

COSEWIC
Assessment and Status Report

on the

Northern Barrens Tiger Beetle
Cicindela patruela

in Canada



ENDANGERED
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC Assessment Summary

Assessment Summary – November 2009

Common name

Northern Barrens Tiger Beetle

Scientific name

Cicindela patruela

Status

Endangered

Reason for designation

This showy metallic green beetle inhabits sandy, open forest habitat dominated by pine and/or oak trees. Found in northeastern and north-central North America, it is globally imperiled reaching its northern limit in southern Ontario where it is currently found at only two localities. The species has disappeared from one well known historic site. Habitat loss resulting from natural succession and increased pedestrian traffic are significant threats.

Occurrence

Ontario, Quebec

Status history

Designated Endangered in November 2009.



COSEWIC
Executive Summary

Northern Barrens Tiger Beetle
Cicindela patruela

Species information

Northern Barrens Tiger Beetle (previously known as Patterned Green Tiger Beetle) is a member of the family Carabidae, order Coleoptera. Three subspecies of *Cicindela patruela* have been described, of which only the nominate subspecies *patruela* is found in Canada. This subspecies is recognized by its dull metallic green colour with a complete white middle band on the wing covers. It is 12-14.5 mm long.

Distribution

The historic range of Northern Barrens Tiger Beetle includes Ontario, Quebec, and 24 states in the north-central and eastern US. Its occurrence is discontinuous and very local throughout its range. In Canada, it is historically known from three locations in Ontario and Quebec. It is believed extirpated at one of these sites, possibly extant at another and currently definitely known at only one. The only confirmed extant site in Canada is at Pinery Provincial Park.

Habitat

Northern Barrens Tiger Beetle occurs along dry, sandy trails, little-used roads, and other small openings in oak-pine savannahs and mixed woods. Larvae use similar habitat, typically off to the side of paths in more consolidated soil and sparse ground cover of bracken fern, blueberries, grasses, mosses and lichens. Northern Barrens Tiger Beetle is often restricted to small areas within large patches of seemingly suitable habitat.

Biology

Northern Barrens Tiger Beetle has a 2-year life cycle. New adults typically emerge in early fall to feed, overwinter in burrows, and emerge the following spring to mate and lay eggs. Post-breeding adults may persist through most of the summer. Eggs hatch in early summer and each larva digs a burrow. Larvae become second or third instars by the autumn, overwinter underground, then continue through the second spring and summer as third instars before pupating in late summer.

Adult Northern Barrens Tiger Beetle are active during warm, sunny weather, consuming a wide range of small invertebrates, particularly ants. Larvae are also predators, lying in ambush at the top of their burrows and grabbing passing prey. The adult beetles are preyed upon by robber flies and a variety of generalist predators.

Population sizes and trends

Northern Barrens Tiger Beetle numbers are low globally for such a widespread insect, and the species appears to be declining throughout much of its range. It is apparently extirpated at one of the three known Canadian occurrences. The total population size at Pinery Provincial Park is estimated at only 400-1000 individuals including both larvae and adults, but this is only a very general estimate. Numbers of Northern Barrens Tiger Beetle observed at one of the subsites at Pinery Provincial Park appear to have declined over the past 15 years and trends at the other nearby subsite are unknown. Information on population numbers is considered insufficient for assessment purposes.

Limiting factors and threats

Northern Barrens Tiger Beetle is at the northern limit of its range and has restricted habitat preferences. It is considered moderately to extremely threatened in its global range primarily due to habitat loss and degradation. In Canada, it is threatened by habitat degradation due to natural succession of savannah and woodland habitat to more shaded conditions, particularly as a consequence of lack of natural fire.

Special significance of the species

Tiger beetles have long been the study of amateur and professional entomologists and are important models for the study of ecology and evolution. Although Northern Barrens Tiger Beetle is too uncommon and obscure through most of its range to be known by most people, tiger beetles are increasingly popular for wildlife viewing as evidenced by the recent publication of a number of field guides. They are the first group of beetles to become part of the trend toward insect viewing which has grown to some extent out of birdwatching. This species and other tiger beetles serve as useful environmental indicators as part of the National General Status Ranking Process.

Existing protection

Northern Barrens Tiger Beetle is ranked globally and in the US as vulnerable. It is not ranked nationally in Canada, but is critically imperiled in Ontario and presumed extirpated in Quebec, and is imperiled or vulnerable in all the states from which it is known. It listed as Special Concern in Minnesota, Wisconsin and Michigan, and Endangered in Maryland. The only extant Canadian population is within Pinery Provincial Park where management provides an opportunity for, but not assurance of, protection of this insect and its habitat.



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 (2009)

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.



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SPECIES INFORMATION

Name and classification

Kingdom: Animalia - Animal, animals, animaux

Phylum: Arthropoda - arthropodes, arthropods, Artrópode

Subphylum: Hexapoda - hexapods

Class: Insecta - hexapoda, insectes, insects, insecto

Subclass: Pterygota - insectes ailés, winged insects

Infraclass: Neoptera - modern, wing-folding insects

Order: Coleoptera Linnaeus, 1758 - beetles, besouro, coléoptères

Suborder: Adephaga Schellenberg, 1806

Family: Carabidae Latreille, 1802 - carabes, ground beetles

Subfamily: Cicindelinae Latreille, 1802 - tiger beetles

Genus: *Cicindela* Linnaeus, 1758

Species: *Cicindela patruela* Dejean, 1825 (Northern Barrens Tiger Beetle)

Subspecies: *Cicindela patruela patruela* Dejean, 1825 – Northern Barrens Tiger Beetle; Cicindèle verte des pinèdes

Cicindela patruela Dejean, 1825, or Northern Barrens Tiger Beetle, is a member of the family Carabidae, order Coleoptera. Recently discovered male genitalic characters suggest that tiger beetles may be the first lineage of this family and it may be appropriately treated as a separate family (Cicindellidae), as done in the past, but this is still under review by experts (H. Goulet, pers. comm., November 2008). *Cicindela patruela* belongs to the subgenus *Cicindela* or common tiger beetles, one of numerous subgenera of the globally distributed genus *Cicindela* Linnaeus (*sensu lato*). *Cicindela patruela* is called Northern Barrens Tiger Beetle in a recently published field guide to the tiger beetles of the United States and Canada (Pearson *et al.* 2006), although older field guides (e.g., Leonard and Bell 1999) use Patterned Green Tiger Beetle.

Cicindela patruela is a member of the *C. sexguttata* group, which includes the nominal species as well as *C. denikei* (Kaulbars and Freitag 1993). *Cicindela patruela* is hypothesized to have split from the *C. sexguttata* - *C. denikei* line during the Pliocene and it remains very similar morphologically. Three subspecies of *C. patruela* are generally accepted, of which *C. patruela patruela* has the widest distribution in U.S. and Canada. *Cicindela p. consentanea* Dejean is a darker form restricted to the pine barrens of Long Island, New Jersey and Delaware. A muddy green to bronze-brown variant of *C. patruela* from west-central Wisconsin was noted by Lawton (1970) and later described as *C. p. huberi* by Johnson (1989). It is found on or near the lakebed of former Glacial Lake Wisconsin (Willis 2001). Some authors (e.g., Bousquet and Laroche 1993; Kaulbars and Freitag 1993) consider *C. p. huberi* as a variant of *C. p. patruela* and not a true subspecies.

Designatable units

Although the two Canadian localities are isolated and in different ecozones (according to some definitions), there is no reason to treat them as separate DUs since they were likely historically connected to a greater degree and there is no evidence for differences in genetic composition or ecology.

Morphological description

Cicindela patruela has the typical form of a tiger beetle, with large bulging eyes and a head at least as wide as the pronotum (thorax) (Figure 1). The abdomen has nearly parallel sides but is slightly wider behind the middle. Threadlike antennae are inserted at the base of large, sickle-shaped, toothed mandibles. Legs are long and slender. *Cicindela patruela* is 12 to 14.5 mm long, and there are three distinct but separated markings (maculations) on the dull, metallic green elytra (Pearson *et al.* 2006). The diagnostic middle band is complete (continuous), transverse and slightly sinuate in the middle. The apical lunule (rear maculation) is reduced to two dots or dots narrowly joined, as is the humeral (shoulder) lunule. The marginal band is always absent.

Cicindela patruela closely resembles *C. sexguttata*, but the latter usually has a broken middle band, typically reduced to 2 dots. In very few specimens the middle band is present as an extremely thin band and a discal dot (Leonard and Bell 1999). The clearest and most consistent characters for differentiating them are the elytral punctation and structure of internal genitalia, e.g., the size and shape of sclerites (Kaulbars and Freitag 1993). Due to differences in elytral microsculpture, *Cicindela patruela* is a duller metallic green, whereas *C. sexguttata* is a more iridescent green (Knisley and Schultz 1997). The ventral surface of the abdomen is metallic green in both species but hairier in *C. patruela* (Leonard and Bell 1999). *Cicindela patruela* can be distinguished from green forms of *C. limbalis* and *C. purpurea* by a smooth rather than hairy frons (forehead).

Tiger beetles have white, grub-like larvae up to 2.5 cm long with a membranous integument (Figure 2). They have a large, darkened, armoured head capsule with six eyes on top and large mandibles underneath. There is a prominent hump with hooks on the larva's lower back to help it maintain its position in the vertical larval burrow. The size, shape, location and number of hooks, sclerites, and/or setae can be used to distinguish larval *C. patruela* from other species (Willis 1980).



Figure 1. *Cicindela patruela* at Pinery Provincial Park, Ontario, May 2007.

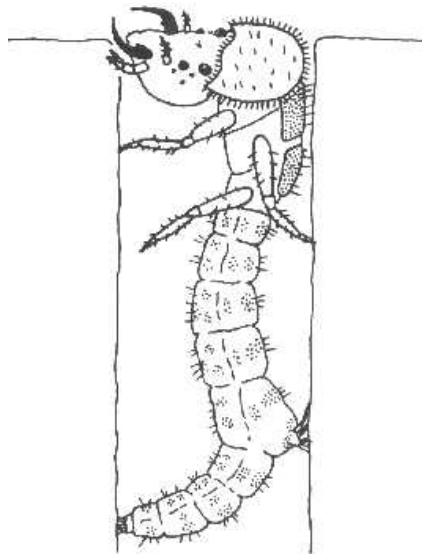


Figure 2. Generalized illustration of a tiger beetle larvae (figure reproduced with permission from Gary Dunn's website <http://members.aol.com/YESedu/ecologyt.html>)

Genetic description

Species-level phylogenies for 110 species of North American *Cicindela* have recently been derived by Barraclough and Vogler (2002) based upon analysis of mitochondrial DNA. Their analyses showed that *Cicindela patruela* has recently diverged from *C. sexguttata*, which is consistent with traditional phylogenies based upon morphological characters, particularly internal genitalia. No genetics studies on intra-specific variation within *C. patruela* have been published to date.

DISTRIBUTION

Global range

Cicindela patruela is widely distributed across north-central and eastern North America. Its range extends from northern Georgia to central Ontario and from Maryland west to central Minnesota. The known historical range of *Cicindela patruela* includes Ontario, Quebec and 24 states in the United States (Figure 3). The global maximum extent of occurrence encompasses about 1.2 million km². It is known to be extant in Ontario and 17 states but its occurrence is discontinuous and localized. There appear to be large areas of potentially suitable habitat within this range where the species does not occur. Based on personal experience and that of other collectors, Knisley estimated 33 to 56 North American occurrences in 1994 (NatureServe 2007), which was a slight underestimate due to unreported and recently discovered occurrences now known. *Cicindela patruela* is regarded as uncommon to rare in all parts of its range, and is possibly extirpated from Quebec, Delaware, New Hampshire, and Rhode Island. *Cicindela patruela* is probably most common in Wisconsin and Michigan (Willis 2001), and possibly Pennsylvania. New populations have recently been discovered in New York and New Jersey where it was presumed extirpated (P.M. Catling pers. comm.).

Canadian range

In Canada, *Cicindela patruela* is known historically from three sites, but is known to persist only at Pinery Provincial Park in Ontario on the southeast shore of Lake Huron where it was first collected in 1991 and may persist at one other site in the Ottawa valley of Quebec (Figure 4, Skevington 1995, Skevington *et al.* 2001). *Cicindela patruela* is at the northern limit of its global range in Canada, and all known Canadian sites are within the Mixedwoods Plain Ecozone (Environment Canada 2007). The distribution of *C. patruela* is thought to strongly reflect post-glacial dispersal, climate, and soil type (Leng 1912; Kaulbars and Freitag 1993). Colder climate and shallow granitic soils may limit its distribution to the north. Canadian occurrences likely reflect post-glacial dispersal along river valleys that provided warm microclimates, sandy alluvial soils, and associated overstorey vegetation.

C. patruela was historically known from Constance Bay on the Ottawa River, approximately 20 km east of Arnprior (Wallis 1961). It has not been collected here since 1950 (Table 1, Foster and Harris 2007b) nor observed at that site in several decades despite repeated attempts to rediscover it by P.M. Catling, H. Goulet (and others), and it is probably extirpated (Goulet 2005a; Skevington 2007) at Constance Bay.

Cicindela patruela was collected May 24 1980 from l'Île aux Allumettes (Pontiac Co.), Quebec, approximately 80 km upstream in the Ottawa River and adjacent to Pembroke, Ontario (H. Goulet, pers. comm.). The exact collecting locality on the 264 km² island is unknown. Although there appears to have been little subsequent survey effort, no *C. patruela* have been recorded since 1980 from l'Île aux Allumettes, but there is no reason to expect that it does not still occur there, so this locality is accepted as extant for extent of occurrence and area of occupancy calculations. The specimen documenting this record has been lost but it was seen and confirmed by Quebec coleopteran expert Andre Larochelle in 1985 (Larochelle, pers. comm.) and by others (H. Goulet, pers. comm.) and is thus treated as an acceptable report.

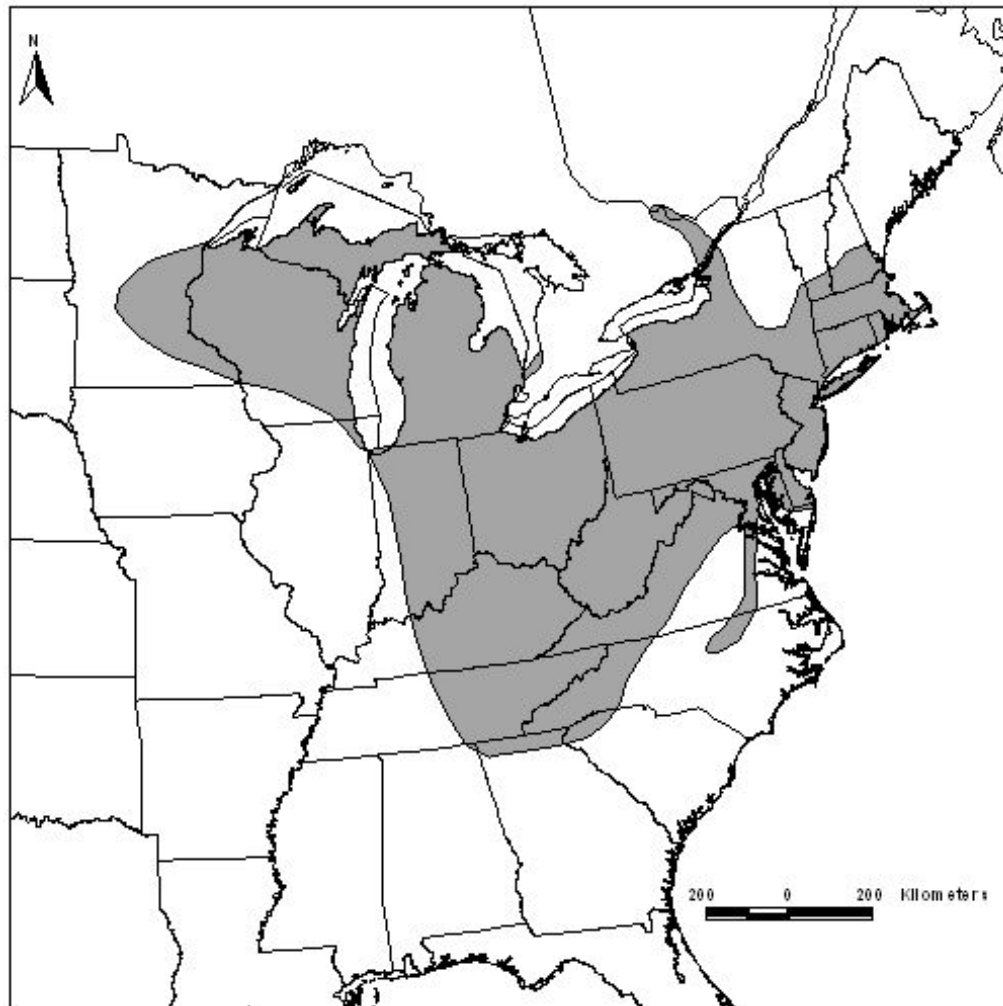


Figure 3. Distribution of *Cicindela patruela* in North America (largely based on Johnson 1989, Pearson *et al.* 1997; Pearson *et al.* 2006).

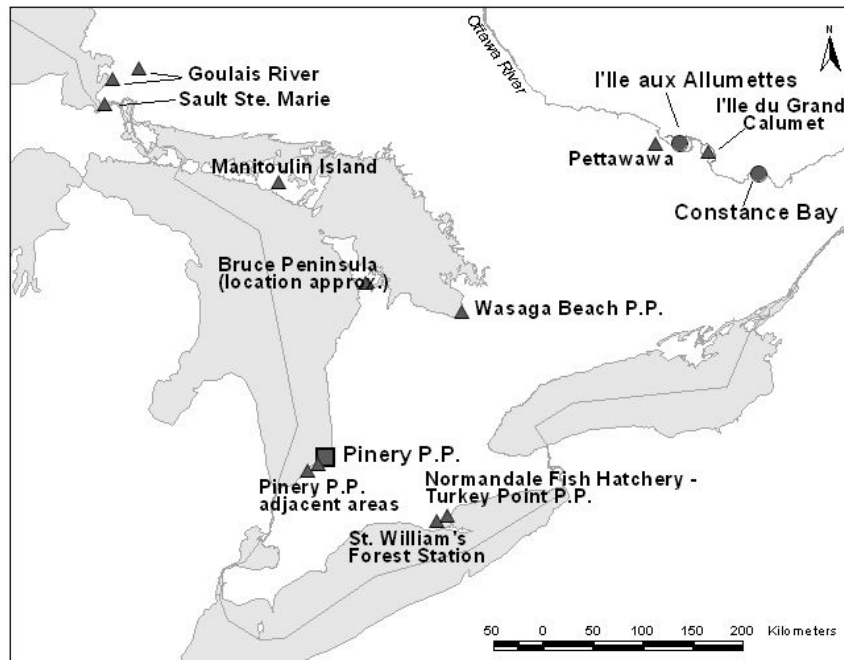


Figure 4. Distribution of *Cicindela patruela* in Canada (dots indicating historic records and squares indicating current occurrence) and surveyed sites (triangles).

C. patruela has only been recently seen in a limited area in Pinery Provincial Park despite hundreds of hours of entomological surveys targeting *C. patruela* and other species elsewhere in the park, as well as in the Port Franks Forested Dunes, the Karner Blue Sanctuary, and adjacent areas (Foster and Harris 2007a; Skevington 2007 pers. comm.). Habitat may also exist in the backshore forested dunes between Ipperwash Beach and Port Franks (former Canadian Forces Ipperwash Range and Training Area, called "Camp Ipperwash") but has not been thoroughly surveyed due to restricted access (D. Sutherland 2005). The forested dunes and sand barrens landform-vegetation type that comprises the known Canadian habitat of *C. patruela* is extremely rare, with Constance Bay, the Pinery, and the back dunes at Wasaga Beach and Turkey Point Plains in Norfolk County being some of the largest and best existing examples (Boyd and Cuddy 1983; Brunton 1992; Bakowsky 1993; Rodger 1998). Surveys for *C. patruela* have been conducted at all these sites, as well as at St. Williams Forestry Station, the other significant oak-pine woodland on the Norfolk Sand Plain. Sandy, open jack pine forests are found in the Petawawa area (Bruinsma 2006) and on l'Île Grand Calumet Island (Coulson 2006), on sand deposits along the Ottawa River (Westmeath, etc.), at Camp Borden in Simcoe County, Lake Erie sand spits, Walpole Island, Bothwell Sand Plain, Rice Lake Plains, Giant's Tomb Island, Awenda Park, Sandbanks Park, and the west side of Algonquin Park (Catling 2006, pers. comm.). It is estimated that each of these sites, which are unusual sandy areas, has been visited on several occasions by entomologists. Although search efforts undoubtedly varied in time and concentration, the lack of discovery of *C. patruela* is considered a reliable indication of its extreme rarity.

Wasaga Beach was erroneously referred to as the only known (but presumed extirpated) Canadian location for *C. patruela* in Skevington (1995), but there are no confirmed records from the Wasaga area despite extensive adult surveys and targeted pitfall trapping by Gurr (2005). *Cicindela patruela* was erroneously reported from the Blyth area in Lambton County, but the record proved to be based on a *C. sexguttata* specimen with an unusually well-developed middle band (Foster and Harris 2007a).

Although it is possible that *Cicindela patruela* is more widely distributed in the 2271 ha area of Pinery Provincial Park, and in adjacent undeveloped areas outside the park (<1000 ha), it seems unlikely given the amount of survey effort by entomologists in this much visited and studied location. If the population in l'Île aux Allumettes where a single specimen was collected in 1980 (Goulet 2006) is reliable and extant, it is likely small since at least half of the island is farmland and much of the rest is densely wooded.

The extent of occurrence is an area connecting the Pinery and Allumette Island occurrences. The area of occupancy is 12 km² using the 2 X 2 km² grid method.

Table 1. Location of recent unsuccessful directed searches for *Cicindela patruela* in Canada (see Figure 3).

Location	Observers	Date
Ottawa River Valley		
Constance Bay	H. Goulet	ca. 1964, 1980, 2000
	S. Marshall	unknown
	P. Catling, D. Cuddy	ca. 2001
	P. Catling	2007
	J. Skevington	2005-2007
l'Île du Grand Calumet	S. Laplante	2006, but Allumette not searched
Petawawa area	D. Coulson	throughout Renfrew County since 2001
	P. Catling	2007
Pinery Area		
Pinery P.P. (other than known sites)	J. Skevington	1993-1996
	I. Carmichael	1994-1996
	A. Rider	1990s to present
	R. Foster, A. Harris	2005-2007
Ski Hill adjacent to NE side of park	A. Rider	late 1990s
Port Franks Forested Dunes and Karner Blue Sanctuary	R. Foster, A. Harris	2005
	J. Skevington	1995-1996
	D. Sutherland	various 1994
Attawandaron Scout Camp	R. Foster	2005

Location	Observers	Date
Norfolk Sand Plain		
St. William's Forest Station (incl. Manester Tract)	D. Sutherland	3 June, 7-8 Sept 1994; 8 July, various
	J. Skevington	1990s, 2000, 2004-2006 (briefly)
	J. Acorn	27 May 2005
	R. Foster, A. Harris	June 2005
	J. Allair	May, June, Aug. 2007
Normandale Hatchery Area	D. Sutherland	various 1994-1995
	J. Allair	May, June, Aug. 2007
Turkey Point P.P.	R. Foster, A. Harris	May 2007
	J. Skevington	1990s, 2000, 2004-2006 (briefly)
	D. Sutherland	4 June 1994; 9, 12 July 1995
Other		
Wasaga Beach P.P.	M. Gurr	2000-2003
	D. Sutherland	20 June 1997
Inverhuron P.P.	M. Gurr	Aug-Nov. 2005
Presqu'île P.P.	M. Gurr	mid-late 1990s
	D. Bree	various since 2000
Sandbanks P.P.	D. Bree	various, including 5 days in 2000
Sault Ste. Marie – Goulais River Area	R. Foster, M. Jones	May 2007
Manitoulin Island (incl. Misery Bay)	H. Goulet	various between 1992 and 2007
Bruce Peninsula (incl. Hepworth Dunes)	S. Marshall	various
	J. Skevington	1991-1992 (none found)

HABITAT

Habitat requirements

Cicindela patruela is a disturbance-dependent species of early successional but possibly long-lasting habitats (Willis 2001). They are typically found along bare to sparsely vegetated, little-used dirt roads, trails, fire lanes, transmission lines, eroded slopes, and forest openings on eroded sandstone outcrops within mixed pine-oak forest (Acciavatti *et al.* 1992; Larochelle and Larivière 2001; McCann 2007; Willis 2001). Although habitats may shift as succession proceeds, we expect that such shifts would occur over periods of one to several decades at least. *Cicindela patruela* has a narrow range of soil tolerances and appears to prefer dry, coarse-grained, sandy soils (Kaulbars and Freitag 1993; Knisley and Shultz 1997). In New Jersey it has been found along gravelly roads and in sandy areas with small pebbles and stones at the surface (Boyd 1973; Willis 2000) and on acidic sandy loam in Ohio (Keeney 2007). Occasionally *C. patruela* is collected from edges of sand quarries or dunes (Willis 2000) but it is most commonly observed on stable, partially compacted soils along trails rather than in more mobile sands (Willis 2001).

Adults may hunt and mate on loose sands along trails, but oviposition typically occurs in shaded, bare patches of consolidated sandy soil among lichens and mosses adjacent to trails (Knisley *et al.*, 1990; Lawton 1974; Willis 2000). Needle and leaf litter is typically very sparse or lacking near larval burrows (Keeney 2007). Adults appear to be distributed slightly differently than larvae and the latter are more important from a conservation perspective due to more specific prey requirements (NatureServe 2007). Adults hunt by flying and running in open habitats while larvae lie in ambush, often in less open situations.

Natural oak-pine forests are the preferred habitat throughout its range (Larochelle and Larivière 2001; Pearson *et al.* 2006), and Canadian populations are associated with partially wooded dunes. At Pinery P.P., *C. patruela* is found in Black Oak (*Q. velutina*) – White Pine savannah and woodland (Figure 5) with some natural and planted red pine (Janes 1953; Patel and Rapport 2000). There are two known sites at the Pinery, one on a trail through oak-pine woodland, where most of the beetles have been located in or near one small clearing, with a few beetles up to 350 m away at other small openings (MacKenzie 2005 pers. comm.; Sutherland 2006 pers. comm.). Understorey plants are Bracken Fern, blueberry, Witch Hazel (*Hamamelis virginiana*), sunflowers (*Helianthus* spp.), and graminoids. More recently, *C. patruela* numbers have been greater along 600 m of another trail through more open oak savannah (30-50% overstorey cover), with a Poison Ivy (*Rhus radicans*) and *Carex pensylvanica* understorey. More extensive habitat descriptions are provided in Foster and Harris (2007a).

The Constance Bay Sand Hills are post-glacial relict dunes that historically supported a multi-aged Jack Pine - Red Oak (*Q. rubra*) forest and sand barrens (Boyd and Cuddy 1984; Brunton 1992). *Cicindela patruela* habitat at Constance Bay was a network of trails through Jack Pine woods, sweet fern, New Jersey Tea (*Ceanothus americanus*), and blueberry (Wallis 1961; Goulet 2005a) and is identical with the typical habitat in Michigan (Graves 1964). At l'Île aux Allumettes the habitat was described by LaLiberté (1980) as a dirt road through the woods ("sur un chemin de terre qui traversait un boisé").

In Wisconsin, jack pine and Black Oak (*Quercus velutina*), red oak (*Q. rubra*) or Northern Pin Oaks (*Q. ellipsoidalis*) are the dominant overstorey species (Willis 2000). It has also been found in 30-40 year old pine plantations in Indiana (Knisley *et al.* 1990) and 25-40 year old Red Pine (*P. resinosa*) plantations in Wisconsin, but not in any younger than 15 years of age (Willis 2001). White Pine (*P. strobus*) and Trembling Aspen (*Populus tremuloides*) are also sometimes present (Willis 2000), but it is apparently not found in oak-hickory forests in Ohio (Keeney 2007). *Cicindela patruela* was found by Kritskey *et al.* (1999) on a 32-year old sand pile with colonizing pines in Ohio. The natural forests with *C. patruela* range from quite open to having a nearly complete canopy, but partially open is the most common (Willis 2000).

In Kentucky, *C. patruela* habitat is pine barrens and dry, rocky/sandy, pine-dominated ridgetops with laurel (*Kalmia*) and blueberries (*Vaccinium*) (Laudermilk 2007). In the northern part of its range, the understorey is often dominated by blueberries, bracken fern (*Pteridium aquilinum*), hazel (*Corylus*), sweet fern (*Comptonia peregrina*) and graminoids such as *Carex pensylvanica* (Willis 2000; Brust 2007). Ground cover has been reported as predominately mosses and lichens, especially *Polytrichum*, *Tortula*, and *Cladonia* (Willis 2000; Keeney 2007). Adults are often found in graminoids along the edges of paths (Lawton 1970).

In Wisconsin, the habitat and range of the imperiled Karner Blue butterfly (*Lycaeides melissa samuelis* Nabokov) are very similar to that of *C. p. huberi* (Willis 2001), and Karner Blues were found at Port Franks adjacent to the Pinery. Numerous other rare species of plants and animals are found at the Pinery and Constance Bay associated with the savannah and dune habitats.



Figure 5. *Cicindela patruela* habitat at Pinery Provincial Park.

Habitat trends

Conversion of forested habitat to agriculture and urban development has occurred throughout much of the range of *C. patruela* since the early 1800s. The man-made trails and unpaved roads that are commonly used by *C. patruela* are a relatively recent feature on the landscape. Habitat prior to settlement by Europeans was likely animal trails through oak-pine woods and barrens, as well as clearings in wooded dunes, sandstone outcrops, eroding banks, or other local edaphic features (Willis 2001). Wildfires, either natural or set by Aboriginal peoples, helped maintain these habitats. Recent fire suppression has allowed many forests to grow too dense for *C. patruela* in Wisconsin (Willis 2001) and elsewhere in its range. This is partially offset by recreational trails, logging and road-building activities. Silviculture, succession, fire suppression and development has led to most of the open jack pine–red oak–trembling aspen forest and barrens at Constance Bay being replaced by dense jack pine and red pine plantations and permanent human residences (Brunton 1992; Goulet 2005a).

Open sandy habitats are declining throughout the province due to development and/or succession (P.M. Catling, pers. comm. 2008). Although oak savannahs and woodlands were formerly more widespread in southern Ontario and more extensive at some locales, less than 0.1% of the original prairie savannah and oak woodland present prior to European settlement still remains (Bakowsky 1993). The vast majority ($\geq 95\%$) occurs at the Pinery and two other sites (Walpole Island, Windsor Prairie, both on the St. Clair clay plains) with the largest of the remaining remnants only 2 ha in size or smaller. Some potentially suitable habitat has been destroyed at the Pinery by campground and other infrastructure development, and suppression of the natural fire regime of the oak savannah in the park (Janes 1953) led to more closed conditions as well. Now the park is managed with a degree of regular burning and conditions have changed substantially in some areas.

Habitat protection/ownership

The only known extant Canadian population is within Pinery Provincial Park, a Natural Environment class park (Ontario Ministry of Natural Resources 1986). The objectives of natural environment class parks are to protect outstanding recreational landscapes, representative ecosystems and provincially significant elements of Ontario's natural and cultural heritage and to provide high quality recreational and educational experiences (Government of Ontario 2007). Prescribed burns were carried out between 1986 and 1993 in an attempt to restore several savanna communities (Rodger 1998) and the park has developed a long-term burn strategy with most areas being included (Dobbyn 2007), which may help to improve habitat conditions for *C. patruela*. Prescribed fires were carried out in 2001 along portions of the interpretive and informal trails to improve the habitat while taking into consideration *C. patruela* populations (MacKenzie 2007). No regular or standardized monitoring of *C. patruela* habitat is currently being undertaken at the Pinery, however. Despite recent improvements in management, the lack of both monitoring and a specific strategy for the protection of this species in the park make the future of *C. patruela* there uncertain.

The Constance Bay site is considered a provincially significant Area of Natural and Scientific Interest (ANSI) but some of the land tenure is private (Boyd and Cuddy 1984). Land tenure for the l'Île aux Allumettes site cannot be determined since the exact collection locality is unknown. It is likely privately owned like much of the island.

In the US, there are a few sites protected within national forests, state parks, and other conservation areas in Massachusetts (Nelson 2007), Minnesota, Ohio (Keeney 2007), and Indiana (Hedge 2007).

BIOLOGY

Life cycle and reproduction

Cicindela patruela is a spring-fall species, the adults appearing in the spring and fall. It has a 2-year life cycle (Shelford 1908; Knisley and Shultz 1997), which is typical of many northern tiger beetles (Pearson and Volger 2001). New adults (usually females) typically emerge in mid-August to early October, feed for several weeks and overwinter in burrows (Willis 2000). In many populations, the majority of new adults may forgo a fall emergence and overwinter in the pupal chamber. This pattern may be due to delayed development and/or the onset of lower autumn temperatures (Knisley and Schulz 1997; Lawton 1970), since a minimum of 19°C soil temperature is required for *C. patruela* imagines to dig out of the pupal burrow (Knisley *et al.* 1990). As a result, above-ground adults are often more abundant in the spring than in the fall (Knisley *et al.* 1990).

Adults emerge between mid-April (southern portion of its range) to late May (Canada), and begin copulating after one or two weeks (Kaulbars 1982). Most mating activity in Wisconsin was from mid-June to mid-July (Willis 2000), and 10-14 days later (Kaulbars 1982) females lay approximately 50 eggs in individual holes 3-5 mm deep (Shelford 1908). Eggs hatch in early summer, and the first instar digs a deeper burrow, which is enlarged in successive instars (Pearson 1988). Larvae become second or third instars by the autumn, overwinter underground, then continue through the second spring and summer as third instars before pupating in late summer (Knisley *et al.* 1990). A small number of adults may persist into early July and even throughout the summer in some populations (Boyd 1973; Lawton 1970). Two cohorts of the species cycle through the life stages offset by one year, with adults of one group mating and laying eggs while the other group is in the larval form preparing for pupation (Kirk 1996). The two population peaks are not discontinuous, with old spring adults overlapping with recently emerged adults in mid- to late summer (Kaulbars 1980; Willis 2000).

Cicindela patruela adults are active predators, ambushing and consuming a wide range of small insects and other invertebrates, particularly ants (Kaulbars 1982; Knisley *et al.* 1990). Larvae are also predaceous on small invertebrates, lying in ambush at the top of their burrows and grabbing passing prey.

Predation

Robber flies (Diptera: Asilidae) have commonly been observed preying upon tiger beetles, seizing the tiger beetle while in flight and stabbing it at the base of the elytra (Lavigne 1972). Robber flies (in the genus *Proctacanthus*) were observed on several occasions predating upon *C. formosa* and other *Cicindela* at the Pinery (Foster and Harris 2007). At least a dozen species of mammals, herptiles, and numerous bird species feed opportunistically upon tiger beetles (Larochelle 1974, 1975a,b). Blue jays (*Cyanocitta cristata*) have been observed in wooded habitats flying from one sunlit patch to the next and targeting sunning insects including *C. sexguttata* (Schultz 1998).

The bee fly, *Anthrax georgicus* (Diptera: Bombyliidae), is a specialist parasitoid of tiger beetle larvae, occurring in high enough densities to have negatively impacted some tiger beetle populations (Bram and Knisley 1982). It is common along the Lake Huron shore (Marshall 2005, 2007, pers. comm.) but its impacts on *C. patruela* populations at the Pinery are unknown. Tiger beetle larvae are also parasitized by *Methocha* (Hymenoptera: Tiphidae), small wingless ant-like wasps (Knisley and Schultz 1997), but it is unknown if this parasite is present in the Pinery Provincial Park populations.

Physiology

Cicindela patruela are ectothermic and maintain high body temperatures through thermoregulatory behaviours such as basking, stiling, and shuttling among different habitats (Schultz 1998). They are rarely active on cloudy days when ground surface temperatures are below 20-22°C, but may be active on sunny days when temperatures were as low as 10-14°C (Shultz 1998). *Cicindela patruela* are most active in mid- to late afternoon when it is easier to maintain an optimum body temperature of 34°C for foraging (Boyd 1973; Knisley *et al.* 1990). When body temperatures exceed 37°C, *C. patruela* typically move to shade under leaves and objects (Knisley *et al.* 1990). They have been observed at the Pinery when ambient temperatures were 35°C (D. Sutherland 2005, pers. comm.; Foster and Harris 2007). In the southern parts of their range they are found at higher elevations where the climate is cooler (Pearson *et al.* 2006). The soil associations of *Cicindela*, including *C. patruela*, are probably due to the temperature and moisture requirements of the larvae (Dunn 1978).

Dispersal/migration

Cicindela patruela exhibits a shifting mosaic population pattern, constantly dispersing to recently created habitats before old habitats become too thickly vegetated by successional growth (Willis 2001). In the short term, however, *C. patruela* populations seem to expand or disperse very little, since colonies apparently occupy only small segments along seemingly suitable unpaved roads and paths (Willis 2001; Wallis 1961). Colour patterns of some Wisconsin populations of *C. p. huberi* suggest that there is little gene flow among populations only a few miles apart (Willis 2001). Mark-recapture studies with other tiger beetle species indicate that although they move within habitat patches, they do not readily disperse to other patches even when these are relatively close (Kaulbars 1982).

Interspecific interactions

Cicindela patruela sometimes coexists with *C. sexguttata* and *C. punctulata* (Willis 2001; Foster and Harris 2007), and in northern parts of its range may sometimes be found with *C. longilabris* (Graves 1963). *Cicindela sexguttata* was known from Constance Bay although not on the same trail as *C. patruela* (Wallis 1961). *Cicindela scutellaris* and *C. formosa* may also be found with *C. patruela*, but they tend to prefer more open habitats with looser sand (Lawton 1970). Larval and adult competition between *C. patruela* and other *Cicindela* species is likely minimized due to species-specific soil, microhabitat, prey size, and thermal preferences (Kaulbars 1982; Pearson and Lederhouse 1987).

Adaptability

The disappearance of *Cicindela patruela* from one Canadian site and some US sites suggests that it is unable to adapt to the pressures of rapid habitat change, despite a general adaptation to disturbed sites. The species is somewhat fragile due to its limited habitat type and its tendency toward small population sizes (Knisley pers. comm. 1994 in NatureServe 2007). Movements to new habitats may be restricted by low habitat availability. *Cicindela patruela* have been raised in captivity (Willis 1980) but captive breeding programs for conservation purposes have not been attempted.

POPULATION SIZES AND TRENDS

Search effort

Surveys for adult *Cicindela patruela* are highly dependent on weather conditions and phenology, and the larvae are difficult to find (Willis 1980). Concerted surveys for adult *C. patruela* have been recently conducted in a few states within its US range, e.g. Georgia (G. Beaton 2007, pers. comm.), Maryland (McCann 2007), Minnesota (Steffens 2007), New Jersey (G. Fowles 2007), New York (J. Corser, 2007), and Rhode Island (E. Endrulat 2007). Timed adult index counts are used to survey *C. patruela* in Maryland (McCann 2007) and are often used to derive an index of abundance for tiger beetles (Knisley and Schultz 1997). Targeted visual searches for adults have been conducted in Canada, but effort has varied widely. Targeted pitfall trapping has also been used unsuccessfully at Wasaga Beach (Gurr 2005). Timed index counts were used by Foster and Harris (2007, see below). For information on search effort related to distribution, please see that section.

Abundance

Determining total population sizes for *Cicindela* is difficult and is based on estimates by Knisley (pers. comm. 1994 to NatureServe 2007). There are 3000 to 6000 adults globally each year. This estimate is probably low, based on the probability of unreported occurrences and since estimates based on other than mark-release-recapture tend to be low for insect populations. For an insect, this species is very sparse and may well produce less than 10,000 adults annually, with only a few hundred or less per occurrence.

Population size at the Pinery is difficult to estimate, particularly since no mark-recapture studies have been conducted. An index of abundance can be estimated based on the approximately 25 adults that were observed on a trail at the Pinery in late August 2005. Assuming that: 1) all individuals were observed only once (care was taken in the field); 2) no teneral adults were missed; and 3) 2/3 of that cohort did not emerge in the fall (Knisley *et al.* 1990), then the population along the trail was $25 \times 3 = 75$ individuals. Given that an apparently smaller number of beetles are found along a nearby trail and there may be beetles in the connecting or adjacent habitats, a minimum abundance estimate of 200 individuals seems appropriate. Experience from past studies suggests that this type of index count will yield an estimate that is about 20-50% of the individuals actually present in the population (Knisley and Schultz 1997). This suggests that the minimum population is approximately 400-1,000 *C. patruela* at the Pinery. This number roughly corresponds to Knisley's estimate of a few hundred beetles or less per occurrence in its global range (NatureServe 2007). If it still occurs on l'îles aux Allumettes and the population size was characteristic of other colonies, this could add 200 individuals, giving a Canadian population of less than 1200. Although these figures may prove useful to a degree, they are not recommended as a primary consideration for assessment due to a lack of reliability.

Fluctuations and trends

Declines among populations are well documented but fluctuation within populations are not known to occur. The global population appears to be declining based on old localities lacking extant populations and many seemingly suitable habitats lacking this species in the eastern portion of its range (NatureServe 2007). A decline of 10-30% is expected over the short term, with a large to moderate decline (decline of 25-90%) anticipated over the long term (NatureServe 2007). Based on examination of museum specimens, *C. patruela* has declined the least in the northwestern portion of its range where human impact on the landscape has been least (Kaulbars 1982). Of over 900 specimens examined, only 3 records from east of Indiana were collected after 1945 (Kaulbars and Freitag 1993). Local declines have been observed for over a century; Hood (1903) noted that *C. patruela* had been common around Boston, but by 1903 was rare or extirpated in that area.

Cicindela patruela is believed extirpated at one of its three known Canadian sites. Historically, the *C. patruela* population at Constance Bay was described by W.H. Brown (who first collected it there) as “a small colony, never too populous”, and appeared to be concentrated largely on one small stretch of sandy lane (Wallis 1961). Kaulbars (1982) considered the Constance Bay population as extirpated in 1982. *Cicindela patruela* has not been recorded in over 25 years from l’Île aux Allumettes, but if the population is extant one would expect a few hundred individuals. At the Pinery, I. Carmichael reported that the species was fairly common in the north end of the park in 1994 (Skevington 1995), shortly after its discovery in 1991. Eleven individuals were seen on one trail on July 11, 1995 (Sutherland 2006). There appears to have been a decline in numbers along this trail since they were first observed there (MacKenzie 2005), and in 2005 only one beetle was observed during field surveys there compared to 15 *C. patruela* on the informal trail on the same day (Foster and Harris 2007). The trend in numbers of *C. patruela* along another trail, therefore in the Pinery as a whole, is unknown.

Assuming that the extirpated Canadian population at Constance Bay was of similar size or slightly smaller than that at Pinery (given less available habitat), there may have been a decline of 30-40% of the total Canadian population over the past 50 years. Although these figures are useful, the lack of reliability suggests that population decline is best treated as unknown. Overall in Canada there has been a decline in the number of populations.

Rescue effect

Given its habitat specificity and distance from other populations in the United States, it is unlikely that localized extirpations in some areas might be recolonized within a few years. Extirpations at the periphery of the range, which would include all Canadian sites, would presumably take a very long time to be recolonized, or recolonization may never happen.

The largest number of populations of *Cicindela patruela* probably occur in Wisconsin and Michigan and are at least a few hundred km distant. The likelihood of natural invasion from US populations is perhaps the greatest on the east side of Lake Huron. Similarly, areas of suitable habitat near Sault Ste. Marie could potentially be colonized from nearby populations in northern Michigan, particularly if global warming continues, but this does seem unlikely based on the short dispersal distances documented for other tiger beetles. Mark-recapture studies of *C. marginipennis* in New Brunswick (see status report) and other species (Kaulbars 1982) suggest confinement to small areas. The greatest distance of dispersal reported for tiger beetles is 160 km (Charlton and Kopper 2000), and this was considered exceptional. In Michigan, *Cicindela patruela* is locally common and can be locally abundant in suitable habitat in the upper half of the lower peninsula west of Marquette, north of Escanaba, and Whitefish Point area (Gary Dunn 2007, pers. comm.).

LIMITING FACTORS AND THREATS

Cicindela patruela is moderately to highly threatened due to habitat destruction and degradation from deforestation, fire suppression, and development in much of its range (NatureServe 2007). *Cicindela patruela* seems to be more sensitive to anthropogenic impacts than *C. sexguttata* and possibly other tiger beetle species (Kaulbars 1982). Suburban housing development led to the loss of *C. patruela* from Washington, D.C. (Mawdsley 2005) and some populations in Ohio could be threatened by sand and gravel extraction (Keeney 2007).

Although within a provincial park in Ontario, *C. patruela* is at risk since its habitat requirements are balanced against recreational pressures as well as the habitat needs of other rare species and plant communities. Natural succession can negatively impact *C. patruela*, as younger, more open forests mature into shaded habitats less suitable for *C. patruela*. Fire suppression and tree planting at Constance Bay contributed to the conversion of natural open barrens habitat to dense mature forests and the demise of *C. patruela* at that site (Goulet 2005b). Although light, fast-moving burns might be beneficial by removing ground litter and opening the canopy, very hot fires could potentially be a threat to localized populations (Keeney 2007). Light, selective logging would probably benefit *C. patruela* but clearcutting would probably eliminate local populations (McCann 2007).

Spraying with broad-spectrum pesticides for silviculture or park management could potentially have negative impacts on *C. patruela* (Willis 2001; McCann 2007). The Constance Bay site was sprayed with DDT in the early 1950s to kill insects on pine trees, which likely played a major role in the decline of *C. patruela* there (Goulet 2005b).

ATVs (all terrain vehicles) have been shown to negatively impact other species of *Cicindela* (Schultz 1988) and heavy use of forest roads and trails by ATVs and mountain bikes can have a negative impact on *C. patruela* populations. Incompatible ATV use may be the cause of a decline in the largest population of *C. patruela* in Maryland (McCann 2007). Some ATV use or other disturbance may be beneficial to *C. patruela* by maintaining open habitats, but too much disturbance is detrimental as a result of plants and insects being run over and destruction of larval burrows (Keeney 2007).

ATVs are not permitted at the Pinery but disturbance by hikers and bikers is a threat. Trampling from excessive visitor use has been shown to threaten sensitive flora (Bowles and Maun 1982). The Pinery has over 600,000 visitors annually and the populations of *C. patruela* are within relatively high use areas (MacKenzie 2007; Patel and Hammond 2000). Trampling of larval burrows and soil compaction are direct possible impacts; an adult *C. patruela* was observed ovipositing in a footprint adjacent to the interpretive trail at the Pinery in 2003 (Rider 2005). Reduced foraging efficiency of adults and increased predation rates by robber flies could also occur when adults are repeatedly disturbed by path users. Asilids often follow entomologists as they walk through *Cicindela* habitat and catch tiger beetles that flush (Knisley and Schultz 1999).

Crushed rock spread on the trails to reduce erosion from visitors may have made the park paths less suitable for *C. patruela*. Some foot and bike traffic on a trail is probably beneficial in keeping it from getting grassed over (Foster and Harris 2007). Currently there is no management plan.

Illegal collecting is a potential threat since tiger beetles, particularly rare species, are sought after by collectors. There are commercial insect collectors active in southern Ontario, and *Cicindela patruela* specimens from Michigan are listed on websites for purchase.

SPECIAL SIGNIFICANCE OF THE SPECIES

Tiger beetles have long been the study of amateur and professional entomologists due to their attractiveness, diurnal habits, and diversity. Consequently, they have been important models for the study of ecology and evolution (Pearson and Volger 2001). Although *Cicindela patruela* is too uncommon and obscure through most of its range to be known by most people, tiger beetles are increasingly popular as indicated by growing numbers of field guides (e.g., Acorn 2001; Leonard and Bell 1999; Pearson *et al.* 2006). They are the first group of beetles to become part of a trend toward insect viewing that has grown to some extent out of birdwatching. *Cicindela patruela* contributes substantially as a high profile species to the recognition of globally significant oak savannah at Pinery Park. This species and other Tiger Beetles serve as useful environmental indicators as part of the National General Status Ranking Process.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The species is not protected under the *Species at Risk Act* in Canada, or under any provincial legislation, nor is it on the US Endangered Species list. It is not covered by the IUCN Red Book or CITES. *Cicindela patruela* is ranked globally as G3 (81 to 100 occurrences; NatureServe 2007). It is not ranked nationally in Canada, but is N3 in the US (NatureServe 2007). It is imperiled (at least S3) in all the states and provinces from which it is known (Table 2) and is listed as Special Concern in Minnesota, Wisconsin and Michigan, and Endangered in Maryland.

Pinery Park, where the only definitely extant Canadian population exists, has a history of decline and/or extirpation of rare and endangered species. On the other hand the park protects a wealth of biodiversity lost from surrounding regions. Increasing attention to management needs and biodiversity in the park offers some hope, but not assurance, that *C. patruela* will survive.

Table 2. State and provincial ranks for *Cicindela patruela* in North America (NatureServe 2007 with updates from state conservation data centres).

Province / State	S-Rank	Notes
Ontario	S1	known definitely from 1 extant site, possibly one other and 1 presumed extirpated (D. Sutherland, P.M. Catling and others pers. comm.; this report)
Quebec	SH	known from 1 possibly extirpated population (N.D Desrosiers pers. comm.)
Connecticut	SU	no records for CT shown in Leonard and Bell (1999)
Delaware	SH	known from a single voucher specimen of <i>C. p. consentanea</i> ; could still potentially remain in little surveyed areas of the south, but likely extirpated (C. Heckscher pers. comm.)
District of Columbia	SNR	collected commonly from a small areas in eastern DC in early 1900s but not seen since 1950s despite intensive surveys (Mawdsley 2005); should be SX
Georgia	SNR	should be ranked as SH or S1 since there are several confirmed records from the Blue Ridge Province in northeastern Georgia; none collected since 1939 despite recent surveys (G. Beaton pers. comm.)
Illinois	SNR	old (early 1900s) <i>C. patruela</i> specimens from Cook Co. (E. Dewalt 2007 pers. comm.) have been confirmed by Freitag (2007) and represent the first recorded occurrences of the species in IL
Indiana	S3	known from a 1998 collection in a state park but likely present elsewhere in state (R. Hedge pers. comm.)
Kentucky	S2S3	several, apparently stable, populations in eastern KY (E. Laudermilk pers. comm.)
Maryland	S1	5 small and isolated extant populations; all historic populations in eastern part of state now extirpated mainly due to development (J. McCann pers. comm.)
Massachusetts	S1	1 robust population apparently secure on state forest and adjacent protected lands (M. Nelson pers. comm.)
Michigan	S3	can be locally abundant in suitable habitat in the upper half of the lower peninsula and in pine barrens areas of the Upper Peninsula (UP); probably occurs as well in other areas in the eastern and central UP; likely extirpated from western and southeastern lower peninsula (Gary Dunn pers. comm.)
Minnesota	S3	Formerly known from 21 locations in 10 counties, but now reduced to 18 locations in 9 counties, of which 3 are recent discoveries (W. Steffens pers. comm.)
New Hampshire	SH	no recent sightings or activities directed to this species (J. Tash pers. comm.)
New Jersey	S2S3	recently observed at 4-5 sites along the border of Ocean and Burlington counties (G. Fowles pers. comm.)
New York	S1	recent surveys discovered a single population (with multiple adjacent sites) of <i>C. p. patruela</i> in lower Hudson valley and several historic records; <i>C. p. consentanea</i> is SH despite recent surveys on Long Island (J. Corser, J. Jaycox, P. Novak pers. comm.)
North Carolina	S2?	no records at the CDC but some shown in Knisley & Schultz (1997) so S3 may be more appropriate (S. Hall, pers. comm.)
Ohio	S3	S-rank is outdated but no recent data available (T. Arbour pers comm.)
Pennsylvania	S2S3	known at least historically from 15 counties (Kaulbars 1982)

Province / State	S-Rank	Notes
Rhode Island	SH	no recent sightings despite recent field surveys (E. Endrulat pers. comm.)
South Carolina	S2	Found only above 2000' elevation in mountains (Cartright 1935)
Tennessee	S3	At least six records from the Blue Ridge Province in eastern TN (Knisley and Shultz 1997)
Vermont	S1	no records since one in the 1800s but there is some significant potentially suitable habitat that remains unsurveyed (M. Ferguson, pers. comm..)
Virginia	S2	known at least historically from 7 counties (Kaulbars 1980)
West Virginia	S2S3	known from observations within the last 30 years from at 6 counties (B. Sargent pers. comm.)
Wisconsin	S3	<i>C. p. huberi</i> is secure and locally common at many sites in central WI; <i>C. p. patruela</i> is more scattered but also secure (M. Brust pers. comm.)

TECHNICAL SUMMARY

Cicindela patruela

Northern Barrens Tiger Beetle

Cicindèle verte des pinèdes

Range of Occurrence in Canada : Ontario, Quebec

Demographic Information

Generation time (average age of parents in the population)	2 years
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 or 5 years, or 3 or 2 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 or 5 years, or 3 or 2 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 or 5 years, or 3 or 2 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible?	Not applicable
Are the causes of the decline understood?	Not applicable
Have the causes of the decline ceased?	Not applicable
[Observed, inferred, or projected] trend in number of populations	Decline
Are there extreme fluctuations in number of mature individuals?	Unknown
Are there extreme fluctuations in number of populations?	Unknown

Extent and Area Information

Estimated extent of occurrence	290 km ²
[Observed, inferred, or projected] trend in extent of occurrence	Declining (extirpated at one historical location)
Are there extreme fluctuations in extent of occurrence?	Unknown
Index of area of occupancy (IAO) Based on the number of 2 km X 2 km grid squares (2 in Pinery, 1 n Ottawa valley) in which there are records of the species = 12 km ²	12 km ²
[Observed, inferred, or projected] trend in area of occupancy – past decline, currently unknown	Declining (extirpated at one historical location)
Are there extreme fluctuations in area of occupancy?	Unknown
Is the total population severely fragmented?	Yes
Number of current locations	2
Trend in number of locations	Declining (extirpated at one historical location)
Are there extreme fluctuations in number of locations?	Unknown
Trend in [area and/or quality] of habitat	Declining

Number of mature individuals in each population

Population	N Mature Individuals
Based on 25 adults seen at one location and other considerations believed to be at least 1,200 maximum, but this figure is not considered reliable.	Unknown
Total	
Number of populations (locations)	2-3

Quantitative Analysis

	None
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Threats (actual or imminent, to populations or habitats)

Habitat loss
Succession
Trampling
Possibly predation (associated with human activity)

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: Local and fragmented throughout range, declining in some areas due to habitat loss and degradation	
Is immigration known?	Unknown
Would immigrants be adapted to survive in Canada?	Probably
Is there sufficient habitat for immigrants in Canada?	Possibly
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Endangered (November 2009) Global: G3 Canada: NNR US: N3 SH: QU, DE, NH, RI S1: ON, MD, MA, NY, VT S2: SC, VA S2?: NC S2S3: KY, NJ, PA, WV S3: IN, MI, MN, OH, TE, WI SNR: DC, GA, IL SU: CT Canadian Wild Species General Status Report identifies this species as "May be at risk" in Canada, Ontario and Quebec (http://www.wildspecies.ca)

Status and Reasons for Designation

Status: Endangered	Alpha-numeric code: B1ab(iii) + 2ab(iii)
Reasons for designation: This showy metallic green beetle inhabits sandy, open forest habitat dominated by pine and/or oak trees. Found in northeastern and north-central North America, it is globally imperiled reaching its northern limit in southern Ontario where it is currently found at only two localities. The species has disappeared from one well known historic site. Habitat loss resulting from natural succession and increased pedestrian traffic are significant threats.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Information on population decline is insufficient.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(iii)+2ab(iii), with EO and IAO below thresholds, two locations, and a decline in habitat quality due to natural succession, trampling and predation.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Information on population size is considered insufficient.
Criterion D (Very Small Population or Restricted Distribution): Close to meeting Endangered D1, but population size information is considered insufficient. Meets Threatened D2.
Criterion E (Quantitative Analysis): None available.

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