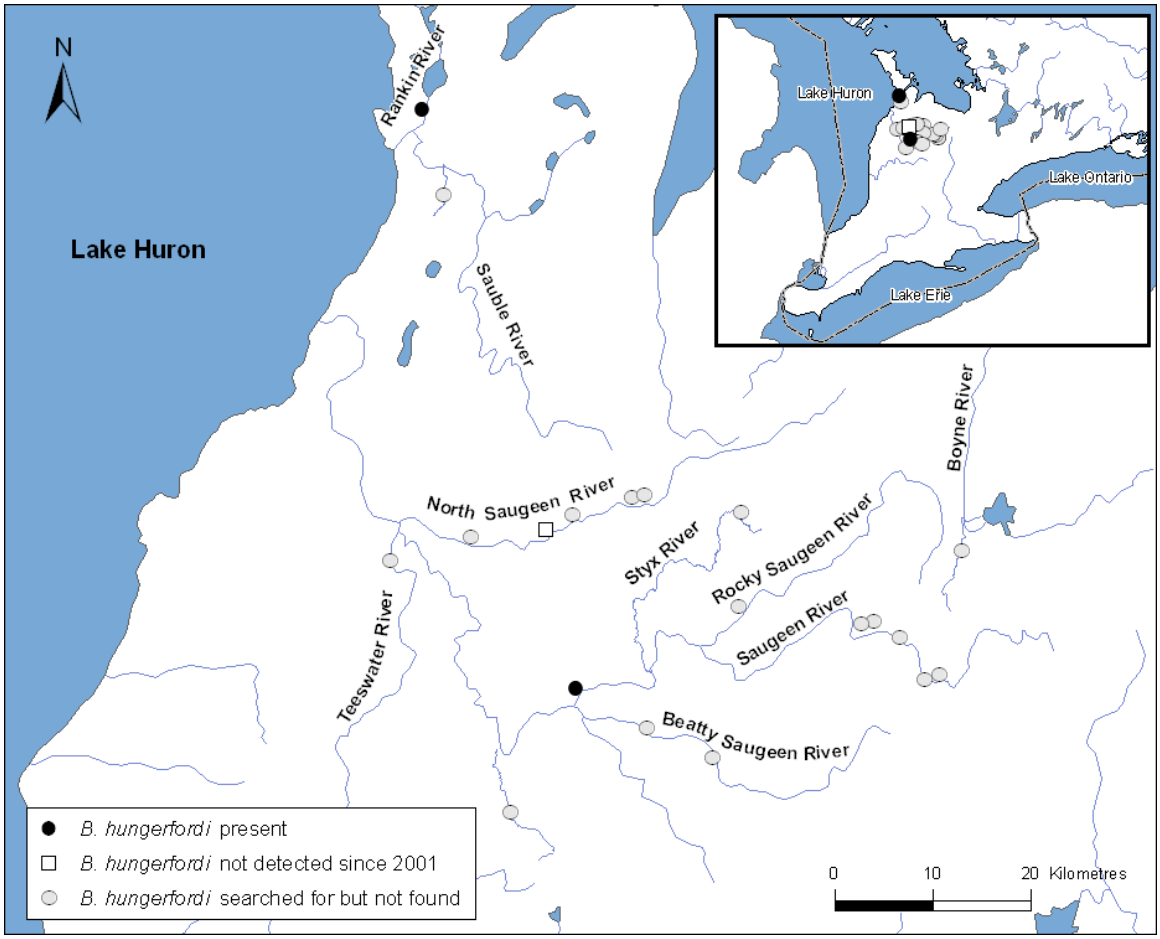

Figure 5. Distribution of Hungerford's Crawling Water Beetle in Canada showing two established populations (dots), a possibly extirpated population (open square) and sampling attempts that did not capture the beetle (grey dots)

The species was first discovered in Canada on August 2, 1986 by Dr. Rob Roughley when 42 specimens were collected at the location on the North Saugeen River near the village of Scone (Roughley 1991). Dr. Steve Marshall collected one adult at this location on October 13, 2001 (University of Guelph Insect Collection Database 2009). Despite many targeted surveys for this beetle before and since 2001, however, its presence at the location has only been detected on the two occasions (Marshall, pers. comm. 2009; Roughley, pers. comm. 2009a; Colin Jones, pers. obs. 2008).

In 2005, surveys of the Rankin River by John Bittorf, employing techniques similar to the protocol of the Ontario Benthos Biomonitoring Network (Jones *et al*. 2007), resulted in the collection of an adult specimen on October 10 (Robinson, pers. comm. 2007). This location was surveyed on August 25, 2008 and again on August 25, 2009 during which several adults and larvae were found (Colin Jones, pers. obs.).

In July 2008, Dr. Steve Marshall discovered a third Canadian location along the Saugeen River in the town of Hanover (Steve Marshall, pers. comm. 2008a). Adult beetles were also found at this location on August 26 (Colin Jones, pers. obs.) and September 1 (Steve Marshall, pers. comm. 2008b) of 2008.

The maximum known extent of occurrence (EO) in Canada encompasses 36 km^2. The maximum index of area of occupancy (IAO) encompasses only 12 km^2 based upon a 2 x 2 km grid and is considered unlikely to change substantially with additional surveys (see below under "**Search effort**."

Search effort

Because Hungerford's Crawling Water Beetle is associated with cool rivers in the upper Great Lakes in the Michigan region of occurrence and is regarded as an early postglacial relict, the likelihood of it being found outside the two watershed areas or elsewhere in Canada seems very low. The upper Great Lakes is well established as an area of plant and insect endemism. Furthermore, the rivers in many other regions of southern Ontario have been more extensively sampled and it has not been found. The following discussion focuses on the known region of occurrence and recent search effort (Table 1).

Table 1. Dates, observers, locations and habitat of sites surveyed for Hungerford's Crawling Water Beetle in Ontario along with search effort and search results. All known positive records are listed first, followed by the negative records from sites surveyed in 2008 and 2009 by the author and then sites with potential habitat but that were not surveyed in 2008 and 2009.

DATE	OBSERVER(S)	LOCATION	HABITAT	SEARCH EFFORT	SEARCH RESULT
1986-08-02	R.E. Roughley	North Saugeen River at Scone Lat: 44.305 Long: -81.076	directly below a dam with an epilimnion outlet, therefore the water is quite warm; stream is characterized by heavy deposits of a marl-like substance on stones and rocks; all specimens were collected in this warm, disturbed marl-like portion of the stream, among stones, cobbles and course gravel within the current (Roughley, 1991, Roughley pers. comm. 2009).	42 adults collected in 2 hours of targetted D-netting. Specimens deposited at the J.B. Wallis Museum of Entomology and the University of Guelph Insect Collection.	Positive
2001-10-13	S.A. Marshall	North Saugeen River at Scone Lat: 44.305 Long: -81.076		Unknown. One specimen collected and deposited at the University of Guelph Insect Collection.	Positive
2005-10-10	John Bittorf Water - Resources Technician, Grey Sauble Conservation Authority	Rankin River, below Rankin River Dam Lat: 44.692 Long: -81.236	No description of habitat provided	1 adult collected in 4 kicks with a D-net and one vegetation sweep. Specimen currently with Environment Canada.	Positive
2008-08-25	C.D. Jones, S.M. Robinson, A. Dwyer	Rankin River, below Rankin River Dam Lat: 44.692 Long: -81.236	river with moderate flow and some riffles, directly below a dam; lots of fine sediments (silt and sand) mixed with coarse gravel and cobble; moderate to heavy aquatic vegetation with lots of algae; Brychius were detected in a variety of micro-habitats from open cobble/gravel with algae to heavily vegetated sites with lots of silt and sand	10 adults (2 collected) and 3 larvae collected in 4 kicks with a D-net – 30 minutes of total effort. Specimens at the Natural Heritage Information Centre, Peterborough, Ontario.	Positive
2009-08-25	C.D. Jones, S.M. Robinson, J. Benvenuti, F. Heesen	Rankin River, below Rankin River Dam Lat: 44.692 Long: -81.236	as above	8 adults and 1 larvae in 20 kicks with a D-net (5 of which produced adult Brychius); 1h 30min with 2 teams (3 hours total effort).	Positive
2008-07-??	S.A. Marshall	Saugeen River at Hanover Lat: 44.158 Long: -81.037		1 adult beetle; effort unknown	Positive

DATE	OBSERVER(S)	LOCATION	HABITAT	SEARCH EFFORT	SEARCH RESULT
2008-08-26	C.D. Jones, S.M. Robinson, J. Jackson, A. Dwyer	Saugeen River at Hanover Lat: 44.158 Long: -81.037	river with moderate flow and no riffles; coarse gravel/pebble substrate with finer sediments; little aquatic vegetation and some algae present on the substrate	1 adult collected in 8 kicks with a D-net; 30 minutes with 2 teams (1 hour total effort). Specimen at the Midhurst District Office, Ontario Ministry of Natural Resources.	Positive
2008-09-01	S.A. Marshall	Saugeen River at Hanover Lat: 44.158 Long: -81.037		adults present but not collected; effort unknown	Positive
2002-08-14	R.E. Roughley, Helena Shaverdo	North Saugeen River at Scone Lat: 44.305 Long: -81.076	lotic stream, 8 – 10 m wide, rather shallow, shores exposed and without aquatic vegetation except *Chara*, bottom substrate rocky – limestone, bottom – very fine sand, blue clay mud, pieces of wood near shore, some parts with stones, gravel and marl	~4 hours of aggressive, targeted surveys in the exact same location as where 42 specimens were collected in 1986	Negative
2008-08-25	C.D. Jones, S.M. Robinson, A. Dwyer	North Saugeen River at Scone Lat: 44.305 Long: -81.076	see above	30 minutes of kick-sampling with a D-net with 2 teams (60 minutes total effort)	Negative
2008-08-25	C.D. Jones, S.M. Robinson, A. Dwyer	Teeswater River at 20th Concession Lat: 44.276 Long: -81.276	cobble-bottomed with riffles and pools and some algae	20 minutes of kick-sampling with a D-net with 2 teams (40 minutes total effort)	Negative
2008-08-25	C.D. Jones, S.M. Robinson, A. Dwyer	Deer Creek at 14th Concession E Lat: 44.692 Long: -81.236	cobble-bottomed with riffles and pools and some algae	20 minutes of kick-sampling with a D-net with 2 teams (40 minutes total effort)	Negative
2008-08-25	C.D. Jones, S.M. Robinson, A. Dwyer	Styx River at Concession 2 Lat: 44.320 Long: -80.826	river with some riffles and pools; cobble substrate with very few fine sediments; some aquatic vegetation	20 minutes of kick-sampling with a D-net with 2 teams (40 minutes total effort)	Negative
2008-08-26	C.D. Jones, S.M. Robinson, J. Jackson, A. Dwyer	North Saugeen River at Scone Lat: 44.305 Long: -81.076	see above	1 hour of kick-sampling with a D-net with 2 teams (2 hrs total effort)	Negative
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Concession Rd 18 E of Sideroad 7 Lat: 44.170 Long: -80.571	cobble-bottomed with riffles and pools and some algae	9 kicks with a D-net (4 kicks upstream of bridge, 5 kicks downstream); 40 minutes with 2 teams (1h 20 mins total effort)	Negative

DATE	OBSERVER(S)	LOCATION	HABITAT	SEARCH EFFORT	SEARCH RESULT
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Concession Rd 18 W of Sideroad 7 Lat: 44.166 Long: -80.591	slight riffle with lots of emergent vegetation	6 kicks with a D-net (4 kicks upstream of bridge, 2 kicks downstream); 30 minutes with 2 teams (1 hour total effort)	Negative
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Priceville, Kinsmen Park Lat: 44.204 Long: -80.622	marginal habitat?; extremely rocky with little to no silt/sand	2 kicks with a D-net; 15 minutes with 2 teams (30 minutes total effort)	Negative
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Northline Lat: 44.219 Long: -80.656	riffles and pools with lots of algae	8 kicks with a D-net; 45 minutes with 2 teams (1.5 hrs total effort)	Negative
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Sideroad 40, south of Northline Lat: 44.217 Long: -80.672	riffles with lots of algae	6 kicks with a D-net; 30 minutes with 2 teams (1 hour total effort)	Negative
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Rocky Saugeen River at Rocky Park Camping Lat: 44.233 Long: -80.829	riffle directly below dam	5 kicks with a D-net; 30 minutes with 2 teams (1 hour total effort)	Negative
2009-08-25	C.D. Jones, S.M. Robinson, F. Heesen	North Saugeen River at Sideroad 15S Lat: 44.298 Long: -81.173	river with moderate flow and some riffles; cobble/gravel substrate with some finer sediments; some aquatic vegetation and algae	5 kicks with a D-net; 30 minutes with 2 teams (1 hour total effort)	Negative
2009-08-25	C.D. Jones, S.M. Robinson, F. Heesen	North Saugeen River at Concession Rd 12 Lat: 44.318 Long: -81.042	river with moderate flow and some riffles; cobble/gravel substrate with some fine sediments and very little vegetation	6 kicks with a D-net; 30 minutes with 2 teams (1 hour total effort)	Negative
2009-08-26	C.D. Jones, S.M. Robinson, F. Heesen	Beatty Saugeen River at Concession Rd 18 Lat: 44.122 Long: -80.947	river with moderate flow and some riffles; cobble/gravel bottom with very few fine sediments; very little aquatic vegetation	6 kicks with a D-net (2 kicks upstream of bridge and 4 kicks downstream); 30minutes with 2 teams (1 hour total effort)	Negative
2009-08-26	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Hanover; directly below dam Lat: 44.160 Long: -81.033	river with moderate flow and some riffles; cobble/gravel bottom with very few fine sediments; very little aquatic vegetation	4 kicks with a D-net; 25 minutes with 2 teams (50 minutes total effort)	Negative
2009-08-26	C.D. Jones, S.M. Robinson, F. Heesen	Otter Creek at Mildmay Lat: 44.044 Long: -81.122	creek with moderate flow, riffles and pools; mucky substrate with some aquatic vegetation	6 kicks with a D-net; 30 minutes with 2 teams (1 hour total effort)	Negative
2009-08-26	C.D. Jones, S.M. Robinson, F. Heesen	Beatty Saugeen River at Concession Rd 14 Lat: 44.095 Long: -80.862	river with moderate current and some riffles; cobble substrate with some finer sediments; some aquatic vegetation	6 kicks with a D-net upstream of bridge; 30 minutes with 2 teams (1 hour total effort)	Negative

DATE	OBSERVER(S)	LOCATION	HABITAT	SEARCH EFFORT	SEARCH RESULT
2009-10-05	C.D. Jones, S.M. Robinson	Boyne River at Hogg's Falls Lat: 44.285 Long: -80.543	river with moderate flow, riffles and pools; broken limestone bedrock substrate with some finer sediments; some aquatic vegetation	8 kicks with a D-net; 20 minutes with 2 people (40 minutes total effort)	Negative
2009-10-05	C.D. Jones, S.M. Robinson	Tributary of Sauble River at Silver Lake Road E of Bruce County Road 14 Lat: 44.613 Long: -81.209	creek with slow/moderate flow; gravel/sand substrate; some aquatic vegetation and algae	10 kicks with a D-net; 30 minutes with 2 people (1 hour total effort)	Negative
2009-10-07	C.D. Jones, S.M. Robinson	North Saugeen River at Sideroad 8, E of Concession 8 Lat: 44.334 Long: -80.966	river with moderate flow, riffles and pools; cobble substrate with some sand; some aquatic vegetation including *Chara* beds	12 kicks with D-net (8 kicks downstream of bridge and 4 kicks upstream); 30 minutes with 2 people (1 hour total effort)	Negative
2009-10-07	C.D. Jones, S.M. Robinson	North Saugeen River at Sideroad 8, W of Concession 6 Lat: 44.336 Long: -80.949	river with slow/moderate flow, riffles and pools; fairly deep with cobble and sand/silt substrate; a fair amount of aquatic vegetation including large *Chara* beds along one shore	3 kicks with a D-net; 20 minutes total effort	Negative
2008-08-25	C.D. Jones, S.M. Robinson, A. Dwyer	North Saugeen River at Sideroad 8, E of County Rd 3 Lat: 44.393 Long: -81.305	river with moderate flow, riffles and pools; cobble substrate with some finer sediments; some aquatic vegetation	habitat assessment only	Potential Habitat - not surveyed
2008-08-25	C.D. Jones, S.M. Robinson, A. Dwyer	North Saugeen River at Sideroad 8, W of Concession 6 Lat: 44.261 Long: -81.191	river with slow/moderate flow, riffles and pools; fairly deep with cobble and sand/silt substrate; a fair amount of aquatic vegetation including large *Chara* beds along one shore	habitat assessment only	Potential Habitat - not surveyed
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Southline Lat: 44.190 Long: -80.605	slight riffle downstream of bridge but posted "No Trespassing"	habitat assessment only	Potential Habitat - not surveyed
2009-08-24	C.D. Jones, S.M. Robinson, F. Heesen	Saugeen River at Northline, just E of County Rd 23 Lat: 44.215 Long: -80.692	river with riffles and pools	habitat assessment only	Potential Habitat - not surveyed
2009-08-25	C.D. Jones, S.M. Robinson, F. Heesen	North Saugeen River at County Rd 3 Lat: 44.326 Long: -81.009	river with slow flow and quite deep but with some riffles downstream of bridge	habitat assessment only	Potential Habitat - not surveyed
2009-10-07	C.D. Jones, S.M. Robinson	North Saugeen River at Sideroad 8, E of County Rd 3 Lat: 44.331 Long: -80.992	river with moderate flow, riffles and pools; cobble substrate with some finer sediments; some aquatic vegetation	habitat assessment only	Potential Habitat - not surveyed
2009-10-07	C.D. Jones, S.M. Robinson	Tributary of North Saugeen River at Concession Rd 8 Lat: 44.318 Long: -80.973	narrow creek with slow/moderate flow; gravel and sand/silt substrate; some aquatic vegetation	habitat assessment only	Potential Habitat - not surveyed

DATE	OBSERVER(S)	LOCATION	HABITAT	SEARCH EFFORT	SEARCH RESULT
2009-10-07	C.D. Jones, S.M. Robinson	North Saugeen River at Concession 8 Lat: 44.335 Long: -80.977	river with moderate flow, riffles and pools; cobble substrate with some finer sediments; some aquatic vegetation including *Chara* beds	habitat assessment only	Potential Habitat - not surveyed

North Saugeen River

he initial discovery by Dr. Rob Roughley in 1986 at the location on the North Saugeen River occurred while washing off a collecting net in the current following approximately five hours of collecting water beetles. The previous five hours of sampling effort were largely directed at undercut banks and small embayments and not within the current itself which probably explains why the species was not initially detected. Following the capture of the first individual, however, an additional two hours of targeted sampling effort within the current resulted in the capture of 42 individuals (Roughley, pers. comm. 2009a).

Since the initial discovery, the location on the North Saugeen River has been sampled dozens of times at various points throughout the spring, summer and autumn by Dr. Steve Marshall. Despite this intensive survey effort, Dr. Marshall has only ever collected a single beetle at this location – the individual collected on October 13, 2001 (Marshall, pers. comm. 2009).

Dr. Rob Roughley and Dr. Helena Shaverdo sampled the North Saugeen River location again on August 14, 2002 in the same location where the 42 specimens were collected in 1986. During this survey, two very experienced collectors spent approximately four hours each (8 person-hours total sampling effort) looking for Hungerford's Crawling Water Beetle without success (Roughley, pers. comm. 2009b).

On August 25, 2008, Colin Jones, Suzanne Robinson and Amanda Dwyer spent two person-hours of sampling effort searching for the beetle at the location on the North Saugeen River. The following day, the same three surveyors and Jessica Jackson spent an additional two person-hours of sampling effort searching the location again. These surveys did not detect the presence of the beetle (C.D. Jones, pers. obs).

Rankin River

The beetle was initially discovered at the Rankin River location as a result of general sampling using a protocol similar to the Ontario Benthos Biomonitoring Network protocol (Jones *et al*. 2007). A single specimen was collected during a survey that consisted of four kicks with a D-net and one vegetation sweep (Robinson, pers. comm. 2007). Following this, a targeted survey by Colin Jones, Suzanne Robinson and Amanda Dwyer on August 25, 2008 resulted in the capture of 10 adults and three larvae in four kicks with a D-net (approximately 0.5 person-hours of sampling effort). Another targeted survey at this location by Colin Jones, Suzanne Robinson, Jodi Benvenuti and

Fiona Heesen on August 25, 2009 resulted in the capture of eight adults and 1 larva in 20 kicks with a D-net (approximately 1.5 person-hours of sampling effort). More than half of the kicks were conducted further downstream (up to 75 metres away) from the original site of capture and none of these resulted in any captures of adults or larvae. Adults were present in five of the eight kicks done in the original location.

Other locations further downstream on the Rankin River have been surveyed by Dr. Steve Marshall but none of these surveys have detected Hungerford's Crawling Water Beetle (Marshall, pers. comm. 2009).

Saugeen River

At the location on the main Saugeen River, Dr. Steve Marshall collected 1 beetle in July 2008. Colin Jones, Suzanne Robinson, Amanda Dwyer and Jessica Jackson visited this location on August 26, 2008 and collected a single beetle during 1 person-hour of sampling effort (C.D. Jones, pers. obs.). During a second visit by Marshall on September 1, 2008, the species was again detected.

General Survey

Additional targeted surveys for Hungerford's Crawling Water Beetle by Colin Jones and Suzanne Robinson, with assistance from other Ontario Ministry of Natural Resources staff, were performed on August 25 and 26, 2008, August 24 -26, 2009 and on October 5 - 7, 2009 at many streams within the Saugeen, Grey-Sauble and Owen Sound watersheds. These surveys included visiting 44 locations on 16 streams. Of these locations, 15 were considered unsuitable and were not surveyed. Streams were visited at accessible locations (e.g., bridge crossings, public parks) and first evaluated for habitat attributes consistent with known Hungerford's Crawling Water Beetle locations. Streams that were slow and sluggish, turbid, deep, mucky-bottomed, choked with aquatic vegetation, or otherwise deemed to be unsuitable habitat for Hungerford's Crawling Water Beetle were not surveyed. Streams that were clear and cool with moderate to fast flow, good stream aeration (i.e., a mixture of riffles and pools), and appropriate substrate (i.e., cobble, gravel, sand) were surveyed for Hungerford's Crawling Water Beetle.

Surveys consisted of kick-sampling within the current using an aquatic D-net. Kick-sampling involves disturbing the substrate (i.e., cobbles, gravel, sand) with one's feet whilst holding the open D-net directly downstream thereby catching any invertebrates that are dislodged from the substrate and carried into the net by the current. The contents of the D-net were then emptied into a white tray and the invertebrates examined for any adult or larval Hungerford's Crawling Water Beetles. Adult Hungerford's Crawling Water Beetles are normally easily detected as shortly after the contents of the net into the pan, they begin actively swimming around. Larval Hungerford's Crawling Water Beetles, however, are more difficult to spot as they are largely inactive and so greater care is necessary when examining the contents of the net. At most locations, 4-20 kick-samples were performed equaling between 30 minutes and 2 hours of sampling effort per location.

Including the three known locations, a total of 20 locations were sampled in 2008 and 2009 using the above-stated methodology. An additional seven locations were visited and deemed to be potentially suitable but were not surveyed for various reasons (e.g., private property, time constraints, etc.). These locations, the sampling effort per location, the date of sampling, habitat, and the search results are listed in Table 1 along with the earlier sampling effort and results discussed above.

In addition to the targeted surveys of 2008 and 2009 by Colin Jones and others, Dr. Steve Marshall has surveyed many, if not most, of the publicly accessible locations (e.g., bridge crossings, parks, etc.) within the Saugeen and Grey-Sauble watersheds over the past 15 years during which he was specifically looking for Hungerford's Crawling Water Beetles (Marshall, pers. comm. 2009).

Dr. Rob Roughley "reported sampling 30-40 locations [for Hungerford's Crawling Water Beetle] in southern Ontario between 1978 and 1989…and locating only one new *B. hungerfordi* population" (Roughley 1989. Letter to L.A. Wilsmann, Michigan Natural Features Inventory, dated 5 December *cited in* Wilsmann and Strand, 1990). Also, between the 1970s and 1980s, during the Ontario Ministry of Natural Resources "Aquatic Habitat Inventory", 198 stations on 40 streams were sampled for invertebrates in Bruce County (in excess of 3400 stations on nearly 1000 streams were sampled throughout Ontario) without detecting Hungerford's Crawling Water Beetle, though species of *Haliplus* and *Peltodytes* were collected (OMNR 1996).

Caution is necessary when interpreting negative survey results. Even with targeted surveys, Hungerford's Crawling Water Beetles can be very difficult to find – this is especially true for locations that have small numbers of beetles (Vande Kopple, pers. comm. 2009). It is clear, however, that at some locations the beetles are relatively easy to find. In August 2008, for example, several adults and larvae were captured in the very first kick-sample at the location on the Rankin River. In addition, during this visit a total of 10 adults and three larvae were collected in only 0.5 person-hours of sampling effort. In August 2009, a similar result was achieved at the same location with similar effort (C.D. Jones, pers. obs.).

Field surveys conducted as part of this assessment, and both directed surveys for Hungerford's Crawling Water Beetle and general surveys of aquatic coleoptera in Bruce and adjacent counties have been extensive. The general surveys have involved hundreds of collections of aquatic insects at various locations. All of these surveys have spanned more than three decades, and all suggest that Hungerford's Crawling Water Beetle is extremely rare and that very few if any additional populations in Canada are likely to exist. The search effort is considered adequate to draw these conclusions. Based on the relatively extensive survey of the North Saugeen location, the number of locations is considered to have declined (from 3 to 2) since 1986 and the strongest evidence for this decline is within the last 10 years.

HABITAT

Habitat requirements

Hungerford's Crawling Water Beetle requires small to medium-sized streams characterized by a moderate to fast flow, good stream aeration, cool temperatures (15°C to 25°C), inorganic substrate, and alkaline water conditions (Wilsmann and Strand 1990). Such streams have some groundwater input and fluctuating seasonal water levels (higher in spring and early summer, lower in late summer and autumn). The lower water levels of late summer and autumn expose damp sand along the shoreline and these areas are thought to be important pupation sites for the beetle (Vande Kopple and Grant 2004).

Populations are often, but not always, found immediately downstream from culverts, beaver dams, and human-made impoundments (USFWS 2006). The presence of the alga *Dichotomosiphon* may be a critical component of the habitat because the grazing beetle larvae appear to be dependent upon it as a food source (Grant and Vande Kopple 2009).

The East Branch of the Maple River, Michigan is the most studied location and Hungerford's Crawling Water Beetle can be found there in two different microhabitats. The first consists of cobbles near the edge of pools with low flow rates (Figure 6). Beetles occur under the cobbles and are not visible from above without moving the cobbles. At such locations filamentous algae grows on the cobble in low mats. Populations at these locations can be large. The second microhabitat occurs in cobble bottom riffle areas with beds of filamentous algae, often growing on sandy areas just behind larger rocks (Figure 7). Beetles in these areas apparently live in and on the algal beds, and can be observed from above. Populations at these locations are small (Scholtens 2002).

Figure 6. Hungerford's Crawling Water Beetle pool habitat on the East Branch of the Maple River, Michigan in September 2009. N from 45.572˚N 84.745˚W. Photo by C.D. Jones.

Figure 7. Hungerford's Crawling Water Beetle riffle habitat on the East Branch of the Maple River, Michigan in September 2009. At approximately 45.544˚N 84.757˚W. Photo by C.D. Jones.

A number of physical parameters were measured at five locations with beetle populations on the East Branch of the Maple River: flow rates ranged from 0.0 to 1.4 m/sec and channel depths from 0 to 200 cm (the majority of the rivers have depths of less than 50 cm); water temperature in early August ranged from 20.0°C - 21.3°C; cobble sizes (longest dimension) typically ranged between 3 and 7 cm and did not exceed 10 cm; all locations had exposure to full sun at some point during the day; and, at normal water levels, all locations had significant areas with exposed sand along the shore (Scholtens 2002).

At the Carp Lake River, Michigan, beetles have been collected in a pool directly below a riffle. The river bed at this location is cobble and sand (Keller *et al*. 1998). They have also been collected at the bottom of a bank in an unidentified macroalgae bed in less than 30 cm of water with good flow (Hinz and Wiley 1999). In addition, they have been collected in a pool directly below a culvert (Figure 8), in a very similar situation to the location on the East Branch of the Maple River (Vande Kopple, pers. comm. 2009).

Figure 8. Hungerford's Crawling Water Beetle pool habitat on the Carp Lake River, Michigan in September 2009. S from 45.695˚N 84.805˚W. Photo by C.D. Jones.

Van Hetton Creek, another Michigan location, is a creek that drains wetlands and also receives some groundwater. Here, beetles were collected several hundred metres downstream from a pool formed by a culvert where they were often associated with dense growths of epilithic algae (Grant *et al*., 2000). This location differs from the other Michigan locations in that the creek channel is composed of sand overlain with a thin layer of detritus (Grant *et al*., 2000).

The three Ontario locations are described as follows:

North Saugeen River – this location is directly below a dam with an epilimnion outlet (Figures 9 and 10) and although not measured, the water temperature is therefore likely to be quite warm. The stream is characterized by heavy deposits of a marl-like substance on the stones and rocks. All the specimens at this location were collected in the warm, disturbed marl-like portion of the stream, among stones, cobbles and coarse gravel (Roughley 1991) within the current (Roughley, pers. comm. 2009a,b).

Figure 9. Looking upstream along the main river channel toward the dam at the Hungerford's Crawling Water Beetle site on the North Saugeen River, Ontario in August 2008. NE from 44.305˚N 81.076˚W. Photo by C.D. Jones.

Figure 10. Looking downstream along the main river channel at the Hungerford's Crawling Water Beetle site on the North Saugeen River, Ontario in August 2008. SW from 44.305˚N 81.076˚W. Photo by C.D. Jones.

Saugeen River – this location is located a few hundred metres below a weir. The river at this location has a moderate flow, no riffles, and in August of 2008 and 2009, ranged in depth from 30 - 90 cm (Figure 11). The substrate is gravel mixed with finer sediments (Figure 12). There is little aquatic macrophytic vegetation, except along the slower margins of the river, but some algae are present on the substrate. Beetles were collected mid-stream.

Figure 11. Hungerford's Crawling Water Beetle habitat on the Saugeen River, Ontario in August 2008. SW from 44.158˚N 81.073˚W. Photo by C.D. Jones.

Figure 12. Substrate of the Hungerford's Crawling Water Beetle habitat on the Saugeen River, Ontario in August 2008. 44.158˚N 81.073˚W. Photo by C.D. Jones.

Rankin River – this location is located directly below a dam with an epilimnion outlet, although water also flows through the stop-boards of the dam (Figures 13 and 14). The river at this location has moderate flow, no riffles and in August of 2008 and 2009, ranged in depth from 15 to 60 cm. The substrate is a mixture of coarse gravel and cobble (Figure 15) with significant patches of sand and silt (Figure 16). There are moderate to heavy patches of aquatic vegetation, including lots of algae (Figure 17). Beetles were collected in both open cobble/gravel patches with algae and in heavily vegetated locations with lots of silt and sand. The pH was 8.09 on October 5, 2005 and 7.91 on October 4, 2008 (Robinson, pers. comm., 2007).

Figure 13. Hungerford's Crawling Water Beetle habitat on the Rankin River, Ontario in August 2008. N from 44.692˚N 81.236˚W. Photo by C.D. Jones.

Figure 14. Hungerford's Crawling Water Beetle habitat on the Rankin River, Ontario in August 2009. N from 44.692˚N 81.236˚W. Photo by C.D. Jones.

Figure 15. Cobble and gravel substrate of the Hungerford's Crawling Water Beetle habitat on the Rankin River, Ontario in August 2009. 44.692˚N 81.236˚W. Photo by C.D. Jones.

Figure 16. Sand and silt substrate of the Hungerford's Crawling Water Beetle habitat on the Rankin River, Ontario in August 2009. 44.692˚N 81.236˚W. Photo by C.D. Jones.

Figure 17. Heavily vegetated section of the Hungerford's Crawling Water Beetle habitat on the Rankin River, Ontario in August 2009. 44.692˚N 81.236˚W. Photo by C.D. Jones.

Habitat trends

Much of the Canadian range of Hungerford's Crawling Water Beetle has been subject to agricultural development and patchy urban development since the early 1800s. Such development can alter the aquatic environment by increasing water temperatures as a result of the clearing of forest cover, reducing groundwater inputs that are important in regulating summer temperatures and base flows of streams, increasing the amount of pollutants entering the water, altering stream chemistry, and increasing sedimentation. Some areas within the two watersheds (Saugeen and Grey-Sauble) containing Hungerford's Crawling Water Beetle are relatively pristine while others are very degraded (Andy McKee, pers. comm., 2008). Poor agricultural practices, wetland degradation, pond creation, and urban development are current threats to these watersheds (Andy McKee, pers. comm., 2008; Imhof 2007) and to Hungerford's Crawling Water Beetle which is associated with water of good quality.

Although not empirical, there is some evidence that habitat at the location on the North Saugeen River has been sufficiently impacted to have resulted in a severe decline or loss of the Hungerford's Crawling Water Beetle population. In addition to the fact that no beetles have been found at the location since 2001, despite intensive survey effort, Dr. Steve Marshall has also noticed a general decline in or loss of other aquatic insect species over the span of his survey work at this location. For example, Marshall formerly regularly collected mayflies of the genus *Baetisca,* but has not done so in more recent years (Marshall, pers. comm. 2009). The exact cause of this apparent decline is uncertain but some contributing factors could include disturbance at the location by bridge construction in the 1980s (Roughley, pers. comm. 1989) or alteration of the micro-habitat that is important to Hungerford's Crawling Water Beetles as a result of the operation of the micro hydro facility immediately upstream of the location. It is important to note, however, that these causes are purely speculative.

BIOLOGY

Relatively little is known of the biology of Hungerford's Crawling Water Beetle (Grant and Vande Kopple 2009). Much of the information in this section is based upon the life history of other species of haliplids.

Life cycle and reproduction

Hungerford's Crawling Water Beetle undergoes complete metamorphosis involving four stages: egg, larva, pupa and adult. The egg stage has not been described nor has egg-laying been observed for Hungerford's Crawling Water Beetle or any species of *Brychius* (USFWS 2006). In other members of the Haliplidae (i.e., *Haliplus* and *Peltodytes*) egg-laying occurs in spring and early summer and perhaps again in the fall (Rougley 2001). Egg-laying is not known in *Brychius* but *Haliplus* females chew a cavity into algae or aquatic vascular plants into which they deposit eggs, while *Peltodytes* females deposit eggs onto the surface of aquatic plants (Roughley 2001). Eggs hatch into larvae 8 - 14 days after oviposition (USFWS 2006).

The larvae of haliplids are herbivorous and as they feed and grow they pass through a series of three instars (i.e., they molt their outer skin or exoskeleton in between each instar). Strand and Spangler (1994) reported that Hungerford's Crawling Water Beetles were often associated with the alga *Chara* and that it might be an important food source for both adults and larvae. A more recent study into the feeding behaviour of Hungerford's Crawling Water Beetle, utilizing stable isotope data, suggests that the larvae may actually specialize upon the filamentous alga *Dichotomosiphon tuberosus* (Grant and Vande Kopple 2009). Additional information on the importance of this food source is given in the section below on **Interspecific interactions**.

It is assumed, based upon anecdotal evidence of Hungerford's and life history studies in *Brychius hornii* (Mousseau 2004) that once mature, larvae move from the water to damp soil along the edge of the river to pupate. For example, in the fall, Strand and Spangler (1994) found Hungerford's larvae buried in an island of damp sand and *Chara* up to 15 cm above the water line. It is generally thought that, like other haliplids, Hungerford's larvae overwinter in the larval stage and pupate in the spring (USFWS 2006). The pupal stage of Hungerford's has not been observed, but in general, the pupal stage can last up to two weeks in haliplids and is probably dependent upon the temperature of the pupal site (Roughley 2001). Once the adults emerge from the pupal chamber, they re-enter the water.

Very few observations have been made and no research has been conducted on mating in adult Hungerford's Crawling Water Beetles. Mating of Hungerford's Crawling Water Beetle has been observed in June (Scholtens 2002) which is also the time when the closely related *Brychius hornii* mates (Mousseau and Roughley 2003). It is not known if Hungerford's Crawling Water Beetle is univoltine (i.e., one generation per year) or bivoltine (i.e., two generations per year) but preliminary data from one study in Michigan suggest that a second generation of adults may emerge late in the season (Grant *et al*. 2000). The same study also suggests that at least some adults survive through the winter because adults were collected in both December and February. The life span of adult Hungerford's is not known but other haliplids have survived as long as 18 months in captivity (Hickman 1931).

Physiology and adaptability

The direct physiological requirements of Hungerford's Crawling Water Beetle are not documented. All of the known locations, however, share some physical and chemical characteristics (described in the section above on **Habitat requirements**). It is not known, however, if these characteristics are important to the physiology of the species and, if so, how.

Dispersal and migration

It is unknown how Hungerford's Crawling Water Beetles disperse. Within a stream, they may disperse passively from one location to another, by traveling downstream within the current – a mode of transport commonly termed "drift". Adult Hungerford's Crawling Water Beetles have been described as "extremely strong swimmers" (White 1986) as have the closely related *Brychius hornii* (Mousseau 2004) and it is also possible that they are able to actively disperse upstream by swimming. Neither drift nor upstream dispersal by swimming have, however, been documented. (Scholtens 2002; USFWS 2006).

Active dispersal is also possible through flight because adult Hungerford's Crawling Water Beetles do have fully functional wings and have been reported to fly (USFWS 2006). Flight is, however, likely rare for this species as there is only a single record of flight despite many hours of observation (USFWS 2009). If dispersal through flight does occur, it may only occur during discrete periods of time (e.g., immediately following emergence from the pupa), or under certain environmental conditions (e.g., warm, humid spring nights) (USFWS 2006).

Interspecific interactions

Recent studies into the feeding behaviour of Hungerford's Crawling Water Beetle, utilizing stable isotope data, have shown that larvae prefer, and may specialize on, the alga *Dichotomosiphon tuberosa* (Grant and Vande Kopple 2009). Adults, on the other hand, tend to feed on a wider variety of algae as well as epiphytic diatoms (Grant and Vande Kopple 2009). Grant and Vande Kopple (2009) hypothesize that this beetle's rarity may be tied to the presence of this very specific alga taxon, which itself is considered rare. In a survey conducted in Michigan in the 1950s, for example, *Dichotomosiphon* was present in only 17 of 690 sediment samples (Henson 1984). In Michigan streams, *Dichotomosiphon* grows in mats on beds of clean sand (R. Vande Kopple, pers. comm. 2009). The growth of *Dichotomosiphon* mats has been significantly correlated with day length (Sherwood and Sheath 1999 in Grant and Vande Kopple 2009). Grant and Vende Kopple (2009) have observed that Hungerford's larvae are most easily found in July to mid-August when daylight hours are long, coinciding with the period when *Dichotomosiphon* is most productive. The only larval records from Ontario are from late August (C.D. Jones, pers. obs.).

POPULATION SIZES AND TRENDS

Sampling effort and methods

No surveys have been conducted in Ontario to estimate population sizes. At one location in Michigan, a mark and recapture technique was used to measure the population size in a single pool (Grant *et al*., 2002). Seasonal relative abundance estimates (number of beetles captured per hour) were also determined monthly from spring until fall, over a three-year period (1999-2001), using a standardized sampling effort (Grant *et al*., 2002).

Abundance

Population size at each of the three known locations in Canada is unknown. In Michigan, the population that has been studied was estimated to consist of approximately 1100 individuals in a single pool. Over the three-year period the population size remained fairly constant (Grant *et al*., 2002).

Fluctuations and trends

There are little to no data on year-to-year fluctuations or trends of Hungerford's Crawling Water Beetle populations in Canada. There is reasonably good evidence of extirpation from the North Saugeen River location, based on the fact that 42 beetles were collected here in 1986 and yet, apart from a single record in 2001, repeated sampling efforts have not been able to detect the presence of the beetle again. Even though this species can be very difficult to find, the fact that a relatively large number were found in 1986, combined with the anecdotal evidence of a decline in other sensitive species from this location (e.g., mayflies in the genus *Baestisca*) (Marshall, pers. comm. 2009) supports the hypothesis of extirpation.

The only data available for year-to-year fluctuations is based upon the three-year abundance study in Michigan mentioned in the above two sections (Grant *et al*. 2002) that indicated little change from year to year.

Rescue effect

The likelihood that dispersal from Michigan populations could repopulate a declining or extirpated population in Ontario is extremely low given the distance of 230 km across Lake Huron between the closest Ontario/Michigan locations. The timing, extent, and distance of dispersal flights in Hungerford's Crawling Water Beetle are, however, unknown (USFWS 2006).

THREATS AND LIMITING FACTORS

Although the habitat requirements of Hungerford's Crawling Water Beetle are not fully understood, it is likely that threats to this species include any activities that degrade or reduce water quality or quantity or remove or disrupt the pools and riffle environment of streams in which this species lives (USFWS 2006) as well as any changes that affect stream ecology. Such threats may include stream modification (e.g., channelization, dredging, bank stabilization, erosion control, and certain kinds of impoundment), pollution, impacts to groundwater quality and quantity (e.g., as a result of development on adjacent lands), and invasive alien species.

Alternations to stream flow as a result of waterpower development, waterpower management regimes, permits to take water (either surface water directly from the stream or groundwater that may fed the stream), discharge of storm water and other activities may also impact Hungerford's Crawling Water Beetle populations by altering the hydrology, temperature, substrate and water chemistry of the stream. These activities all currently occur in the three Canadian watersheds where Hungerford's Crawling Water Beetles are found. Such activities and the resulting changes to stream flow could also impact the shoreline pupation sites of this beetle (e.g., through erosion and/or flooding).

The Saugeen River location is adjacent to lands where an expansion to a landfill site is proposed (S. Robinson, pers. comm. 2010). Such an expansion could have impacts on groundwater quality. Changes in groundwater quality and quantity can result in changes to the benthic invertebrate and algal communities (Dewson *et al*. 2007, Hancock 2002, Stevenson *et al*. 1996). Landfill expansion could, therefore, result in negative direct or indirect (e.g., by altering algal communities on which Hungerford's Crawling Water Beetles feed upon) effects upon the Hungerford's Crawling Water Beetle population at this location.

Very little is known about disease and predation in this species but there are no indications that these factors may be contributing to any declines (USFWS 2006).

Rare insects are often considered to be valuable to collectors, but given that this species is tiny and not particularly showy, collection threat is likely minimal.

PROTECTION, STATUS, AND RANKS

Legal protection and status

Hungerford's Crawling Water Beetle was listed as endangered on March 7, 1994, under provisions of the *United States Endangered Species Act* (USFWS 2006). It is also listed as endangered in the state of Michigan (MNFI 2007). The species is currently not protected under the *Species at Risk Act* in Canada or Ontario's *Endangered Species Act*. It is not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Non-legal status and ranks

This species is ranked globally as G1 (Critically Imperiled – at very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors) by NatureServe (2009). It is ranked nationally as N1 (Critically Imperiled) in both Canada and the United States (NatureServe 2009) and subnationally as S1 (Critically Imperiled) in both Michigan (MNFI 2007) and Ontario (ONHIC 2009). This species is not included in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species because it has not been assessed nor has it been assigned a provincial or national General Status rank.

Habitat protection and ownership

At the North Saugeen River location, a small 2 hectare municipal park exists along one side of the river, immediately adjacent to the area where Hungerford's Crawling Water Beetles have been found in the past. The rest of the surrounding property, as well as the majority of the land upstream of the location is privately owned. The dam and small hydro-electric facility immediately upstream of the location is privately owned and operated.

The vast majority of land adjacent to, and immediately upstream of, the Rankin River location, up to and including Boat Lake, is publicly owned. The land is a combination of provincial Crown land (269 hectares), Grey-Sauble Conservation property (853 hectares), Bruce County Forest (20 hectares) and private property (179 hectares). The west side of the river where beetles have been collected is adjacent to Grey-Sauble Conservation property and provincial Crown land. A thin strip adjacent to the east side of the river is the property of a public utilities agency. The dam immediately upstream of the location is owned and operated by Grey-Sauble Conservation. The 82 hectare parcel along the east side of the river, immediately upstream of the dam is privately owned and is currently undeveloped.

The Saugeen River location is contained within municipal lands, including a park. Lands to the west of the location are municipally owned and managed by the municipality but are used for infrastructure (i.e., landfill) and are not specifically dedicated to parklands. A small section of the river immediately upstream of the location passes through a parcel of private property. Upstream of this, the river is bordered by a combination of municipal parkland and private property for approximately 3 km.

In Ontario, the habitats of species of conservation concern (i.e., those considered to be provincially rare and tracked by the Natural Heritage Information Centre, Ontario Ministry of Natural Resources), including Hungerford's Crawling Water Beetle, can receive policy level protection as significant wildlife habitat through the natural heritage provisions of the Provincial Policy Statement (2005) under the provincial *Planning Act*. The identification of significant wildlife habitat is, however, solely left up to municipalities for planning purposes and it is doubtful that it has been identified for this species.

Although not directed specifically at Hungerford's Crawling Water Beetle (because it is currently not legally protected), the rivers where it is found are afforded some protection under other legislation. Habitat protection may be afforded by the respective Conservation Authorities through the *Development, Interference with Wetlands and Alteration to Shorelines and Watercourses Regulations* under the provincial *Conservation Authorities Act*. Some habitat protection is also afforded under the provisions of the federal *Fisheries Act.* The provincial *Lakes and Rivers Improvement Act* may also indirectly protect Hungerford's habitat as it is intended to regulate improvements to lakes and rivers while preserving the natural amenities of such waters. Aspects of the provincial *Nutrient Management Act, Environmental Assessment Act, Environmental Protection Act, Water Resources Act,* and *Source Water Protection Act* may also provide indirect protection for the habitat of Hungerford's Crawling Water Beetle.

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John Bittorf, Water Resources Technician
Grey-Sauble Conservation
Owen Sound, Ontario

Alan Dextrase, Senior Species at Risk Biologist
Species at Risk Branch
Ontario Ministry of Natural Resources
Peterborough, Ontario

Jack Dingledine
U.S. Fish and Wildlife Service
East Lansing Field Office
East Lansing, Michigan

Dr. Henri Goulet, Research Scientist (Entomology)
Agriculture and Agri-Food Canada
Ottawa, Ontario

Barbara Hosler
U.S. Fish and Wildlife Service
East Lansing Field Office
East Lansing, Michigan

Brad Hubley, Technician
Entomology,
Royal Ontario Museum
Toronto, Ontario

Jack Imhof, National Biologist
Trout Unlimited Canada

Dr. Steve Marshall, Professor
Department of Environmental Biology
University of Guelph
Guelph, Ontario

Andy McKee, Lake Huron COA Coordinator
Upper Great Lakes Management Unit
Ontario Ministry of Natural Resources
Owen Sound, Ontario

Martha Nicol, Water Quality Specialist
Saugeen Conservation
Hanover, Ontario

Dr. Rob Roughley, Professor
Entomology Department
University of Manitoba
Winnipeg, Manitoba

Richard Russell
Canadian Wildlife Service - Ontario
Environment Canada
Ottawa, Ontario

Andrew Smith, Research Associate
Canadian Museum of Nature
Ottawa, Ontario

Don Sutherland, Zoologist
Natural Heritage Information Centre
Ontario Ministry of Natural Resources
Peterborough, Ontario

Robert Vande Kopple, Resident Biologist
University of Michigan Biological Station
Pellston, Michigan

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Colin Jones has a B.Sc. in Biology from the University of Guelph and a B.Ed. from the University of Ottawa. After graduating, Colin worked in Algonquin Provincial Park as a Park Naturalist for 5 years. During that time, Colin conducted many insect surveys, especially concentrating his efforts on Lepidoptera and Odonata. Since 1999, he has worked as a biologist for the Natural Heritage Information Centre, Ontario Ministry of Natural Resources in Peterborough, Ontario where most of his work concentrates on the conservation of rare species with an emphasis on invertebrates. Colin has been a member of the COSEWIC Arthropods Specialist Subcommittee since 2005.

COLLECTIONS EXAMINED

University of Guelph Insect Collection
Guelph, Ontario

Insect Collection
Canadian Museum of Nature
Hull, Quebec

Canadian National Collection of Insects, Arachnids and Nematodes
Agriculture and Agri-Food Canada
Ottawa, Ontario

Entomology Collection
Royal Ontario Museum
Toronto, Ontario

Ontario Benthos Biomonitoring Network Samples
Saugeen Valley Conservation Authority
Hanover, Ontario