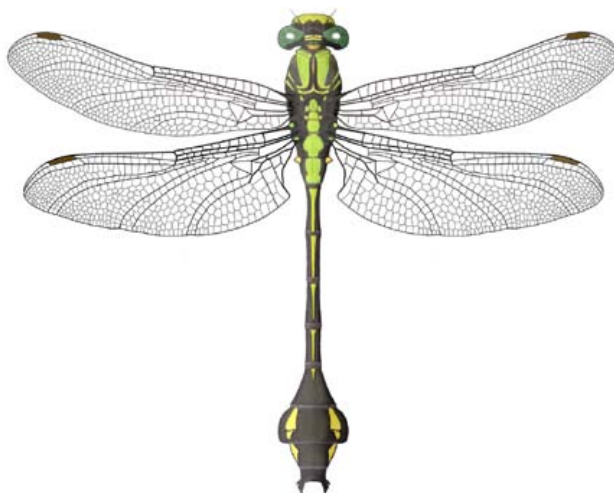


**COSEWIC**  
**Assessment and Status Report**

on the

**Skillet Clubtail**  
*Gomphus ventricosus*

in Canada



**ENDANGERED**  
**2010**

**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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## COSEWIC Assessment Summary

### Assessment Summary – November 2010

**Common name**

Skillet Clubtail

**Scientific name**

*Gomphus ventricosus*

**Status**

Endangered

**Reason for designation**

This rare dragonfly of large, clean, and medium to slow-running rivers with fine sand, silt, or clay bottoms is currently known in only 3 locations in Canada. It disappeared over 60 years ago from two other rivers. The largest population is subject to a number of threats that are cumulatively leading to a decline in the quality of habitat.

**Occurrence**

New Brunswick

**Status history**

Designated Endangered in November 2010.



**COSEWIC**  
**Executive Summary**

**Skillet Clubtail**  
*Gomphus ventricosus*

**Wildlife species information**

The Skillet Clubtail is one of the most striking dragonfly species in Canada due to the almost circular expansion at the end of its otherwise slim abdomen. It is dark brown and black, with strong yellow markings on the dorsal abdomen, greenish-yellow markings on the thorax, dark green eyes, and clear wings.

**Distribution**

The global range of the Skillet Clubtail is confined to North America east of the Mississippi and Red rivers, north to Rainy River and as far south as Tennessee. In Canada it has been reported historically from Nova Scotia, Ontario and Quebec, is currently well known from a location along the southern Saint John River in New Brunswick and possibly breeding in two other New Brunswick locations.

**Habitat**

It is a specialist of clean, large, medium to slow-running waters with fine substrate, usually having a significant component of silt and/or clay. Such habitats are usually confined to segments of larger running waters where they flow through rich soils at a low gradient, and it is a comparatively rare type of habitat in southeastern Canada. Examples with clean water are particularly rare because such rivers are often surrounded by agricultural landscapes. Habitat of the largest known population is likely declining.

**Biology**

Eggs are deposited in the water, and the shallow-burrowing larvae take at least two years to develop before emergence. The species has a largely synchronous emergence in the latter two weeks of June over most of its Canadian range, as early as the end of May in the centre of the continent, and flies until mid-August. Following emergence, the dragonflies fly from the river for an extended period of maturation. Adults seem to spend little time at the larval waters, and likely spend the bulk of their life in the surrounding forest.

Larvae are believed to be fed upon by turtles, fish, and crayfish, as well as by other predacious aquatic insects. It seems likely that most adult mortality is from insectivorous birds feeding in the riparian forests and clearings. Larvae likely eat whatever small creatures are also present in or on their substrate habitat based on observations of related species. Adults feed on whatever flying insects are available.

### **Population sizes and trends**

Population size of the species in Canada is unknown, but several hundred individuals are likely necessary to sustain each population. The Canadian population is likely stable at present, but declined by 40% more than approximately 60 years ago.

A very substantial search effort in New Brunswick and Nova Scotia, and elsewhere in eastern and central Canada, has produced very few records of the species, suggesting that it is truly very rare. It appears that populations on the Saint John River (NB) and possibly on two other New Brunswick rivers are the only definitely extant populations for the species in Canada.

### **Limiting factors and threats**

Anthropogenic habitat change represents the greatest potential threat to the species. Water of “marginal” quality has been identified in the Saint John River population. Eutrophication due to excessive nutrient input from sewage, or sedimentation due to agricultural or forestry runoff, pesticides and herbicides, and accidental or illegal dumping of chemicals may kill larvae in rivers. The extent to which pollution is a current problem is unclear. Terrestrial habitat is declining although very rapid and extensive declines seem unlikely in the near future.

Invasive species can alter the biota to the detriment of the species; a particular diatom would likely extirpate the species where introduced. Predators supported by humans with food and/or cover, including a variety of birds such as Common Grackles, European Starlings and various swallows, the latter nesting under bridges, may have substantial impact on emerging larvae. The deliberate or inadvertent introduction of higher aquatic organisms may represent a threat; crayfish and fish species can have serious impacts.

Direct potential threats to the species are road-kill as a result of collision with vehicles, interference with emergence by recreational use of waters and construction along shorelines. With regard to recreational use, waves from passing boats during the hours of emergence may kill the emerging dragonflies, but the importance of this threat is unknown.

A potentially serious impact on the aquatic habitat is sea level rise. Already the downstream limit of the Saint John population is within 5 km of saline influence, and this influence will move upstream with noticeable effects likely over the next decade.

### **Special significance of the species**

This species is an indicator of large, clean, running water habitats, with the (comparatively rare for Canada) substrate of fine sand, clay or silt, and may be expected to occur with other restricted species. It reaches its northern range limit in Canada, and its global viability may be dependent upon the lower level of anthropogenic impact on Canadian waters than is experienced farther to the south.

### **Existing protection or other status designations**

Status designations for the Skillet Clubtail reflect rarity across the global distribution. It has a NatureServe global conservation rank of vulnerable (G3), and is ranked nationally for the United States as N3 and for Canada as N1. The general status rank assigned to the species was 2 (“may be at risk”) nationally and for all individual provinces within its range. All United States listings and rankings are in the rare categories. No definitely known Canadian location for the species has formal habitat protection.

## TECHNICAL SUMMARY

*Gomphus ventricosus*

Skillet Clubtail

Gomphe ventru

Range of Occurrence in Canada: New Brunswick (formerly also Ontario, Quebec and Nova Scotia)

### Demographic Information

Generation time (average age of parents in the population)	2 yrs
[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. Probable decline >60 years ago. In Ontario and Quebec. NS records excluded.	Stable
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 [3 NB locations]	2,473 km <sup>2</sup>
[Observed, inferred, or projected] trend in extent of occurrence (decline in Quebec and Ontario >60 years ago)	Stable
Are there extreme fluctuations in extent of occurrence?	No
Index of area of occupancy (IAO) (based on 2 X 2 km grid)	44 km <sup>2</sup>
[Observed, inferred, or projected] trend in index of area of occupancy (decline in Quebec and Ontario >60 years ago)	Stable
Are there extreme fluctuations in index of area of occupancy?	Unknown
Is the total population severely fragmented?	No
Number of current locations	3
Trend in number of locations (decline in Quebec and Ontario >60 years ago)	Stable
Are there extreme fluctuations in number of locations?	Unknown
Trend in [area and/or quality] of habitat (natural vegetation)	Likely declining

### Number of mature individuals in each population

Population	N Mature Individuals
No information on population sizes	
Total	
Number of populations (locations) both = 3	3

**Quantitative Analysis**

	Not available
--	---------------

**Threats (actual or imminent, to populations or habitats)**

In New Brunswick the increasing urban development of Fredericton is reducing adult habitat and increasing risk due to automobile collision. Threats to larval habitat include pollution, increasing saline influence due to sea level rise and several invasive species.

**Rescue Effect (immigration from an outside source)**

Status of outside population(s)? USA: Rare	
Is immigration known?	Not known
Would immigrants be adapted to survive in Canada?	Possibly
Is there sufficient habitat for immigrants in Canada?	Not very likely
Is rescue from outside populations likely?	Not likely

**Current Status**

COSEWIC: Endangered (2010)

**Status and Reasons for Designation**

<b>Status:</b> Endangered	<b>Alpha-numeric code:</b> B1ab(iii)+2ab(iii)
<b>Reasons for designation:</b> This rare dragonfly of large, clean, and medium to slow running waters with fine sand, silt, or clay bottoms is currently known in only 3 locations in Canada. It disappeared over 60 years ago from two other rivers. The largest population is subject to a number of threats that are cumulatively leading to a decline in the quality of habitat.	

**Applicability of Criteria**

<b>Criterion A</b> (Decline in Total Number of Mature Individuals): Not applicable as there is no information on population sizes.
<b>Criterion B</b> (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(iii)+2ab(iii) as the IAO (44 km <sup>2</sup> ) is less than the threshold (500 km <sup>2</sup> ), the EO (2 473 km <sup>2</sup> ) is less than the threshold (5 000 km <sup>2</sup> ), there are less than 5 locations and the species' habitat is declining at the largest known locations.
<b>Criterion C</b> (Small and Declining Number of Mature Individuals): Not applicable as there is no information on population sizes.
<b>Criterion D</b> (Very Small Population or Restricted Distribution): Not applicable.
<b>Criterion E</b> (Quantitative Analysis): Not applicable





### 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 (2010)

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

# **COSEWIC Status Report**

on the

## **Skillet Clubtail** *Gomphus ventricosus*

**in Canada**

2010

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## WILDLIFE SPECIES INFORMATION

### Name and classification

Kingdom: Animalia - animals, animaux

Phylum: Arthropoda - arthropods, arthropodes

Subphylum: Hexapoda - hexapods

Class: Insecta - hexapoda, insects, insectes

Subclass: Pterygota - insects ailés, winged insects

Infraclass: Palaeoptera - ancient winged insects

Order: Odonata Fabricius 1793 - damselflies, dragonflies, libélula

Suborder: Anisoptera Sélys 1854 - dragonflies, libellules

Family: Gomphidae - clubtails

Genus: *Gomphus* Leach 1815

Subgenus: *Gomphus* (*Gomphurus*) Needham 1901

Species: *Gomphus* (*Gomphurus*) *ventricosus* (Walsh 1863)

English Name: Skillet Clubtail

French Name: Gomphe ventru

The Skillet Clubtail is a dragonfly in the insect order Odonata, suborder Anisoptera (dragonflies), and family Gomphidae (clubtails). The species is distinct, although there are close relatives, and there are no proposed subspecies or species forms. The genus was described by Leach in 1815 – although there have been a number of proposals for its subdivision at the genus level, none are currently accepted by the majority of workers. The subgenus *Gomphurus* was described by Needham in 1901. The species is placed in the *dilatatus* group, characterized by greatest breadth of abdominal flare in the subgenus, by Needham *et al.* (2000), along with *G. externus* Hagen in Sélys 1858, *G. lineatifrons* Calvert 1921, *G. modestus* Needham 1942, and *G. vastus* (Walsh 1862).

The English name Skillet Clubtail was assigned in Paulson and Dunkle (1996) and employed by Catling *et al.* (2005) in the most recent Canadian list. The French name Gomphe ventru was employed in Pilon and Lagacé (1998). The name “Skillet Clubtail” refers to the appearance of the abdomen – the slender abdomen with broad, circular flare at the end resembles a skillet or frying pan.

### Morphological description

The Skillet Clubtail is one of the most striking dragonfly species to be found at its lotic (running waters) habitat, due to the almost circular flare at the end of its otherwise slim abdomen (Figure 1). Although this characteristic is typical of the subgenus *Gomphurus*, this species displays it most dramatically. The species is intermediate in size for its family and variable in size over its range – male specimens examined from New Brunswick are small compared to the published North American size range of 48-53 mm (Needham *et al.* 2000). The published Canadian size range is 45-48 mm (Walker 1958).

The species is dark brown and black, with strong yellow markings on the dorsal abdomen and flare, greenish-yellow markings on the thorax, dark green eyes, and clear wings. The light body markings of teneral are yellow for some days following emergence.

The female resembles the male except in the thicker abdomen, reduced flare, lack of secondary genitalia, presence of a subgenital plate, and in the different number and shape of the abdominal appendages.

As a result of some similarity with the sympatric congener *G. vastus* (Cobra Clubtail), it is advisable to confirm identification with morphological characters. Although there are colour markings which are diagnostic to a degree, they are not entirely trustworthy.

The larvae (Figure 2) are of moderate size, elongate and compressed, and difficult to discriminate from those of congeners of *Gomphurus* and also of the subgenus *Hylogomphus*. Evidence of the presence of this species is more easily confirmed by locating exuviae (shed larval skins), as adults are rarely encountered.

Early stadia of the larvae are very difficult to identify, and medium to late stadia and exuviae are a challenge to identify. Larvae of Skillet Clubtail can be keyed to the subgenus *Gomphurus* by the shortness of abdominal segments 9 and 10, which discriminates it from the subgenus *Gomphus*, and by the presence of coarse cuticular granules on the dorsal abdomen, which discriminates it from the subgenus *Hylogomphus*.

Of the other two members of the *Gomphurus* group within the known range of *G. ventricosus* in Canada (*G. externus* is not found east of the Prairie Provinces), the larvae of *G. ventricosus* can be discriminated from *G. vastus* by the absence of a substantial end hook on the labial palp, and from *G. fraternus* (Midland Clubtail) by the straight median lobe of the prementum.

### **Genetic description**

There have not been any genetic studies of *G. ventricosus*. It is not known if there are genetic or morphological differences among populations. As the Canadian population is largely continuous with the eastern North American range, it is likely but unproven that Canadian individuals are not substantially different from those farther south. Populations may have been more continuous across the Canadian range in the past.

### **Designatable units**

The species is broadly distributed in Canada. Although the distances between records from Ontario, Quebec, New Brunswick, and Nova Scotia are great, only the Nova Scotia population appears to be truly isolated from the principal range in the

United States. However, the species is not reported from the state of Maine, which somewhat isolates its New Brunswick population from populations to the south. No differences between populations in different parts of the range have been reported. The Canadian populations are not considered discrete because they were probably more continuous in pre-settlement times. The ecogeographic zones appear of limited relevancy based on widespread distribution, and the species has a more or less continuous distribution just south of the Canadian border. These considerations suggest that it is best treated as a single designatable unit. For determination of occurrence, occupancy and threat considerations, only 3 New Brunswick populations, clearly acceptable as one designatable unit, are under consideration.

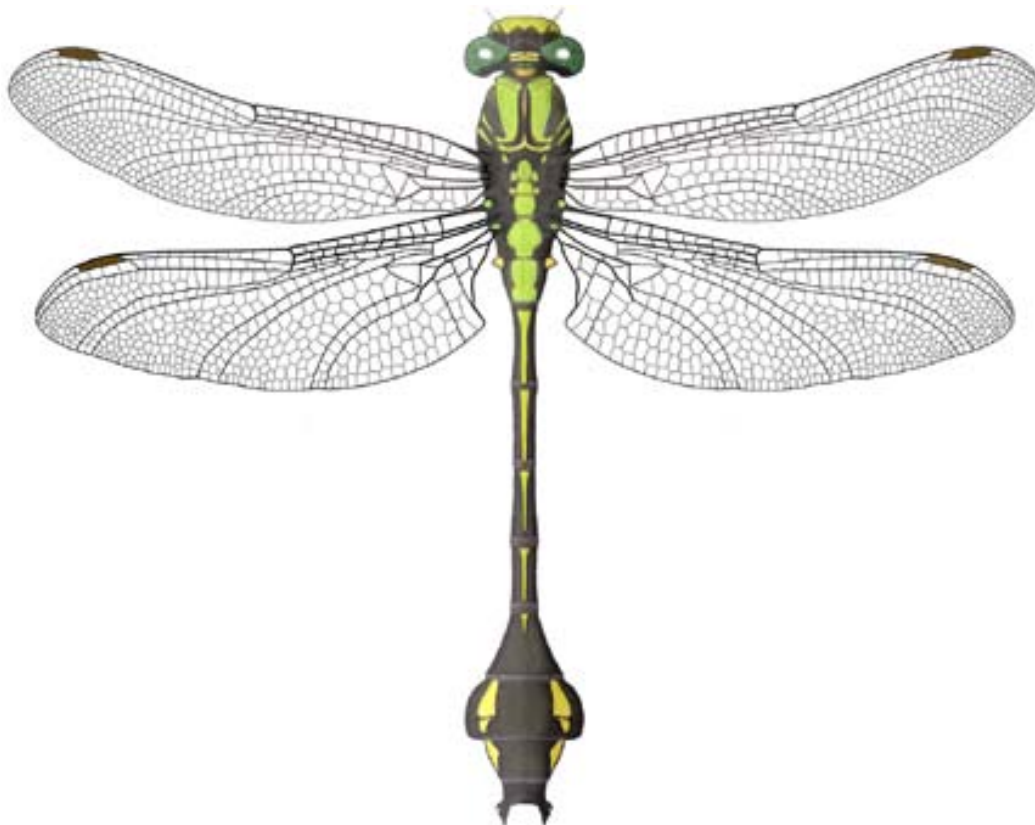


Figure 1. Dorsal view of the male *Gomphus ventricosus*. Source: P.M. Brunelle.



Figure 2. Dorsal view of the larva of *Gomphus ventricosus*. Source: P.M. Brunelle.

## DISTRIBUTION

### Global range

Figure 3 shows the global range of Skillet Clubtail (from Donnelly 2004 and the Odonata Central Distribution Maps website, Abbott 2007). With regard to adjacent regions this dragonfly is extirpated from Pennsylvania and possibly extirpated from New York. See the “Existing protection or other status designations” section of the report for status in various states.

The Skillet Clubtail is confined to North America east of the Mississippi and Red rivers as far north as mainland Nova Scotia, while in the west, the most northern report is in Minnesota near the meeting of the international, Manitoba, and Ontario borders. The most southern record is from Tennessee.



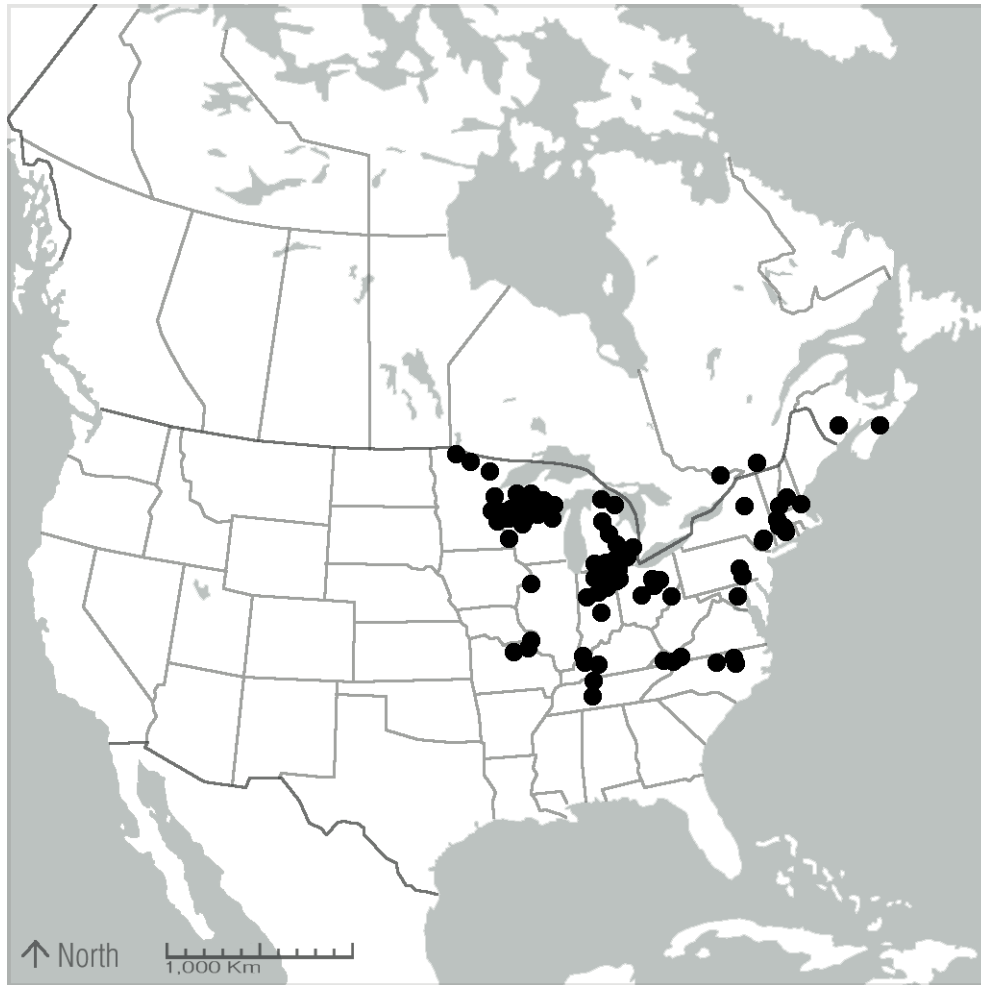


Figure 3. Global range of *Gomphus ventricosus* (from Donnelly 2004 and Abbott 2007).

### Canadian range

Except for substantial data from the vicinity of Fredericton, New Brunswick, reports of the species in Canada are few, usually historical, and rarely indicative of a larval habitat. All reports are from the Atlantic Maritime, Boreal Shield and Mixedwood Plains terrestrial ecozones (NSWG 1996).

Figure 5 illustrates the distribution of the species in the Maritime Provinces and Figure 4 shows the distribution of the species on the Rainy River, Minnesota, adjacent to Ontario. Source: ADIP (Atlantic Dragonfly Information Project) data and published accounts. See Brunelle (2009) for details of all known Canadian records of the species.

In Ontario, two records (Forest and Ignace) have recently been withdrawn as having been misidentified (Jones 2007). There is one historical occurrence recorded from “Ottawa” in July 1924, a male collected by A.L. Pritchard (OOD 2009, C.D. Jones, pers. comm.). It was likely collected from the Ottawa River but at least 700 hours of

survey efforts on the river, including searches for exuviae, have not produced a record (C. Jones, P. Catling, pers. comm.). However, the species is reported on the basis of exuviae from the Minnesota bank of the Rainy River (northwestern Ontario near the Manitoba border), where it forms the international border between Minnesota and Ontario (Steffens and Smith 1999). Although this might be considered as reliable evidence for an Ontario population (see Figure 4), it was not within Canada and has to be excluded for purposes of assessment. The species remains unknown from the Ontario region of Rainy River despite extensive survey there (e.g., Oldham and Elder 2000).

In Quebec there is only one historical record – “Farnham,” June 18, 1940. Three males were collected by A. Robert approximately one kilometre from the Yamaska River, which he indicated has substrate alternately pebble and clay in that area (Robert 1963). There are no other records for Quebec.

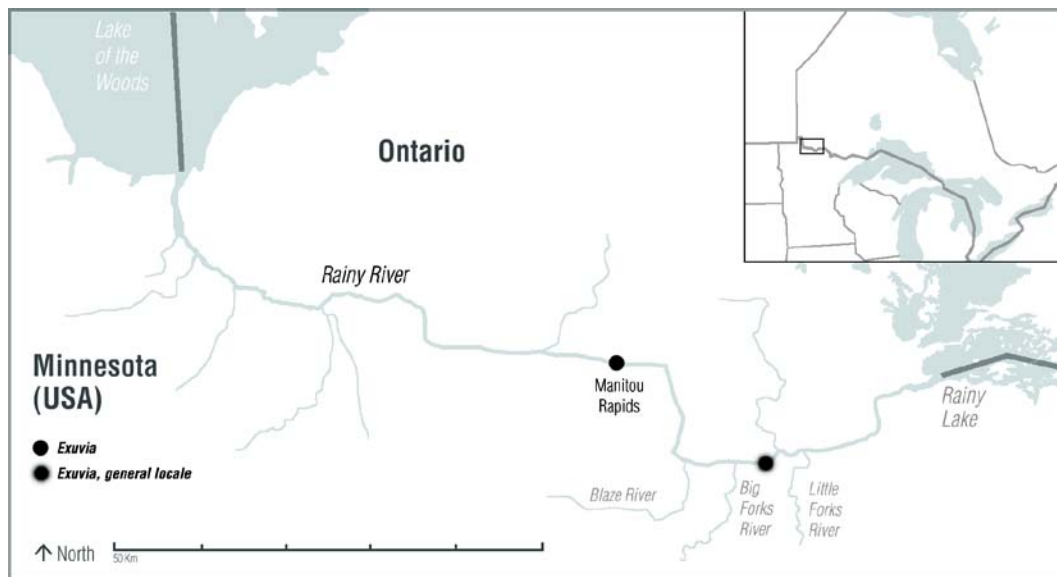


Figure 4. Rainy River, Minnesota current range of *Gomphus ventricosus* (Steffens and Smith 1999).I

In Nova Scotia there are two records. “Mount Uniacke,” Hants County, is a historical record (ADIP Record 303078, June 18, 1948, an adult collected by D.C. Ferguson, see also Cook 1950). The whereabouts of this specimen is currently unknown, but it may be present but uncatalogued in the collection of the Royal Ontario Museum, as it was sent to Edmund Walker many years ago (C. Cook, pers. comm.). There appears to be no appropriate river in the Mount Uniacke area and the insect may have been foraging a long distance from its larval habitat. The second record is of one exuvia – Shubenacadie River, Highway 2 bridge, Enfield, Halifax County, ADIP Record 303079, June 27, 1992, collected by Paul M. Brunelle, determined by Robert A. Cannings. This specimen has been lost, and subsequent survey at this site and elsewhere on the river has failed to yield further records of the species.

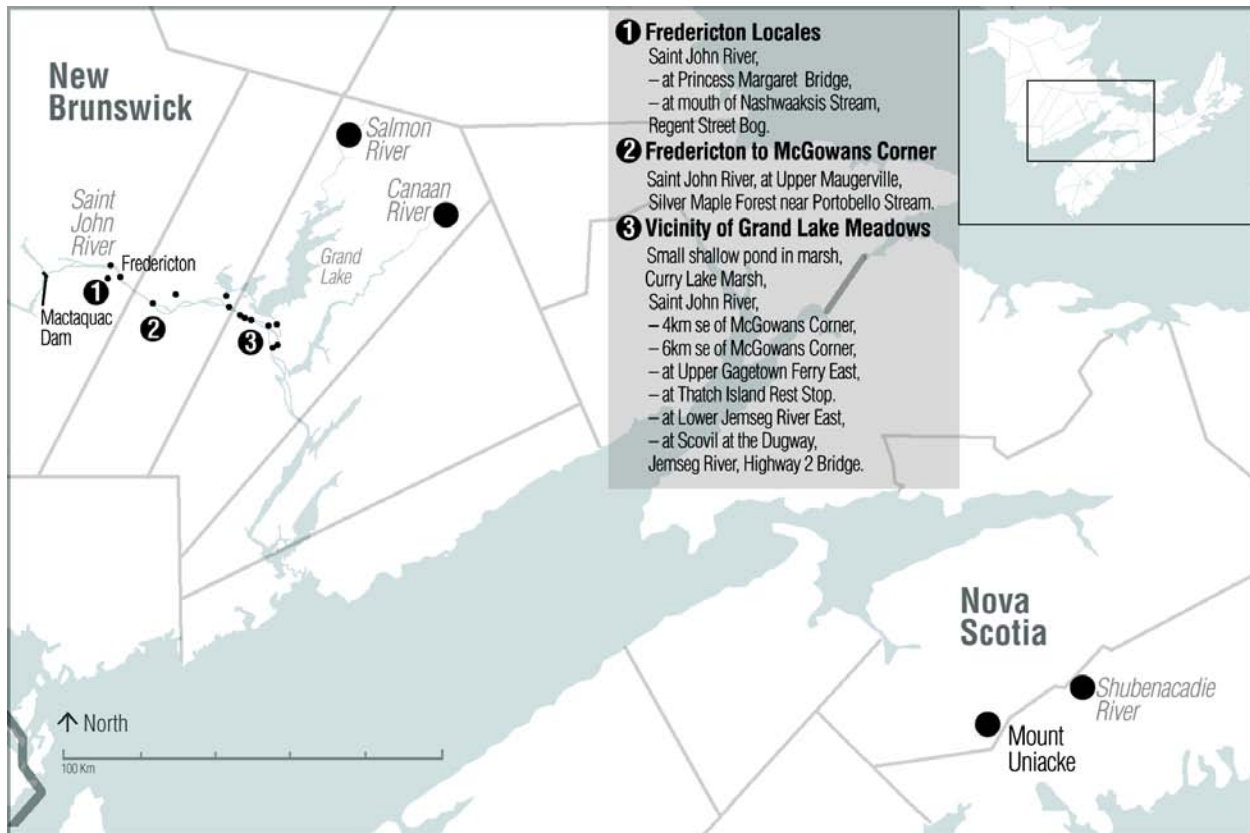


Figure 5. Maritime Provinces historic range of *Gomphus ventricosus*. The Nova Scotia localities are excluded from the current distribution. Source: P.M. Brunelle.

The most extensive knowledge of the species in Canada is from New Brunswick on the Saint John River downstream of the Mactaquac Dam, and from Fredericton downstream to the confluence of the Jemseg River (ca. 50 km of river). The site with the largest number of observations is in Fredericton just upstream of the east end of the Princess Margaret Bridge, where Dwayne Sabine has conducted a five-year exuviae survey which has yielded many emergence records and exuviae of the species (Figures 6, 7, and 8).

At the Princess Margaret Bridge the shore is a shallow cove, which likely constitutes a settle-point, and hence a concentration of emergence (flotsam present in the cove supports this). The species has been encountered at a number of sites on the river south as far as the confluence of the Jemseg River. Surveys along the Mactaquac Headpond and upstream into northern New Brunswick and northwestern Maine, including extensive searches for exuviae, have not yielded further records of the species. Teneral and adults have been collected at Fredericton from the beginning of June to mid-July.

There are three other potential larval rivers on which the species has been taken in New Brunswick (see Brunelle 2009 for details). Denis A. Doucet and Jim Edsall took an

adult male on the Canaan River on July 17, 2007, but exuviae were not found, though looked for. Similarly, adults have twice been encountered on the Salmon River, the first by Stuart A. Tingley on July 3, 2001; again no exuviae were found. Doucet and Edsall took exuviae on the Jemseg River in 2007. However, this site is only 5 km from the main stem of the Saint John River at a very low gradient, and the population should be considered part of the Saint John River metapopulation.

Although the possibility of additional locations in Canada cannot be ruled out, it is very unlikely that more than a few will be found, if any, given the extent of dragonfly survey work over the past decade (see below under “Population sizes and trends – Search effort”).

The lack of more recent records for Nova Scotia, despite searching in the area of historical occurrence and the fact that specimens are not available to verify the Nova Scotia reports, appears to be a satisfactory reason to exclude these from range calculations. Also, because the general search effort around Ottawa at the appropriate time (estimated to be at least 700 hours, P.M. Catling pers. comm.) has not revealed a population, this location seems best excluded. Finally, hundreds of hours have been spent by Quebec entomologists looking for this species in southern Quebec, and particularly at the Farnham site, without a positive result, so this is also excluded. Thus, it seems more appropriate to consider EO and IAO with regard the three current locations (three in New Brunswick) leading to an EO of 2473 km<sup>2</sup> and an IAO of 44 km<sup>2</sup>. The Saint John River occurrences are regarded as one location (although they are to some extent separated into three) because this area is probably continuously inhabited and subject to the same single threats related to water quality, saline influence and general landscape changes. The locations represent a series of disjunctions but are not highly fragmented in the sense of being reduced and isolated from a once more continuous range.

## **HABITAT**

### **Habitat requirements**

Catling and Brownell (2000, citing Louton 1983) describe the habitat as “medium to large turbid rivers with a bottom of silt, cobble and bedrock.” Dunkle (2000) describes the habitat as “Small to large turbid rivers with at least a partly muddy bottom but good water quality. Sometimes clean lakes with sand or sand-marl (calcium-rich) bottoms.” There is no indication that the species occupies lakes in Canada. The USFWS (U.S. Fish and Wildlife Service 2002) characterizes the habitat as “depositional lotic” and “lentic littoral” with substrate of “sediments, primarily silt.” Steffens and Smith (1999) give information on rivers in which the species has been recorded in Minnesota, generally by exuviae – “warmwater wadable streams or non-wadable rivers from 90-600 ft. wide (27-180 m) with moderate to rapid current and in forested watersheds.”

The Skillet Clubtail appears to be a specialist of medium to slow-running mesotrophic waters with fine substrate, usually having a significant component of silt and/or clay; however, there appears to have been no focused study on larval microhabitat preferences. Such habitats are usually confined to segments of larger running waters where they run through rich soils at a low gradient. Furthermore, it is considered sensitive to habitat and water quality degradation, especially siltation and/or low levels of dissolved oxygen (NatureServe 2009). However, given its evident substrate preferences, a sensitivity to siltation, unless of extreme volume, seems unlikely (P. Brunelle, pers. obs.).

The principal habitat for the species, the Saint John River in Fredericton (Figures 6, 7, and 8) conforms to these descriptions. This has become a comparatively rare habitat for Canada and is highly subject to impacts from human activities (see “Habitat trends” below). Given the rarity of encounters with adults at the larval rivers, the stipulation in Steffens and Smith (1999) that they are found in “*forested watersheds*” may be significant – adult survival success until ovipositing may be enhanced by the presence of forest cover, although given the species’ known proclivity for perching low in shrubbery, as in bogs, well-developed or riparian forest may not be required.



Figure 6. Habitat of *Gomphus ventricosus*; Saint John River, Fredericton. Source: P.M. Brunelle. Looking upstream (west).



Figure 7. Habitat of *Gomphus ventricosus*; Saint John River, Fredericton. Source: P.M. Brunelle. Looking downstream (east).



Figure 8. Habitat of *Gomphus ventricosus*; Saint John River, Fredericton. Source: P.M. Brunelle. Note the fine substrate.

## Habitat trends

The lack of any recent report from eastern Ontario, Quebec and Nova Scotia suggests a decline of the habitat at two to four of the seven known locations. That this decline occurred more than approximately 60 years ago is suggested by the fact that there have been many entomologists in the area and many dragonfly surveys. The larval habitat that existed in Ontario and Quebec may have been susceptible to impact from agriculture, being found largely in areas of productive soils. Pollution from an adjacent agricultural landscape may account for the absence of Skillet Clubtail in what appear otherwise to be regions containing suitable habitat, such as southern Ontario, southern Manitoba, and the St. Lawrence River Valley of Quebec.

With respect to the extant populations, the Saint John River below the Mactaquac Dam is in a large, growing urban and agricultural area where natural vegetation required by adults continues to decline (A. Kennedy pers. comm.). For this Saint John River population approximately 60% of the landscape within 3 km of the river is natural vegetation. Although this natural vegetation is declining, a substantial rapid decline over the period of a decade seems unlikely to occur. For example, much of the landscape, including 40,000 hectares of managed forest at Gagetown, is not likely to disappear in the near future.

Loss of natural terrestrial vegetation is not the only problem at the Saint John River location. An area of water of “marginal” quality has been identified near Oromocto (New Brunswick Dept. of Environment. 2007) near to the centre of the population. Although Fredericton is still quite small (55,000-60,000), the increasing urban development is likely to worsen water quality. Another part of the Saint John population is indicated to have good water quality, so that the extent to which pollution is a current problem remains unclear.

A potentially more serious difficulty with the aquatic habitat is sea level rise. Already the downstream limit of the Saint John population is within 5 km of saline influence (Gillis 1974) and this influence will move upstream with noticeable effects likely over the next decade (Daigle 2009). As with many dragonflies, *G. ventricosus* may not be tolerant of saline conditions. If the saline influence extended to the Mactaquac Dam, then the headpond, extending back at least 35 km and being unsuitable habitat, would prevent movement of the population upstream.

There is a possibility that the dam upstream has improved larval habitat by reducing the tendency of the river to run shallow in late summer and early fall. Avoidance of shallow flow in the Fredericton area may keep salt water below Scovil, which is 60 km downstream ensuring an extensive area of suitable habitat. However, the Mactaquac Dam is operated as a “run-of-river” dam with little impact on natural flows, so the extent of this beneficial effect is unclear (M. Toner, pers. comm.).

NatureServe (2009) reports a global short-term trend of 10-30% historical decline in population, although they stipulate that most of the remaining populations appear to be stable (citing Vogt pers. comm. 1994).

### **Habitat protection/ownership**

None of the aquatic larval habitats of Canadian populations of the species are definitely within a protected area, and given that the habitats are generally in developed areas it seems unlikely that their areas will be protected in the future. The Regent Street bog in Fredericton, where a number of foraging adults have been collected, is the property of the University of New Brunswick, which controls research there but does not have a specific plan for long-term protection of biodiversity on the site. Some adult habitat also exists within Portobello Creek National Wildlife Area (A. Kennedy pers. comm.) and possibly also in New Brunswick's Grand Lake Meadows Protected Natural Area complex. It is also likely that with 1 km frontage on the Saint John River and an extensive area, there is both larval and adult habitat at Canadian Forces Base Gagetown, which is within the area of the Saint John population (D. McCullum, pers. comm.).

## **BIOLOGY**

### **Life cycle and reproduction**

As with all Clubtails, the eggs are laid in water exophytically (outside of plants) by dipping the end of the abdomen to release them. There have been no published comments on ovipositing, and current workers have not reported on this behaviour, suggesting that it occurs in the middle of rivers beyond ready observation.

Larvae take at least two years to develop to emergence and likely longer. The larvae "*were found at the margin of steep soil banks stabilized by terrestrial plants*" (Catling and Brownell 2000, citing Louton 1983). It is apparently not known whether the larvae burrow; however, the clean appearance of exuviae suggest that they do not lie unprotected on the substrate (lack of algal growth), and it seems likely that they burrow shallowly, perhaps less than their ventro-dorsal height below the surface. This is somewhat substantiated by the abrupt lateral curves of the abdominal end – deep burrowing species tend to have elongated end segments to the abdomen.

Figure 9 gives known emergence dates. It is likely that emergence begins with drifting of the larvae, and hence larvae leaving the water to emerge will be concentrated where strong current slows abruptly ("settle-points," Paul Brunelle, pers. obs.). Typical settle-points will be the heads of pools into which rapids are emptying, and generally below structures along the erosional banks of the rivers. The Sabine study on the Saint John River (45.9431°N) indicates that the Skillet Clubtail has a largely synchronous emergence (all individuals emerging over a small number of typically contiguous days) in the latter two weeks of June – similar to that of other river clubtails.



Exuviae are usually taken in depositional areas where the adjacent current is strong, suggesting that they either live in the fast but even current adjacent to those banks, or that they drift prior to emerging, in which case they would tend to end up at those banks. While they sometimes emerge close to the water's edge, they are often a considerable distance up riparian tree trunks (D. Sabine, pers. comm.). The one exuvia reported for Nova Scotia (ADIP record 303079) was a metre or more up the trunk of a tree within a metre of the water's edge at a small cove.

Following emergence, the teneral flies from the river for an extended period of maturation. While most Odonata species return frequently to rivers to establish territories and breed, the Skillet Clubtail seems to spend little time at its larval waters. It is likely that it spends the bulk of its adult life in the surrounding forest, possibly in the canopy, where virtually no observation has been done, but perhaps more commonly low down perched on brush in bogs and fields where it forages. At water, however, males are reported to "*perch on leaves or the bank, often inconspicuously down among plants... making short patrols consisting of a few loops with a bouncy flight over the water, gradually working toward shore, then suddenly fly to a perch*" (Dunkle 2000). This is not particularly cryptic behaviour for a gomphid, and the lack of observations of it on the Saint John River particularly suggest that it is rarely territorial at water. Mating probably occurs away from the larval habitat.

The majority of existing adult observations have been while dragonflies were feeding in open areas not particularly far from suitable rivers. For example, in the several encounters on Regent Street Bog, approximately 3 km uphill from the Saint John River at Fredericton, they were typically perched on the moss or low shrubs less than a metre above the ground (A.W. Thomas, pers. comm.).

	Earliest Flight <sup>B</sup>	May <sup>A</sup>			June					July					August					Latest Flight <sup>B</sup>	Rec. <sup>C</sup>
		C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E		
<b>Flight in NA</b>	May 13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Aug. 11	45
<b>Flight in Canada</b>	May 30	.	.	2 <sup>EX</sup>	.	.	3	12	13	7	10	1	.	.	.	.	.	.	.	July 3	45
>48°N	May 30	.	.	2 <sup>EX</sup>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	May 31	2
46 to 47°N	July 3	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	July 3	1
45 to 46°N	June 19	.	.	.	.	.	.	12	12	6	9	1	.	.	.	.	.	.	.	July 14	40
44 to 45°N	June 18	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	June 27	2
<b>New Brunswick</b>	June 19	.	.	.	.	.	.	12	12	7	9	1	.	.	.	.	.	.	.	July 3	41
<b>Nova Scotia</b>	June 18	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	June 27	2
<b>Ontario</b>	May 30	.	.	2 <sup>EX</sup>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	May 31	2
<b>Québec</b>	June 18	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	June 18	1
<b>Behaviour</b>																					
Emergence	<May 30	.	.	.	.	.	.	12	4	.	.	.	.	.	.	.	.	.	.	June 28	16
Exuviae Collection	May 30	.	.	.	.	.	11 <sup>EX</sup>	6 <sup>EX</sup>	3 <sup>EX</sup>	7 <sup>EX</sup>	.	1 <sup>EX</sup>	1 <sup>EX</sup>	.	1 <sup>EX</sup>	.	.	.	Aug. 7	32	
Foraging	_____	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	_____	---
Territorial	_____	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	_____	---
<b>Flight as published in the United States</b>																					
Connecticut	June 13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	June 13	
Indiana	mid-June	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	last week July	
Michigan	May 17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	July 24	
Minnesota	May 13	1 <sup>EX</sup>	5 <sup>EX</sup>	10 <sup>EX</sup>	1 <sup>EX</sup>	1 <sup>EX</sup>	.	.	.	.	.	.	.	.	.	.	.	.	.	June 11	
Ohio	Aug. 11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Aug. 11	

Note: Numbers given in the columns are of records (species/site/date), not the number of insects encountered.  
The grey bars are flight period based on information in hand. Exuviae records (EX) can indicate start of the flight period, but not extend it past the last encounter with adults.

<sup>A</sup> Subdivisions of the month. Each month is divided into five units ('quints') of six days, except for quints E, which is seven days long in May and July.

<sup>B</sup> Earliest and latest flight recorded in the geographical area.

<sup>C</sup> Total record number. This may differ from the sum of the columns due to multiple lifestage records.  
Data for Ontario and Québec as published, and for New Brunswick and Nova Scotia from ADIP as of 2007.  
Published Data: Connecticut, Garman (1927); Indiana, Walker (1958); Michigan, Needham et al. (2000); Minnesota, Steffens and Smith (1999); Ohio, Needham et al. (2000).

Figure 9. Flight of *Gomphus ventricosus*. Source: P.M. Brunelle.

Figure 9 indicates the known flight period for Canada. Flight periods in Odonata are largely dependent upon seasonal temperatures, closely related to latitude, elevation (not particularly significant within its Canadian range), and proximity to the ocean (not relevant outside the Maritime Provinces). There is a pronounced tendency in most if not all species for flight to begin earlier in the season in the centre of the continent.

The Skillet Clubtail flies from late May to mid-August in North America. After emergence, adults will live until taken by a predator (death through other natural causes seems to be rare in Odonata, Paul Brunelle, pers. obs.). Usually with dragonflies the bulk of the individuals will be gone in a month or so, but rare individuals of the early summer emerging species may last as long as three months. It is a reasonable assumption that few if any of the earlier emerging species survive long enough to be killed by the first frosts. Due to the very few encounters with adults of the Skillet Clubtail, there are not enough data to speculate on the reproduction period, although what little is known is also given in Figure 9.

## **Predation**

Larvae are believed to be fed upon by turtles, fish, and crayfish, as well as by other predacious odonate larvae, including the larger stadia conspecifics. Emerging specimens are highly vulnerable to birds, frogs, and ants. Teneral on their maiden flight are highly vulnerable to insectivorous birds. It is likely that the adults occasionally fall prey to the ubiquitous Dragonhunter (*Hagenius brevistylus* Sélys 1854), a large dragonfly which feeds predominantly on other Odonata, and which may be its principal at-water insect predator. Other large predacious insects may also take the Skillet Clubtail; some wasps (Hymenoptera: Vespidae) and some robber flies (Diptera: Asilidae) appear to be large and aggressive enough to do so. Insectivorous birds such as swallows are a common predator on Clubtail dragonflies, and would likely take the Skillet Clubtail when present (Catling, pers. comm.). It seems likely that most adult mortality is from insectivorous birds feeding on adults and teneral along shores and in the forests and clearings it inhabits.

## **Food resources**

As with other lotic gomphids, Skillet Clubtail larvae likely eat whatever small creatures are also present in or on their substrate habitat: likely fly larvae, worms, conspecifics, congeners, and other invertebrates, and potentially including larval fish and amphibians. Nothing is reported of the food preferences of Skillet Clubtail adults. Presumably they feed on whatever flying insects are present, as do most Odonata species. They have not been reported to glean insect prey from solid surfaces.

## **Dispersal/migration**

The Skillet Clubtail is not a migratory species. Although dispersal is more likely along the river corridors of its catchments, the forest-dwelling nature of the species suggests that its adults are quite capable of crossing the uplands between catchments. It should not be considered a particularly vagile species, however, because it has rarely been found more than 3 km from a likely or known larval habitat. Most experts believe, on the basis of available records throughout the range, that they stay within 10 km of the larval habitat (Dragonfly Society of America (Catling, Daigle, Donnelly, Dunkle, etc.), pers. comm).

## Interspecific interactions

Although the Skillet Clubtail is a moderately small species and rarely territorial, males will occasionally actively defend territory from other lotic odonates such as *Gomphus* (clubtail), and *Ophiogomphus* (snaketail) species when flying over the appropriate larval habitat. They are probably not territorial, however, when perched on the bank or away from water.

Odonate species found with the Skillet Clubtail (ADIP records) on the Saint John River at Fredericton are (by comparison, the Skillet Clubtail has 22 records): ZYGOPTERA; *Calopteryx aequabilis* (River Jewelwing, 7 records), *Argia moesta* (Powdered Dancer, 5), *Enallagma civile* (Familiar Bluet, 19), *E. hageni* (Hagen's Bluet, 18), and *Ischnura verticalis* (Eastern Forktail, 28), ANISOPTERA; *Basiaeschna janata* (Springtime Darner, 18), *Dromogomphus spinosus* (Black-shouldered Spinyleg, 16), *Gomphus (Hylogomphus) abbreviatus* (Spine-crowned Clubtail, 6), *G. (H.) adelphus* (Moustached Clubtail, 29), *G. (Gomphus) exilis* (Lancet Clubtail, 11), *G. (G.) vastus* (Cobra Clubtail, 25), *Hagenius brevistylus* (Dragonhunter, 6), *Ophiogomphus aspersus* (Brook Snaketail, 3), *O. carolus* (Riffle Snaketail, 16), *O. colubrinus* (Boreal Snaketail, 22), *O. m. mainensis* (Maine Snaketail, 3), *O. rupinsulensis* (Rusty Snaketail, 20), *Stylogomphus albistylus* (Eastern Least Clubtail, 9), *Stylurus scudderi* (Zebra Clubtail, 25), *Didymops transversa* (Stream Cruiser, 17), *Macromia i. illinoiensis* (Swift River Cruiser, 9), and *Epithea (Epicordulia) princeps* (Prince Baskettail, 23). This list is in part as indicative of the larger lentic habitats in the region as it is of lotic conditions.

Given habitat preferences, the species most likely to be indicator species for the Skillet Clubtail are *Dromogomphus spinosus*, *Gomphus vastus*, *Ophiogomphus colubrinus*, *O. rupinsulensis*, *Stylurus scudderi*, and *Epithea princeps*.

## Adaptability

With its apparently unusual habitat requirements that are often met at distant points on a landscape and only moderate vagility, it seems unlikely that the Skillet Clubtail is capable of making timely or sufficient adjustment to enable it to survive substantial habitat alteration.

## POPULATION SIZES AND TRENDS

### Abundance, fluctuations and trends

Population size of the Skillet Clubtail in Canada is unknown, but several hundreds of individuals are likely necessary to sustain a population, based on observations of the populations of other stream-dwelling dragonflies (Paul Brunelle, pers. obs.). The available data are insufficient to speculate on fluctuation in abundance of populations.

Odonate surveys have increased greatly throughout the range of the Skillet Clubtail since the first records of this species in Canada (see “Search effort” below). Despite this, the species remains known only historically in Quebec and is considered extirpated at the single locality in that province. Knowledge of the species is largely historical for Nova Scotia and for Ontario, again suggesting that those populations have disappeared. If a Rainy River population is verified in Ontario, the concerns of Steffens and Smith (1999) regarding the state of the Rainy River will become relevant.

The southern Saint John River metapopulation (New Brunswick) and the Rainy River population (Ontario) are the only ones definitely extant for the species in Canada. However, the two other locations in New Brunswick cannot be ruled out as having viable populations.

### **Search effort**

Adult Skillet Clubtails are very rarely encountered at the larval habitat other than as teneral adults at emergence during the brief emergence period. Adults have been occasionally observed on shoreline brush but are most often encountered perched low down on brush kilometres from any potential larval habitat. This behaviour is common in lotic gomphids (although apparently more extreme in this species than for most with respect to proximity to water), and experienced surveyors look for such species away from the larval habitat and also survey in other habitat types, particularly bogs, where they would encounter *G. ventricosus* if present. Therefore, the wandering behaviour of the adults does not account for the comparatively few records of the species.

There have been substantial lotic exuviae surveys throughout its range in Canada, and many short and isolated efforts by individuals to find it.

Recent Maritime Provinces surveys of significance are (if no results for the Skillet Clubtail are indicated there were none):

- (1) Since 1988, Brunelle has intermittently conducted adult and exuviae surveys on the Shubenacadie River in Halifax and Hants counties, central Nova Scotia. There has been only one Skillet Clubtail exuvia collected (ADIP Record 303079). Time = 40 hours.
- (2) From 1993 to 1996, and intermittently since, Brunelle has conducted adult and exuviae surveys on Canoose Stream and the St. Croix River in Charlotte County, southwestern New Brunswick. Time = 352 hours.
- (3) In 2003, Bredin and Brunelle (2004) conducted adult and exuviae surveys on the Eel River in Carleton and York counties, western New Brunswick. Time = 85 hours.
- (4) From 1999 to 2003, Brunelle conducted adult and exuviae surveys on the Saint John River in northern Maine. Time – 55 hours.
- (5) In 2004, Brunelle conducted adult and exuviae surveys on the Saint John River, Madawaska County, in northwestern New Brunswick. Time = 11 hours.

- (6) Since 2002, Dwayne Sabine has conducted predominantly exuviae surveys on the Saint John River at Fredericton, York County, in middle New Brunswick. There have been extensive results for the Skillet Clubtail. Time = 142 hours.
- (7) In 2007 and 2008, Denis Doucet, with Brunelle and Jim Edsall in 2007, conducted adult and exuviae surveys on the Southwest Miramichi River and its major tributaries in middle to eastern New Brunswick. Time = 53 hours.

The databases of ADIP contain sufficient survey visit information to estimate the effort expended to date on lotic survey in New Brunswick and Nova Scotia. Note that “field hours” as used below refers to time spent during visits to the particular habitat, not including travel. “Records” refer to the encounter with a particular species at a particular place on a particular date – different lifestages of the same species are included in the same record, as are multiple voucher specimens.

The following paragraphs include a précis of the survey efforts expended on lotic habitats in New Brunswick and Nova Scotia. Comparative data are not available for Ontario and Quebec, but a similar or greater level of effort is likely since 60,000 dragonfly records have been accumulated for Ontario and coverage has been widespread (Jones 2004) including both adults and many thousands of exuviae. There are, however, a few parts of Ontario where this species may occur, such as the Sault Ste. Marie area (less well surveyed and the species is known from adjacent Michigan). However, few if any new records are anticipated. Likewise for Quebec, Odonata survey was extensive preceding and following the authoritative book on Quebec dragonflies by Pilon and Lagacé (1998). Although the search effort described below for Nova Scotia and New Brunswick was usually not aimed specifically at the Skillet Clubtail, this does not compromise the results given below because adults of all species are typically netted during surveys. This is done because some species (often the rarest) are difficult to determine on the wing. In addition, surveyors taking exuviae will have in most cases not been selective in the field, and any exuviae seen will have been taken as a voucher. Regardless of the general nature of Odonata survey in these provinces to date, the Skillet Clubtail has been a high priority target for dragonfly surveyors in these provinces, as a result of its rarity.

There have been 2,900 visits to running water sites in New Brunswick and Nova Scotia by surveyors for dragonflies. 1,387 visits were made during the period of June to mid-July. This is the period during which Skillet Clubtails are considered most likely to still be found if they had emerged there (Paul Brunelle, pers. obs.). 358 rivers and streams were visited, many at multiple stations and with repeat visits, and about 1,400 field hours were spent during the presumed flight period. Adult dragonflies were consistently sought during these visits and 4,939 records of all lifestages taken. Exuviae were searched for in 590 of these visits and 988 exuviae records taken; larvae during 220 larvae records were obtained in 107 visits. Only 32 visits on 3 rivers confirmed the presence of the Skillet Clubtail.

This low level of encounter (2.3% of the 1,387 lotic visits during the presumed flight period, 5.4% of the 590 visits in which exuviae were sampled – bearing in mind that the Saint John River has had a disproportionately large proportion of exuviae surveys among the provinces) is particularly significant in that Skillet Clubtail exuviae are as obvious as many other exuviae taken in those surveys. For example, exuviae of the similarly sized Moustached Clubtail (*Gomphus (Hylogomphus) adelphus*) were taken 88 times during these visits.

Larvae are much more rarely surveyed for, and that type of survey is generally conducted by professional surveyors (whereas exuviae are often collected by ADIP (Atlantic Dragonfly Information Project) volunteers. There have been 339 visits in which larvae were sampled, at 120 rivers or streams, but Skillet Clubtail larvae have not been taken.

A caveat on the preceding statistics is that exuviae or larvae may have been searched for in further visits but that effort, particularly if unsuccessful, may not have been reported to ADIP.

To summarize, a very substantial search effort in New Brunswick and Nova Scotia, and elsewhere in eastern and central Canada, has produced very few records of the Skillet Clubtail, suggesting that it is truly very rare. It is anticipated that few, if any, additional sites will be discovered. Related information is found in the section on habitat.

### **Rescue effect**

It is unlikely that extirpations of catchment populations of the Skillet Clubtail in Canada would be rescued within decades by natural dispersion from adjacent populations to the south, even if the Canadian catchment habitats recover. The reason for this is that the species has been ranked as a conservation concern in most states of the United States in which it is reported, including those adjacent to Canada. Environmental impacts on natural aquatic habitats increase to the south with higher human population density and concomitantly increased agriculture and industrialization, and it may be that Canadian populations are at lesser risk. With respect to Ontario, Steffens and Smith (1999) noted dragonfly deformities in individuals captured along the length of the Rainy River boundary, which they suggested may indicate that the river has “*serious pollution problems*” warranting further study. The population of *G. ventricosus* there may be in trouble thus reducing the likelihood of rescue. The New Brunswick populations are not likely to be rescued if lost – the evident absence of the species from Maine and the Appalachian region of Quebec makes rescue extremely unlikely.

## LIMITING FACTORS AND THREATS

Anthropogenic habitat change represents the greatest potential threat to the Skillet Clubtail, and larger rivers figure more prominently in human settlement, transportation, industry and recreation. The related threats most likely to have an impact on this species are habitat loss, pollution and invasive species.

With most lotic gomphids, the greatest perceived threat to populations is the impoundment of running waters. The Mactaquac dam is only 15 km above the collection of Skillet Clubtail exuviae at Fredericton. The creation of its reservoir (1964) may have destroyed habitat, and thus populations of this species. However, its occurrence below the dam suggests that the downstream conditions are presently conducive to its survival.

The terrestrial habitat of adults at the St. John River population has declined as Fredericton and the surrounding urban area has grown and there have also been losses as a result of agricultural expansion (A. Kennedy pers. comm., see also "Habitat trends").

Larvae of this species require clear or naturally turbid unpolluted running waters, with the appropriate substrate believed to be fine sand, clay and/or silt. Pollution is a potential threat, particularly by broadcast pesticides used in agriculture or forestry management; and most particularly by those used for the control of aquatic larvae of biting insects. Pollution has been suggested as a detrimental in the Rainy River, Minnesota, population adjacent to Ontario (Steffens and Smith 1999). As Odonata rank very high in the invertebrate food chain, they will take up persistent insecticides, potentially to a debilitating or lethal level. Toxic chemical spills are a potential threat, particularly where road and rail corridors are adjacent to the river. However, roads directly in the vicinity of the New Brunswick locations are few, and contact is not extensive.

Eutrophication due to excessive nutrient input from sewage, or sedimentation due to agricultural or forestry runoff are threats to larval habitat. Clearing and insecticidal spraying of forests surrounding their rivers may exert a negative impact on adult populations, which are thought to spend much of their time in the surrounding forest. The only definite indication of pollution involving documented "marginal" water quality is noted under "Habitat trends." The extent that pollution is currently a problem is unclear but it is expected to worsen with continuing urban growth.



Invasive species may represent a threat either directly to the species, or indirectly by alteration of the biotic composition of the habitat. Invasive aquatic plants such as Curly Pondweed (*Potamogeton crispus*) and Eurasian Water-Milfoil (*Myriophyllum spicatum*) are currently a concern in the region; they will invade a water body and grow to a high density, followed by a die-off which can yield lethal water quality characteristics. Distributed principally on recreational watercraft, and possibly by waterfowl, and hence able to cross catchments, these plants are largely still-water species, but some can survive well in the lower portions of rivers. The application of herbicides for the control of these invasive species in the catchment is also a concern.

The diatom *Didymosphenia geminata* has recently been identified as a growing threat to the benthos of eastern North America. It has been introduced to the Connecticut River near Pittsburg in New Hampshire, and while it is not yet a factor within the Skillet Clubtail's known Canadian range, its stifling of the substrate and benthos under thick mats could be a future threat to the species.

The deliberate or inadvertent introduction of higher aquatic organisms may represent a threat to the Skillet Clubtail, and there is very little detailed knowledge of the impacts of these invasions. It seems very unlikely that introduced Odonata species will be viable. These introductions are an increasing trend in the northeastern U.S. in a shortsighted attempt to control mosquito populations, concern over which has intensified since West Nile Virus became a public health issue. Typically these introductions are of still-water species into standing rather than running waters. In addition, if a river was suitable for these generally more opportunistic species, it is probable that they would have colonized it already, and if it is north of their bioclimatic limit it is unlikely that they will persist.

Crayfish (Decapoda, Cambaridae) species have been illegally introduced in the region for use as bait in recreational fishing. They are known to consume surface-dwelling and shallow-burrowing larvae (Paul Brunelle, pers. obs.), based on aquarium and *in situ* studies of the Spinycheek Crayfish (*Orconectes limosa*) from the St. Croix River, New Brunswick. As the Skillet Clubtail larvae are thought not to burrow deeply, any introduced species of crayfish are likely to be deleterious to the species. In addition, when the larvae emerge from the substrate to drift, and to travel to the shore to emerge, they must run the gauntlet of crayfish at the substrate surface. In New Brunswick two other species of crayfish are recorded from the northern areas and possibly from the Saint John River; the introduced Virile Crayfish (*Orconectes virilis*), and the Appalachian Brook Crayfish (*Cambarus bartoni*). While the latter is indigenous and similar in behaviour (shallow burrowing) to the Spinycheek Crayfish, the behaviour of the Virile Crayfish is not known.

Fish species are also illegally introduced for recreational fishing. In spite of the illegality this continues to occur as is shown by the spread of the Chain Pickerel (*Esox niger*) in Nova Scotia (Paul Brunelle, pers. obs.). In the St. Croix River, Smallmouth Bass (*Micropterus dolomieu*) introduced historically by the government are voracious predators on the benthos (Paul Brunelle, pers. obs. *in situ*). They possibly do not

represent a constant threat to larval Skillet Clubtails, but they may have a significant impact when the Skillet Clubtail larvae emerge from the substrate for nocturnal drifting or to emerge, as the bass feed at night (John Gilhen, pers. comm.). Inadvertent introduction of Muskellunge (*Esox masquinongy* Mitchell) to the upper reaches of the Saint John River may eventually pose a threat to the benthos of the lower reaches of the river.

In addition to the invasive species, subsidized predators such as Common Grackles (*Quiscalus quiscula*), European Starlings (*Sturnus vulgaris*) and various swallows as well as raccoons (*Procyon lotor*), which may be abundant in urban areas as a result of food provided by people), may be having an increasing impact on *G. ventricosus* around Fredericton during periods of emergence.

A potentially significant threat to the survival of Skillet Clubtail on the Saint John River lies in the gradual encroachment of saline influence with sea level rise, and the barrier, represented by the Mactaquac headpond, to upstream migration of the species (see also "Habitat trends"). A study of water chemistry in the Saint John River system identified Musquash Island, at the outlet of Washademoak Lake, as the upstream extent of saline influence at low seasonal water flows (Gillis 1974). This is roughly 5 km downstream of Scovil, the species record that is farthest downstream. While modelling the extent of sea level rise is complex, one recent analysis projected an increase of  $12\pm 3$  cm at Saint John relative to 2000 levels by 2025 (Daigle 2009).

There are only a few obvious and immediate anthropogenic threats to individual Skillet Clubtails. Road-kill resulting from collision with automobiles, which can lead to substantial mortality in some dragonfly species, seems likely to be a factor for the Skillet Clubtail due to its adult behaviour as it perches on low shrubbery, and thus near the ground surface. Moreover, newly emerged dragonflies leaving the water's edge during the emergence period might suffer high mortality in crossing roads following the bank of the river or nearby, along which vehicles travel at more than 50 km/hr. This speed seems to represent the upper boundary of the ability of dragonflies to avoid approaching vehicles. The amount of traffic and the nature of the road are significant. Well-constructed roads through woodlands and secondary highways, which allow high speed but have narrow rights of way, seem particularly dangerous for dragonflies. Larger highways with wide rights of way are much less so (Paul Brunelle, pers. obs., based on six years travelling with a net on the front of a vehicle). The urban area of Fredericton presents a road-kill danger to *G. ventricosus*, particularly the large highways.

Another direct threat is interference with emergence by recreational use of waters and shoreline construction. Any boat or vehicle that casts a wake during the hours of emergence may interfere with emerging larvae. Even landing canoes, wading and shore walking at the emergence site is potentially damaging to the emerging population during the comparatively short (two week) emergence period. However, *G. ventricosus* emerges at night and transforms some distance from the water's edge and often well up riparian tree trunks; therefore boat wakes and trampling are minor risks to the species.

## **SPECIAL SIGNIFICANCE OF THE SPECIES**

The presence of the Skillet Clubtail is indicative of large, clean, running water habitats, with the comparatively rare (for Canada) substrate of fine sand, clay or silt. Because it can act as an indicator species, other unusual and significant species will likely occur where it is found. It is considered rare or at risk, and a protection priority, throughout its North American range. Organized and widespread inventory of Odonata has occurred over the past two decades in Canada east of the Prairie Provinces, and as a result of this work, the Skillet Clubtail is believed to be very rare here.

The species reaches its northern extreme in Canada. Its global viability may come to be dependent upon the lower level of anthropogenic impact on Canadian waters, relative to catchments to the south.

## **EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS**

Status designations for the Skillet Clubtail reflect its rarity overall. NatureServe has ranked the species globally at G3 (“vulnerable”), and nationally for the United States at N3 and for Canada at N1 (NatureServe 2009). The status level of 3 indicates that it is “uncommon.”

The National General Status review of 2002 and 2005 (Twolan and Nadeau 2004) assigned the species the rank of 2 (“may be at risk”) nationally and provincially (Ontario, Quebec, New Brunswick, and Nova Scotia). NatureServe has assessed the status as S1 (“endangered”) for the provinces of New Brunswick, Nova Scotia, and Ontario, and as SH (“historical”) for Quebec. The S1 rank formerly assigned to Ontario is based on information since determined to be erroneous – the status of the Skillet Clubtail in that province should be SH if the Rainy River occurrences are *pro forma* not accepted (as being on the U.S. side of the river), and this is how it is currently listed.

NatureServe (2009) has assessed the individual states in the United States as (X = “presumably extinct,” H = “possibly extirpated,” U = “unrankable,” NR = “not yet ranked”); Connecticut (S2), Indiana (S1S2), Iowa (SNR), Kentucky (SH), Maryland (SH), Massachusetts (S2), Michigan (SNR), Minnesota (SNR), Missouri (SU), New Hampshire (S1), New Jersey (SNR), New York (SH), North Carolina (S1S2), Ohio (S2), Pennsylvania (SX), Tennessee (S3?), Vermont (S1), Virginia (S1), and Wisconsin (S3).

In Canada, the species and its habitat currently have no formal protection. The Regent Street bog, Fredericton, New Brunswick, where adults forage, is under the protection of the University of New Brunswick (Brunelle 2009).

## ABORIGINAL AND TRADITIONAL KNOWLEDGE

No information has been found with respect to this particular species.

## BIOGRAPHICAL SUMMARY OF REPORT WRITER

Paul Michael Brunelle has been studying the Odonata of Atlantic Canada and northern New England since 1987. He has authored a number of papers on the subject, and has proposed ranking statuses for Canada (NatureServe), all the Maritime Provinces, repeatedly, and for the State of Maine. He was invited to participate in the 2002 Odonata assessment for National General Status, and the recent revisions to NGS ranks for the Maritime Provinces. Brunelle established the Atlantic Dragonfly Inventory Program (ADIP) volunteer survey in the early 1990s. In 1997 he was retained by the State of Maine to plan the Maine Damselfly and Dragonfly Survey (MDDS), prepare its publications, give volunteer briefing seminars, and determine and input specimens. He was also retained to survey for rare Odonata species in the State. In 2000, Brunelle completed the description of the Broadtailed Shadowdragon (*Neurocordulia michaeli*) from New Brunswick. Brunelle has entered more than 61,000 records in the ADIP/MDDS databases since their inception; more than 10,000 of which are from his own fieldwork. In 2007 he prepared the COSEWIC draft status report for *Ophiogomphus howei*, the Pygmy Snaketail.

## COLLECTIONS EXAMINED

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## **INFORMATION SOURCES**

### **Publications**

- Bredin, K.A., and P.M. Brunelle. 2004. Atlantic Canada Conservation Data Centre Freshwater Mussel and Odonate Surveys of the Eel River, New Brunswick, in 2003. Report to the New Brunswick Wildlife Council Trust Fund. 19 pp.
- Brunelle, P.M. 2009. Details of Canadian and United States Records of the Skillet Clubtail. Accessory report to COSEWIC. 9 pp.
- Catling, P.M., and V.R. Brownell. 2000. Damselflies and dragonflies (Odonata) of Ontario: resource guide and annotated list. i-v,1-198. ISBN 0-9682013-1-8.
- Catling, P.M., R.A. Cannings, and P.M. Brunelle. 2005. An annotated Checklist of the Odonata of Canada. *Bulletin of American Odonatology* 9(1): 1-20.
- Cook, C. 1950. Notes on a collection of dragonflies (Odonata) from Nova Scotia. *Canadian Entomologist* 82(9): 190-194.
- Daigle, R.J. 2009. Sea-Level Rise Estimates for New Brunswick Municipalities: Saint John, Miramichi, Bathurst, Campbellton, Sackville, Richibucto, Shippagan. September 2009. Report prepared for Riley Environment Limited by R.J. Daigle Enviro, Moncton, NB. 18 pp.
- Donnelly, T.W. 2004. Distribution of North American Odonata. Part I: Aeshnidae, Petaluridae, Gomphidae, Cordulegastridae. *Bulletin of American Odonatology* 7(4): 61-90.
- Dunkle, S.W. 2000. *Dragonflies through binoculars: a field guide to dragonflies of North America*. Oxford University Press. 266 pp. ISBN 0-19-511268-7.

- Gillis, G. 1974. An Ecological Survey in the Saint John Estuary. Report No.15-h. The Saint John River Basin Board. Fredericton, New Brunswick. 64 pp. plus appendices.
- Jones, C.D. 2004. Ontario Odonata records through the years. Ontario Odonata 4: 23-28.
- Jones, C.D. 2007. Skillet Clubtail (*Gomphus ventricosus*) in Ontario. Pp. 49, in P.M. Catling, C.D. Jones and P. Pratt (eds.). Ontario Odonata Volume 7. Toronto Entomologists' Association, Toronto, Ontario.
- Louton, J.A. 1983. The larva of *Gomphurus ventricosus* (Walsh), and comments on relationships within the genus (Anisoptera: Gomphidae). Odonatologica 12(1): 83-86.
- Needham, J.G., M.J. Westfall, and M.L. May. 2000. Dragonflies of North America: revised edition. Scientific Publishers, Gainesville, Florida. 940 pp. ISBN 0-945417-94-2.
- New Brunswick Dept. of Environment. 2007. New Brunswick watersheds – St. John River. Environmental Reporting Series poster.
- NSWG. 1996. A national ecological framework for Canada: terrestrial ecozones, ecoregions and ecodistricts: New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland. Ecological Stratification Working Group. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull. Report and national map at 1:7,500,000 scale. 1 map.
- Oldham, M.J. and D. Elder. 2000. Noteworthy Odonata records from Northwestern Ontario. Ontario Odonata 1: 28-33.
- Paulson, D.R., and S.W. Dunkle. 1996. Common names of North American dragonflies and damselflies, adopted by the Dragonfly Society of the Americas. Argia 8(2) Supplement.
- Pilon, J.-G., and L.D. Lagacé. 1998. Les odonates du Québec. Entomofaune du Québec, Chicoutimi, Québec. 367 pp.
- Robert, A. 1963. Les libellules du Québec. Ministère du Tourisme, de la Chasse et de la Pêche du Québec, Service de la recherche, Québec. 223 pp.
- Steffens, W.P., and W.A. Smith. 1999. Status Survey for Special Concern and Endangered Dragonflies of Minnesota: Population Status, Inventory and Monitoring Recommendations Minnesota Department of Natural Resources Natural Heritage and Nongame Research Program. 1–56 pp.

- Twolan, L. and Nadeau, S. 2004. Wild Species: the General Status program in Canada. Environment Canada 1996). Pp. 1 – 5 *in* T.D. Hooper, editor. Proceedings of the Species at Risk 2004 Pathways to Recovery Conference. 1 March 2–6, 2004, Victoria, B.C. Species at Risk 2004 Pathways to Recovery Conference Organizing Committee, Victoria, B.C.  
[http://www.llbc.leg.bc.ca/Public/PubDocs/bcdocs/400484/twolan\\_edited\\_final\\_may\\_26.pdf](http://www.llbc.leg.bc.ca/Public/PubDocs/bcdocs/400484/twolan_edited_final_may_26.pdf)
- USFS. 2002. Aquatic Resource Analysis (AQUA). National Forests in North Carolina, Pisgah National Forest, Appalachian Ranger District, Northside Timber Sale, Yancey County. United States Forest Service.
- Walker, E.M. 1958. The Odonata of Canada and Alaska: vol. 2: part III: the Anisoptera: four families. University of Toronto Press, Toronto, Ontario. ISBN 0-8020-7076-0.
- Walsh, B.D. 1863. Observations on certain American Neuroptera by H. Hagen, M.D. of Koenigsberg, Prussia; translated from the original French MS, and published by permission of the author, with notes and descriptions of about twenty new North American species of Pseudoneuroptera. Entomological Society of Philadelphia Proceedings 2: 167-272.

## Websites

- Abbott, J.C. 2007. OdonataCentral: An online resource for the distribution and identification of Odonata. Texas Natural Science Center, The University of Texas at Austin. Available at <http://www.odonatacentral.org> (Accessed: 2009)
- Canadian Endangered Species Conservation Council (CESCC). 2006. Wild Species 2005: The General Status of Species in Canada. General status search tool. Available at:  
<http://www.wildspecies.ca/wildspecies2005/search.cfm?lang=e&sec=9>. Page updated 2006; accessed 2009.
- NatureServe. 2009. NatureServe Explorer. Online database available at:  
<http://www.natureserve.org/explorer>. Accessed 2009.
- OOD. 2009. Ontario Odonata Database. Ontario Ministry of Natural Resources. Accessed January 2009. <http://nhic.mnr.gov.on.ca/MNR/nhic/odonates/about.html>
- Wikipedia. 2009. Accessed January 2009. [http://en.wikipedia.org/wiki/Mactaquac\\_Dam](http://en.wikipedia.org/wiki/Mactaquac_Dam)

## Individuals/organizations

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