COSEWIC
Assessment and Update Status Report

on the

Prothonotary Warbler
Protonotaria citrea

in Canada

ENDANGERED
2007

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

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DES ESPÈCES EN PÉRIL
AU CANADA

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Page, A.M. 1996. COSEWIC update status report on the Prothonotary Warbler *Protonotaria citrea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-23 pp.

McCracken, J.D. 1984. COSEWIC status report on the Prothonotary Warbler *Protonotaria citrea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-30 pp.

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COSEWIC
Assessment Summary

Assessment Summary – April 2007

Common name
Prothonotary Warbler

Scientific name
Protonotaria citrea

Status
Endangered

Reason for designation
In Canada, this species breeds only in deciduous swamp forests in southwestern Ontario. It has shown an 80% decrease in abundance over the last 10 years and its current population is between 28 and 34 mature individuals only. Threats include loss and degradation of breeding habitat, loss of coastal mangrove forests in Central and South America where the species winters, and disturbances of habitat that result in increased nest site competition with House Wrens and increased nest parasitism by Brown-headed Cowbirds.

Occurrence
Ontario

Status history
Designated Special Concern in April 1984. Status re-examined and designated Endangered in April 1996. Status re-examined and confirmed in May 2000 and in April 2007. Last assessment based on an update status report.

COSEWIC
Executive Summary

Prothonotary Warbler
Protonotaria citrea

Species information

The Prothonotary Warbler is one of North America's most dazzling songbirds. Males and females look alike, but males are more brightly coloured. Both have golden yellow heads and breasts, olive-green backs, and blue-grey wings and tails. White tail spots are quite prominent. Prothonotary Warblers are small birds, weighing about 14 grams, and measuring about 14 cm long.

Distribution

The Prothonotary Warbler breeds throughout much of the eastern U.S. north as far as southwestern Ontario. It is most abundant in the southeastern U.S. Populations in Canada are small and scattered, and are found mostly along the north shore of Lake Erie. Its wintering range extends from the coastal lowlands of southern Mexico, south to coastal areas of northern South America.

Habitat

During the breeding season, Prothonotary Warblers occupy large, mature and semi-mature, deciduous swamp forest and riparian floodplains. Permanent and semi-permanent pools of open water are characteristic, and nests are typically situated over standing or slow-moving water. The species nests in natural cavities and those excavated by other species, using small, shallow cavities that are situated at low heights. Properly designed nest boxes are also readily accepted. Males often build one or more incomplete ("dummy") nests. Nesting densities are at least partially limited by the availability of suitable cavities. The Prothonotary Warbler's key wintering habitat is coastal mangrove forest in Central America and northern South America. It also winters in swamps and wet woodlands, mainly below 1300 m.

Biology

The Prothonotary Warbler is highly territorial during the breeding season, but not on the wintering grounds. Territory size (about 1-2 ha) is influenced by habitat quality, habitat configuration and population density. The typical clutch size is 4-6 eggs. In the southern U.S., the species is usually double-brooded, while populations in the north

(including Canada) are typically single-brooded. Nesting success is highly variable, and largely depends on predation rates. Destruction of eggs and young by House Wrens is a major source of nest failure at sites where wrens are common. For a cavity-nesting species, the Prothonotary Warbler shows an exceptionally high level of cowbird parasitism (27% in Ontario). In Ontario, annual nest success over a seven-year period ranged from 44% to 67%.

The average life span of males is about 2.5 years. Probability estimates for annual survival of adults are about 53% for males and 47% for females. In Canada, an average of about 37% of all territorial males remain unmated during the course of the breeding season. An apparent shortage of females in the Canadian population limits reproductive potential. The Canadian population is also strongly skewed in favour of older birds, indicating poor recruitment/immigration.

Prothonotary Warblers are insectivores, feeding mostly on caterpillars, flies, midges, and spiders.

Population sizes and trends

The continental population of Prothonotary Warbler is estimated at about 900,000 pairs, over 99% of which reside in the U.S., mostly in the southeastern states. In recent years, Canada has supported no more than 20 pairs, plus several unmated territorial males. The current (i.e. 2005) population estimate in Canada is between 28 and 34 individuals, including unmated males.

Breeding Bird Survey results indicate that the continental population of Prothonotary Warbler has experienced a significant long-term decline, averaging - 1.3%/year from 1966-2005 (40% overall). In Canada, information from intensive surveys that target Prothonotary Warblers suggest that the population has decreased from an estimated 40 pairs in 1995 to 8 pairs in 2005, which amounts to an 80% decrease in population size in the last decade.

Despite the population decline, results of the Ontario Breeding Bird Atlas indicate that the overall distribution of the species in Canada has remained relatively unchanged over the past 20 years.

Limiting factors and threats

In Canada, the range of the Prothonotary Warbler appears to be limited primarily by climate and habitat availability. The following threats have been identified: range-wide loss and degradation of swamp forest breeding habitat; loss of wintering habitat especially widespread destruction of mangrove forest; habitat disturbance that increases nest site competition and reduces breeding productivity (primarily due to interspecific egg destruction by wrens and/or cowbird parasitism); invasive forest insects (e.g. emerald ash borer) that have potential to create serious habitat disturbances; invasive plants (e.g. common reed and European black alder) that render

habitat unsuitable; and catastrophic weather events and changes in precipitation related to climate change.

Special significance of the species

Within its breeding range, the Prothonotary Warbler may be a useful indicator of the quality of forested wetlands. During spring migration in Canada, it has local socio-economic benefits, because of its intense popularity with bird watchers.

Existing protection

The Prothonotary Warbler is presently regulated as an Endangered species under Canada's *Species at Risk Act* and by Ontario's *Endangered Species Act*. General protection is also afforded through the *Migratory Birds Convention Act*. Additional provincial regulations and policies, which promote protection of its breeding habitat in Ontario, also benefit the species. In addition, the majority of the breeding population now remaining in Ontario occurs on public, protected lands.

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

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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Update
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2007

TABLE OF CONTENTS

List of figures

List of tables

List of appendices

SPECIES INFORMATION

Name and classification

Class: Aves
Order: Passeriformes
Family: Fringillidae
Genus: *Protonotaria*
Species: *citrea* (Boddaert, 1783)
English name: Prothonotary Warbler
French name: Paruline orange

This is a monotypic genus; and no subspecies or races are recognized (Petit 1999).

Morphological description

The Prothonotary Warbler is one of North America's most dazzling songbirds. Males and females look alike, but males are more brightly coloured. Both have golden yellow heads and breasts, olive-green backs, and blue-grey wings and tails. Prothonotary Warblers do not have wing bars, but white tail spots are quite prominent. Though rather large for a warbler, Prothonotary Warblers are small birds, weighing about 14 grams, and measuring about 14 cm long (see Petit 1999). The male's territorial song is a loud, ringing "t*sweeet-tsweet-tsweet-tsweet*," usually uttered in a rapid series of 4-6 notes, but sometimes nonstop up to 14 times (Bryan *et al.* 1987).

Genetic description

No genetic information is available, but there is little variation in morphometric or plumage characters across the species' range (Petit 1999). In addition, Bryan *et al.* (1987) documented a surprising level of uniformity in songs of the Prothonotary Warbler across eastern North America. These observations suggest little genetic structuring within the population.

DISTRIBUTION

Global range

The Prothonotary Warbler breeds throughout much of the eastern U.S., and north to southwestern Ontario (Figure 1). It is most abundant in the southeastern U.S. and up the Mississippi River, becoming decidedly less common in the northern part of its range.

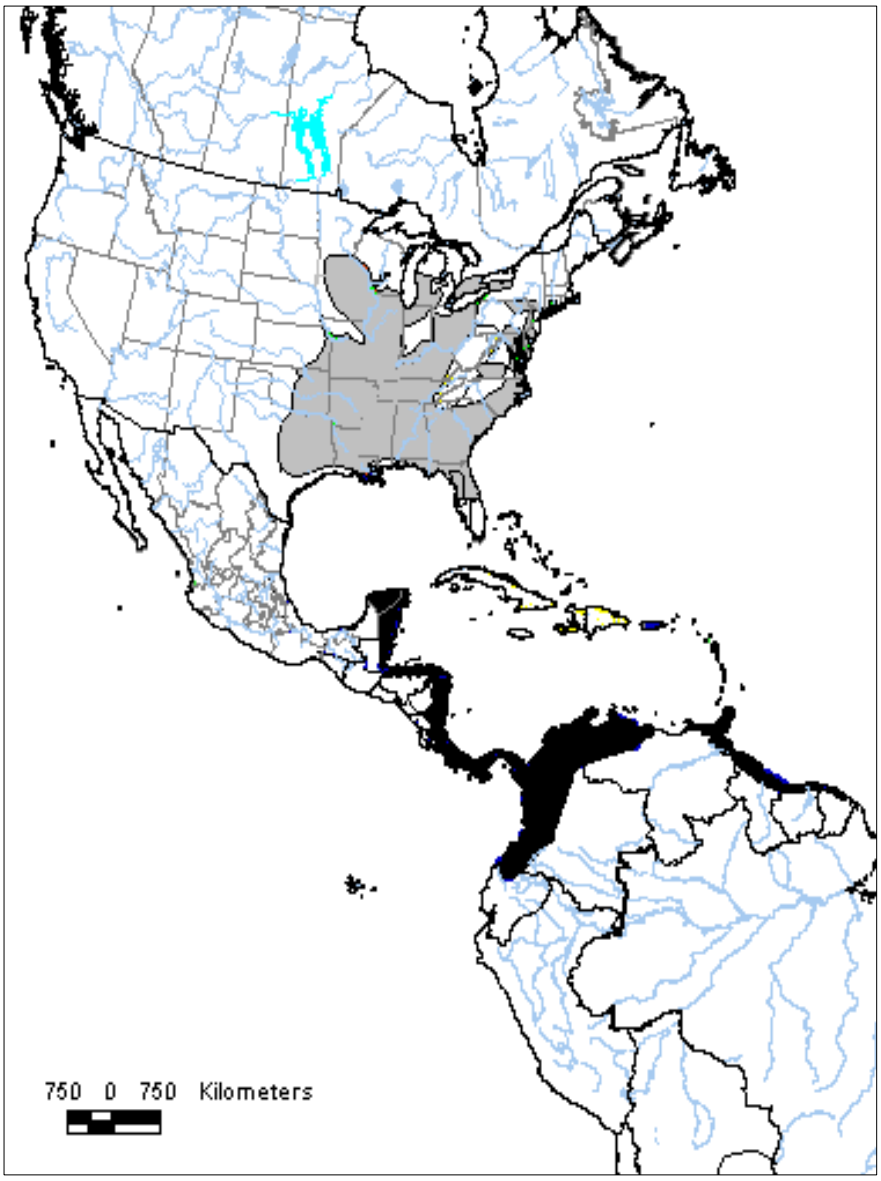

Figure 1. Global breeding (grey shading) and wintering (black shading) range of the Prothonotary Warbler (modified from Ridgely *et al.* 2003).

The Prothonotary Warbler's wintering range extends from southern Mexico through Central America and northern South America. Its centres of winter abundance are reported to include northern Venezuela, Colombia (Bent 1953; Lefebvre *et al.* 1992; Lefebvre *et al.* 1994), coastal Panama (Lefebvre and Poulin 1996), and coastal Costa Rica (Warkentin and Hernández 1996; Woodcock *et al.* 2005). However, extensive quantitative surveys of wintering populations have not been conducted.

Canadian range

Being at the northern edge of its range in southwestern Ontario, the Prothonotary Warbler has been primarily found nesting along and adjacent to the Lake Erie shoreline (e.g. Holiday Beach, Point Pelee, Wheatley, Rondeau, Long Point; Figure 2). Nesting has occurred regularly at one site along the Lake Ontario shoreline (Hamilton), and rarely at one site along the Lake Huron shoreline (Pinery Provincial Park) and along the St. Clair River. In some inland sites in southwestern Ontario, territorial but apparently unmated males may defend territories in suitable habitat (e.g. Brant, Halton, Peel, Middlesex, and Huron counties), but such occurrences are not enduring and inland nestings have rarely been documented. It formerly nested at Turkey Point, Point Abino, Lobo, and near Orwell and Copenhagen.

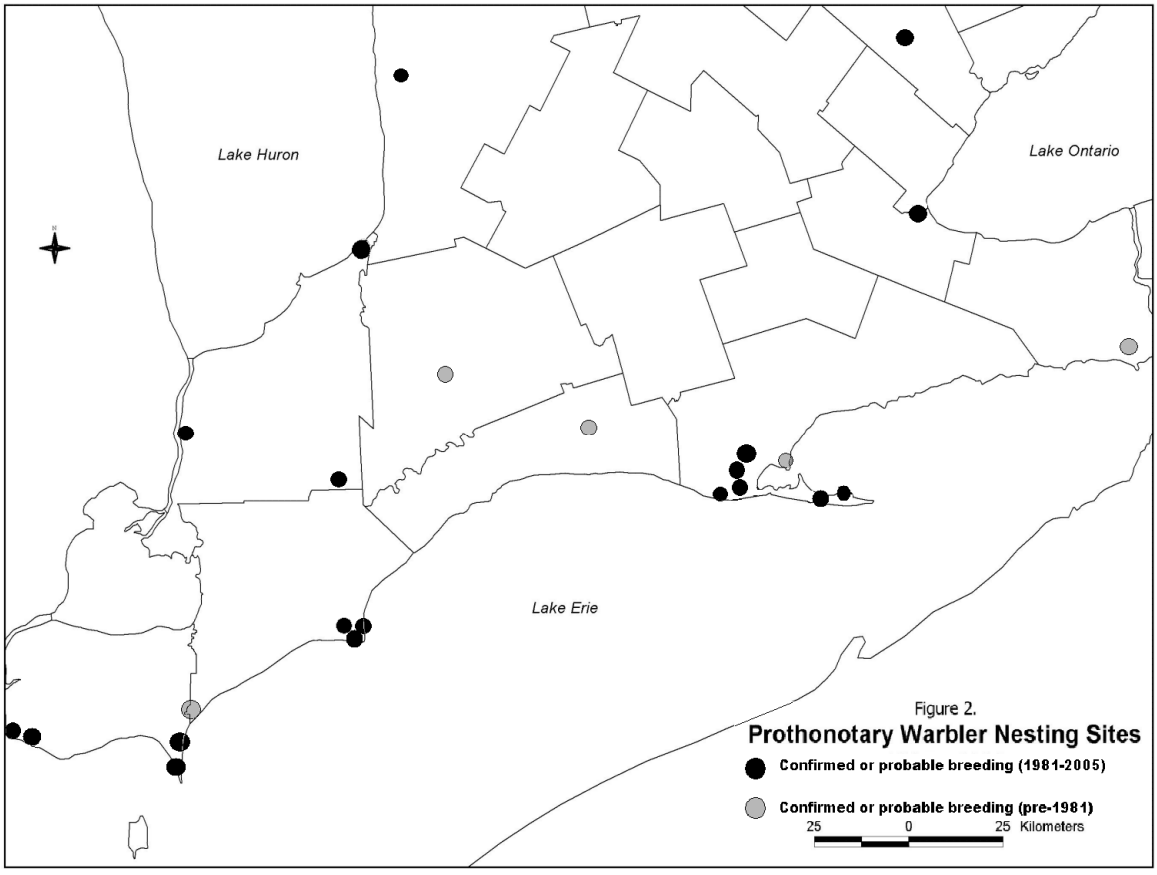

Figure 2. Current and historical breeding occurrences of Prothonotary Warblers in Canada.

Rondeau typically supports about half of the Canadian population in any given year. The Long Point region and Holiday Beach are also important breeding areas.

In the last two decades, about 15 different locations have been occupied in Canada. Based upon the range envelope of known and probable breeding occurrences

in Canada (Figure 2), the Prothonotary Warbler's Extent of Occurrence (EO) encompasses about 15,000 km^2. Based upon a maximum population of 20 pairs and a maximum territory size of 2 ha, the species' Area of Occupancy (AO) is no more than 0.4 km^2.

HABITAT

Habitat requirements

During the breeding season in Canada, Prothonotary Warblers occupy mature and semi-mature, deciduous swamp forest and riparian floodplains (McCracken 1984; Petit 1999). Tree cover is typically dominated by silver maple (*Acer saccharinum*), ash (*Fraxinus spp*.), and yellow birch (*Betula alleghaniensis*), often with a mature buttonbush (*Cephalanthus occidentalis*) component in open flooded areas. Canopy closure ranges from incomplete to complete, but is usually extensive enough to limit the development of an extensive herbaceous and shrubby plant understory. Nest sites are usually shaded for at least part of the day (Blem and Blem 1991; 1992; Best and Fondrk 1995).

Permanent and semi-permanent pools of open water are characteristic, and nests are typically situated over standing or slow-moving water. At Ontario sites, water depth typically ranges from 0.5 to 1.5 m, and the surface area of water typically represents between 70% and 100% of the territory (J.D. McCracken, pers. obs.). Pools in these territories may be 1 ha or more in size, though sites containing smaller pools will also be readily occupied, especially if several pools are in close proximity (J.D. McCracken, pers. obs.).

The Prothonotary Warbler was described as an area-sensitive species by Keller *et al.* (1993), Petit (1999), and Thompson *et al*. (1993), but not by Robbins *et al.* (1989) or Hodges and Krementz (1996). In riparian forests in the southeast U.S., Prothonotary Warbler populations can probably be conserved if a 100 m wide corridor of suitable habitat is protected (Hodges and Krementz 1996), while Kilgo *et al.* (1998) found that the species' probability of occurrence was greatest in forests that were at least 500 m wide. In Canada, over 95% of known breeding sites occur within forest patches that are at least 100 ha in size (Flaxman and Lindsay 2004).

The Prothonotary Warbler is a secondary-cavity nester, often using naturally formed tree cavities in dead or dying trees, but more commonly occupying cavities that have been excavated by chickadees (*Parus sp.*) and Downy Woodpeckers (*Picoides pubescens;* Petit 1999). Properly designed nest boxes are readily accepted, and perhaps even preferred (e.g. Best and Fondrk 1995; McCracken *et al*. 2006). Indeed, Twedt and Henne-Kerr (2001) demonstrated that local breeding densities of Prothonotary Warblers were enhanced by nest box provisioning, effectively showing that cavity availability is a limiting factor (see also Petit 1999). Prothonotary Warblers have also been known to nest in a variety of unusual situations, including a coffee can,

tin pail, glass jar, an old hornet's nest, a mailbox (Bent 1953), and an empty Red-winged Blackbird (*Agelaius phoeniceus*) nest (Petit and Petit 1988).

As noted above, nest sites are almost always directly above water. Cavities are invariably shallow and usually situated at low heights (typically about 2 metres from the ground or water; Petit 1999). Males often build one or more incomplete "dummy" nests (Bent 1953; Petit 1999; Blem and Blem 1992). The female often selects one of these to complete, but may also build an entirely new nest on her own. In any case, several suitable cavities appear to be required in each territory, in order to accommodate both the functional nest plus one or more "dummy" nests (Petit 1999).

Nests are constructed primarily of green mosses, often with some liverworts and dead leaves (Petit 1999). They are lined with fine rootlets, lichens and grasses. Moist green moss is an essential material in both incomplete ("dummy") and functional nests (e.g. Blem and Blem 1994). There is no information on whether particular species of mosses are favoured, but *Anomodon attenuatus* and *Bryohaplocladium microphyllum* were the dominant species used in Virginia (Blem and Blem 1994). Both species are common in Ontario (D.A. Sutherland, pers. comm. 2006).

No information has been published on habitat use during the post-fledgling period (Petit 1999). Fledged young are apt to range widely (Petit 1999), often occupying the upper tree canopy within 250 m or more of the nest site, regardless of the availability of standing water (J.D. McCracken, pers. obs.).

The Prothonotary Warbler's key wintering habitat is coastal mangrove forest in Central America and northern South America (Lefebvre *et al.* 1992; Lefebvre *et al.* 1994; Petit *et al.* 1995; Lefebvre and Poulin 1996; Warkentin and Hernández 1996). It also winters in swamps and wet woodlands and occasionally in drier woodlands (including pine forest), mainly below 1300 m (Bent 1953; Arendt 1992; Curson 1994). The habitat preferences (e.g. structure, species composition, spatial characteristics, stand age, moisture regimes) of wintering Prothonotary Warblers have not yet been quantitatively described, though black mangrove (*Avicennia germinans*) forest is a primary habitat type in Venezuela, Panama and Costa Rica (Lefebvre *et al.* 1994; Lefebvre and Poulin 1996; Warkentin and Hernández 1996; Woodcock *et al.* 2004).

Habitat trends

In the contiguous U.S., only 10% of the original bottomland forest habitat remains (Dickson *et al.* 1995). In the southeastern U.S., forested wetlands are being lost at a very high rate (Winger 1986; Hefner *et al.* 1994). Losses have been particularly high in coastal Louisiana and the Carolinas (U.S. Dept. Interior 1994) — two of the species' core breeding areas.

Likewise, much of southwestern Ontario's historical wetlands and forests have disappeared, been heavily fragmented, and/or have been drained for agricultural purposes (see Snell 1987; Page 1996). In southern Ontario, Snell (1987) estimated that

wetlands had been reduced by about 1.5 million ha (61%) from the time of European settlement to 1982. The great majority of this loss occurred before the 1960s. Nevertheless, between 1967 and 1982, wetlands in southern Ontario had been reduced by about 39,000 ha, mostly due to agricultural activities (Snell 1987). Since 86% of the wetlands that were then remaining in southern Ontario were forested swamps (Snell 1987), most of the recent loss is assumed to have involved this type of habitat. There are now few, large intact blocks of deciduous swamp forest remaining in this region. In recent decades, habitat loss has slowed considerably, with the introduction of provincial policies designed to protect significant wetlands in southern Ontario. Nevertheless, swamp forests continue to be drained through the large system of municipal drains and tile drainage.

On the wintering grounds, loss of coastal mangrove forest is high and likely increasing (Petit *et al.* 1995; McCracken 1998a; see Limiting Factors and Threats below).

Habitat protection/ownership

In Canada, the majority of habitat that has been occupied by Prothonotary Warblers since 1981 occurs on public lands that are typically afforded strong to very strong levels of habitat protection (see also Appendix 1):

Federal lands: The species nests regularly at Big Creek National Wildlife Area and occasionally at Long Point National Wildlife Area (Norfolk Co.). It also occasionally nests at Point Pelee National Park (Essex Co.) when water levels are high.

Provincial Crown lands: Prothonotary Warblers nest regularly at Rondeau Provincial Park (Chatham-Kent), and sporadically at Wheatley Provincial Park (Essex Co.) and Pinery Provincial Park (Lambton Co.).

Conservation Authority lands: Nesting is fairly regular at Holiday Beach Conservation Area (Essex Co.) and Backus Woods (Norfolk Co.), and sporadic at Hillman Marsh Conservation Area (Essex Co.).

Other Conservation lands: Small numbers nest fairly regularly at Coote's Paradise (Hamilton-Wentworth).

There are no known nesting occurrences on First Nations lands. On private lands, several known nesting occurrences occur within "Environmentally Sensitive Areas" that are afforded various levels of protection through municipal plans and/or the Provincial Policy Statement on significant wetlands. Several privately owned sites are managed by hunt clubs, which typically have a strong interest in conserving wetland habitat.

BIOLOGY

Life cycle and reproduction

The Prothonotary Warbler is highly territorial during the breeding season, but not on the wintering grounds (Lefebvre *et al.* 1994; Petit 1999). At breeding sites that support ample suitable habitat, males often settle in well-defended territories that are adjacent to other males (J.D. McCracken, pers. obs.).

Based on territory spot-mapping studies conducted in the core of its range in the southeastern U.S., breeding densities were reported to range from 15 to 70 territorial males per 100 ha, and average about 37 territories per 100 ha (Hamel *et al*. 1982, cited in NatureServe 2005). Territory size is influenced by habitat quality, habitat configuration and population density (see Petit 1999). Mean territory size was about 1.5 ha in Michigan (Walkinshaw 1953), about 0.5 ha in Tennessee (Petit 1989), and from 1-2 ha in Ontario (J.D. McCracken, pers. obs). When feeding nestlings, adults forage in an area that is considerably larger than the male's defended territory – averaging up to 5.4 ha for females (Reynolds 1997 cited in Petit 1999).

Polygyny is rare, but increases when density of nest sites is high (Petit 1991 in Petit 1999). At least three cases of polygyny are known in Canada, all of which involved after-second year (ASY) males (J.D. McCracken, pers. obs.).

Peck and James (1998) reported egg dates in Ontario ranging from 25 May – 3 July, but several nests with eggs have since been found as late as 21 July (Prothonotary Warbler Recovery Team, unpubl. data).

Clutch size ranges from 2 to 8 eggs, but 4 to 6 is the most usual (Walkinshaw 1957; Blem and Blem 1992). Older females are inclined to lay larger clutches than younger females, and first clutches are larger than second clutches (Blem and Blem 1992; Blem *et al*. 1999a). Both clutch size and reproductive success are positively related to the abundance of insect prey (Lyons 2005).

In the southern U.S., the Prothonotary Warbler is typically double-brooded, while northern populations are typically single-brooded (Walkinshaw 1941). Double broods in Ontario are rare, but second nesting attempts are commonplace if the first nest is destroyed early in the season (J.D. McCracken, unpubl. data).

Nests are constructed by both sexes, with the male's involvement limited to helping place the moss foundation, while the female completes the lining (Petit 1999). Incubation period ranges from 10-14 days and averages about 12 days (Podlesak and Blem 2002). Incubation is done entirely by the female (Petit 1999). Both parents assist with feeding the young, which remain in the nest for 9-11 days (Podlesak and Blem 2002).

Nesting success is highly variable, and largely depends on predation and parasitism rates, which in turn are largely influenced by whether the studies are based on natural cavity nests or employ nest boxes. Well-designed nest boxes confer protection against cowbird parasitism and mammalian predators when predator guards are used. Variability is also heavily influenced by the local density of House Wrens (Troglodytes aedon), a very aggressive competing species that is known to usurp Prothonotary Warbler nests and destroy their eggs and young. For example, Walkingshaw (1941) reported that 56% of the Prothonotary Warbler eggs that were laid in nest boxes successfully fledged young in Tennessee, compared to only 26% in Michigan. He attributed the low success rate in Michigan to high densities of House Wrens. In the absence of House Wrens, 44% of Prothonotary Warbler nests in nest boxes in Mississippi were successful, fledging an average of 3.1 young (Twedt and Henne-Kerr 2001). In Ontario, annual nest success (primarily in nest boxes) over a seven-year period ranged from 44% to 67%, with most losses attributed to House Wrens (Dobbyn and McCracken 2005; McCracken and Wood 2005).

Prothonotary Warblers mature in one year and, like most small birds, generally have a short life span. Walkinshaw (1953) estimated that the average life span of males was about 2.5 years. The longevity record for the Prothonotary Warbler is about 8 years (Blem *et al.* 1999a). Probability estimates for annual survival of adults in Tennessee were about 53% for males and 47% for females (Petit 1999). Likewise, in one study in Virginia, about 48% of female Prothonotary Warblers that were banded as adults returned to nest at least once in subsequent years (Blem *et al.* 1999a). Walkinshaw (1953) reported return rates of male and females in Michigan at 50% and 20%, respectively.

Information on the sex structure of the population in Canada is limited to data collected during annual population and nesting surveys that were undertaken from 1997-2005. It is recognized that unmated males are much more likely to be located by surveyors than unmated females. Nevertheless, an average of about 37% of all territorial male Prothonotary Warblers in Canada remained unmated during the course of the breeding season (McCracken and Wood 2005). Hence, at the northern limits of its breeding range in Canada, the sex ratio appears to be skewed towards males, suggesting that males have a higher propensity to drift farther north during spring migration than females.

During the period 1999-2005, the national recovery team captured and banded a total of 35 adult Prothonotary Warblers during the nesting season (Table 1). Ward (2005) noted that age structure should be skewed in favour of older birds in isolated populations where immigration is low. Indeed, this appears to be the case for Prothonotary Warblers in Canada, where after-second year (ASY) birds accounted for about 71% of the captured population (Table 1). The proportion of known yearling males (indicative of immigration) accounted for only about 18% of the breeding population, which appears consistent with Ward's (2005) findings for isolated populations.

Table 1. Ages of adult Prothonotary Warblers captured at nest sites in Canada (1999-2005). AHY = after hatching year, SY = second year, ASY = after second year.

Sex	AHY	SY	ASY	Total
Male	0	3	14	17
Female	2	5	11	18
Total	2	8	25	35

The Prothonotary Warbler is an insectivore, gleaning insects from leaves, twigs and branches, mostly from the subcanopy layer up to about 7 m in height (Petit 1999). During the breeding season, favoured foods include caterpillars, flies, midges, and spiders. Breeding males and females that are attending nests may segregate according to foraging height and prey items, with males foraging higher than females and more apt to deliver caterpillars to nestlings than females (Petit 1999; J.D. McCracken, pers. obs.). If fledged young move into the upper canopy, adults will adjust their foraging height (and presumably diet) accordingly.

Predation/parasitism

Some protection from some types of potential nest predators is probably conferred because Prothonotary Warbler nests are situated in cavities over open water (e.g. Nice 1957; Hoover 2006). Moreover, it is generally believed that nest boxes offer protection against many forms of predation (e.g. Nilsson 1986; Moller 1989; Blem *et al*. 1998; 1999b; Mitrus 2003; McCracken and Wood 2005), compared to nests in natural cavities.

Including studies involving nest boxes, nest predation rates are highly variable, ranging from: 2.6% to 53.3% in Tennessee (Petit *et al.* 1987; Petit 1989; Petit 1991; Petit and Petit 1996); 15.5% in Virginia (Blem and Blem 1992); 27.6% in Wisconsin (Flaspohler 1996); 44% in Michigan (Walkinshaw 1941); 42% in Illinois (Hoover 2006) and about 40% in Ontario (J.D. McCracken, unpubl. data).

Excluding avian predators, losses of Prothonotary Warbler young and eggs are attributed to fox snakes (*Elaphe vulpina*), raccoons (*Procyon lotor*), mice (*Peromyscus* spp.), weasels (*Mustela* spp.), and squirrels (Walkinshaw 1938; Bent 1953; Guillory 1987; Petit 1989; Blem and Blem 1992; Flaspohler 1996; Petit and Petit 1996; Petit 1999; Hoover 2006). In Canada, the raccoon is probably the predominant mammalian predator at cavity nests and in unprotected nest boxes affixed to trees, whereas the southern flying squirrel (*Glaucomys volans*) is the predominant mammalian predator on nests placed in protected nest boxes affixed to metal poles (J.D. McCracken, unpubl. data).

In the northern part of the Prothonotary Warbler's breeding range the destruction of eggs and young by House Wrens is apt to be the single most serious cause of Prothonotary Warbler nest failure (Walkinshaw 1941; Bent 1953; Walkinshaw 1953;

Best and Fondrk 1995; Flaspohler 1996; Knutson and Klaas 1997; McCracken and Wood 2005). Moreover, unlike the protection that nest boxes afford against many other kinds of predators, they confer no protection against House Wrens (Doherty and Grubb 2002; McCracken 2004; Dobbyn and McCracken 2005). In Canada, House Wrens figure most prominently in the destruction of Prothonotary Warbler nests at sites that do not have large, unbroken areas of forest interior (Dobbyn and McCracken 2005; McCracken *et al*. 2006). As such, some habitat changes can lead to increased interspecific interactions with wrens (see Limiting Factors and Threats).

Brood parasitism from Brown-headed Cowbirds (*Molothrus ater*) may also limit population size and contribute to population declines by reducing productivity of Prothonotary Warblers (McCracken 1984; Flaspohler 1996). For a cavity-nesting species like the Prothonotary Warbler, cowbird parasitism rates in natural cavities can be surprisingly high: 21% in Tennessee (Petit 1989; 1991); 25.7% in Iowa (based upon data in Bent 1953); 26.9% in Wisconsin (Flaspohler 1996); and 27.1% in Ontario (Peck and James 1998). Many Prothonotary Warbler breeding studies are based on artificial nest structures, which usually confer protection against parasitism (Walkinshaw 1991; Best and Fondrk 1995; Flaspohler 1996; McCracken and Wood 2005), because nest hole diameter is typically smaller than in many natural situations, preventing access to cowbirds. In addition to the amount of edge in local sites, it is likely that land-use patterns and regional forest fragmentation determine the regional abundance of cowbirds (Flaspohler 1996). Distance from the historical heartland of the cowbird's range may also be a factor (Hoover and Brittingham 1993).

Physiology

Most information on physiology relates to migration and wintering energetics. There does not appear to be anything unusual about the Prothonotary Warbler's energetics, though it may be able to replenish spring fat reserves faster than some other warbler species (Moore and Kerlinger 1987, cited in Petit 1999). As a trans-Gulf migrant (see Petit 1999), it relies upon an ability to lay down extensive fat deposits before carrying out long, non-stop flights over open water.

During nesting, there is evidence that the use of moist green moss in nests has a favourable damping effect on extremes of temperature and humidity (Blem and Blem 1994).

Dispersal/migration

The Prothonotary Warbler is a long-distance migrant that typically begins to arrive in southern Ontario in the first week of May and departs by September (James 1991). In spring, males precede females to the breeding grounds (Blem and Blem 1992; Petit 1999), and older birds typically precede younger birds (J.D. McCracken, pers. obs.). Because of the species' rarity, no important areas that concentrate migrating Prothonotary Warblers are recognized in Canada. Nevertheless, during spring migration, the species occurs most regularly in small numbers along the north shore of

Lake Erie (e.g. Holiday Beach, Pelee Island, Point Pelee, Rondeau, Long Point). There are very few records of the species at these locations in the fall, probably because these sites are not used as fall stop-over destinations. The species appears to simply depart the province in one migration jump.

The Prothonotary Warbler is a nocturnal migrant. In Canada, it is believed to migrate solitarily, but it frequently occurs in small flocks when undertaking trans-Gulf migrations and on the wintering grounds (see Petit 1999).

Little information is available on post-fledging dispersal, but most young likely remain within about 250 m of the natal area for the first few weeks (Petit 1999; J.D. McCracken, pers. obs.). Petit (1999) reported an instance of a fledgling that was about 6 weeks old wandering several kilometres.

First-year Prothonotary Warblers are not very site-faithful to natal areas (Walkinshaw 1941, 1953; McCracken *et al*. 2006; Wood 2006), and likely disperse widely. However, after-second-year (ASY) individuals, particularly males, exhibit strong fidelity to breeding sites, often using the same nest sites in successive years (Walkinshaw 1941, 1953; McCracken and Wood 2005; Wood 2006). In one study in Virginia, up to 48% of females that were banded as adults returned to the same forest to nest at least once in subsequent years (Blem *et al.* 1999a). Many of the breeding locations in Canada have a long record of occupancy, though the species does not necessarily recur at every site in every year (McCracken 1984, 1987).

To date, the only recorded long-distance dispersal event in Canada involves an adult female that was originally colour-banded at a nest north of Long Point, ON and relocated three years later nesting at Rondeau, ON – a dispersal distance of about 120 km (McCracken and Wood 2005).

There is incomplete information on the degree of year-to-year site fidelity to wintering sites, but there is every indication that the Prothonotary Warbler is quite site faithful, with annual rates of returns ranging from about 13% to 29% (McNeil 1982; Faaborg and Arendt 1984; Lefebvre *et al.* 1994; Warkentin and Hernández 1996; Woodcock *et al.* 2005).

Interspecific interactions

Petit (1999) reported that Prothonotary Warblers were intolerant of many species during the breeding season. Where they occupy the same breeding territory, males interact particularly aggressively towards Yellow Warblers (Dendroica petechia), presumably because of similar colouration and chip notes (J.D. McCracken, pers. obs.). There is one known instance of hybridization between a male Prothonotary and a female Yellow Warbler (Speirs 1956).

As noted earlier, interspecific interactions with House Wrens are often intense. Not only do wrens directly destroy Prothonotary Warbler eggs and young, but they also build

many “dummy” nests, often filling every available cavity in their territory with sticks. This directly displaces nesting Prothonotary Warblers, and indirectly reduces cavity availability, thereby further increasing competition for nest sites. Moreover, the sticks are liable to persist in the cavities for many years, effectively rendering them unsuitable for other species. House Wrens produce at least two broods per year, which means that their impacts extend throughout the duration of the Prothonotary Warbler’s nesting season.

In very open areas, Tree Swallows (*Tachycineta bicolor*) can also be serious competitors for nest sites (Best and Fondrk 1995; McCracken *et al*. 2006). However, because Tree Swallows nest relatively early and are typically single-brooded, competition for nest sites begins to decline at the end of June, and they are not considered as serious a competitor as wrens. Moreover, unlike wrens, swallows do not aggressively destroy the eggs of competitors, nor do they usurp other cavities by building “dummy” nests.

Adaptability

Although the Prothonotary Warbler has rather exacting habitat requirements at all times of the year, it readily makes use of artificial structures for nesting, and readily occupies various types of nest boxes, including wax-board milk cartons (e.g. Fleming 1986; Hoover 2006) and plastic bottles (e.g. Fondrk 1996). This attribute has resulted in the proliferation of numerous nest box programs, many of which have apparently been effective at bolstering local populations of Prothonotary Warblers (see Petit 1999). However, there is also evidence that nest box provisioning could be ineffectual, and potentially even detrimental, at sites where House Wren densities are high (Walkinshaw 1991; Dobbyn and McCracken 2005).

Prothonotary Warblers appear to be very “tame,” and tolerate human presence at all times of the year, even in the vicinity of the nest site (Walkinshaw 1957; Petit 1999).

POPULATION SIZES AND TRENDS

Search effort

Because of the relative inaccessibility of its swamp forest habitat, the Prothonotary Warbler is not particularly well surveyed by the roadside-based Breeding Bird Survey (Robbins *et al.* 1986; Flaspohler 1996). Hence, specialized search effort is required to accurately reveal its presence and numbers. Breeding bird atlas surveys and associated site and regional inventories offer the best information on its distribution and numbers in Canada. A second Ontario atlas, which has just completed five years of effort, provides the best information on distribution and trends in Canada. The two atlas periods (1981-85 and 2001-05) involved comparable search effort: about 124,000 person hours were logged in the first atlas versus over 148,000 hours in the second. In addition, intensive surveys for the species have been conducted annually since 1997 by

the national recovery team, so current information on the species in Canada is undoubtedly more comprehensive than historically.

Abundance

Based on extrapolations made from Breeding Bird Survey data, the continental population of Prothonotary Warbler is estimated at about 900,000 pairs (Rich *et al.* 2004), over 99% of which reside in the U.S., mostly in the southeastern states. Intensive surveys in Canada from 1997 to 2006 have seldom located more than 20 mated pairs (McCracken *et al*. 2006). In addition to paired birds, from 5-14 unmated territorial males have been located annually since 1997. The most recent population survey conducted in 2005, suggests a current population size of between 28 and 34 adults, including unmated males.

Fluctuations and trends

Although the Breeding Bird Survey is not particularly suited for monitoring Prothonotary Warbler population trends (i.e., flagged as data with a deficiency; Sauer *et al*. 2005) it is the only such source of information at the continental scale. Breeding Bird Survey results suggest that the continental population has experienced a significant long-term decline of –1.3%/year between 1966 and 2005 ($p = 0.02$; N = 474 routes; Sauer *et al.* 2005), or a population decline of about 40% overall. Results from the last 10 years (1996-2005) indicate a non-significant increase of 0.13%/year ($p = 0.89$; N = 283 routes). The long-term declines appear to have been quite widespread, including the southeastern core of the Prothonotary Warbler's breeding range.

In Canada, trend information cannot be determined from Breeding Bird Surveys because sample sizes are too small. Trend information, therefore, comes from surveys that target Prothonotary Warblers and from the Ontario Breeding Bird Atlas.

Intensive surveys conducted annually since 1997 have found between 8 and 20 pairs (McCracken *et a*l. 2006), down from an estimated maximum of 40-80 pairs during the period 1981-1986 (McCracken 1984, 1987). Based on information from these surveys, the population of Prothonotary Warblers in Canada has decreased from an estimated 40 pairs in 1995 (Page 1996) to 8 pairs in 2005, which amounts to an 80% decrease in population size in the last decade.

In Canada, the species is best known from Rondeau Provincial Park. The Rondeau population was estimated at about 100 pairs during the early 1930s. Following the removal of many dead trees killed by Dutch elm disease, the population was drastically reduced (see McCracken 1984). In all likelihood, the 100-pair estimate was a broad extrapolation, and likely overly optimistic (A. Woodliffe, pers. comm. 2006). Nevertheless, as recently as the early 1950s, Nickell (1969) reported that the Prothonotary Warbler was one of the most numerous species in forested sections of the park. In 1981, the population was estimated at 20-25 pairs (McCracken 1984). Intensive annual surveys of the park were conducted from 1997-2005, during which

time the number of known pairs has ranged from a high of 13 pairs in 2000 to a low of 3 pairs in 2005 and 2006 – the lowest on record (McCracken *et al*. 2006; J.D. McCracken, unpubl. data).

Despite the population decline, the Prothonotary Warbler's distribution in Canada has not changed significantly over the past two decades. During the first Ontario Breeding Bird Atlas in 1981-85, the species was reported from a total of 15 10x10 km squares versus 16 squares during the present atlas (2001-05).

At many locations in Canada (e.g. Point Pelee, Holiday Beach, Long Point region, Hamilton), Prothonotary Warbler populations exhibit a pulsating pattern, with breeding activity periodically blinking on for a number of years and then off. Recolonization of formerly occupied sites, rather than colonization of new areas, appears to attest to the species' rather narrow habitat tolerances.

Rescue effect

Although there is no direct evidence of immigration of Prothonotary Warblers from the U.S., some immigration must take place, particularly from nearby breeding stations in northern Ohio, and potentially from more scattered populations residing in Michigan, Pennsylvania, and New York. A population viability analysis for the Canadian population was conducted by Tischendorf (2003), who used metapopulation and individual-based, spatially explicit models that were based on parameters for fecundity, juvenile and adult survival, density dependence, initial population size (24 pairs), 1000 simulation runs, dispersal, demographic stochasticity, and environmental stochasticity. In the absence of immigration, all models showed that the Canadian population had a >90% probability of extirpation within 100 years. However, results predicted that immigration of at least one female per year from potential source populations in the U.S. was sufficient to eliminate the extirpation risk.

Rescue effect depends, however, on the probability that immigrants successfully locate mates and breed, which is entirely density-dependant. Small amounts of immigration are unlikely to sustain small, fragmented, isolated populations of migrant landbirds (McCracken 1998b; Ward 2005). Tischendorf's (2003) modelling procedures did not consider the fragmented and isolated nature of the Prothonotary Warbler population in Canada, and so may be overly optimistic.

The probability of rescue effect also largely depends upon the density and distribution of a species in adjacent jurisdictions and how well it is faring there. Breeding bird atlas maps from the Great Lakes states (e.g. Eaton 1988; Peterjohn and Rice 1991; Walkinshaw 1991) reveal that occurrences of Prothonotary Warblers within 100 km of Ontario are extremely scattered and localized, suggesting that there are few reliable source populations for Canada. This suggests that if Prothonotary Warblers were to disappear from Canada they would not likely be replaced by birds from the U.S.

LIMITING FACTORS AND THREATS

In Canada, the breeding range of the Prothonotary Warbler appears to be limited primarily by suitable climate and habitat availability (Tischendorf 2003). Judging from abundance mapping derived from the Breeding Bird Survey (Sauer *et al.* 2005), the Prothonotary Warbler's northern breeding range may be influenced further by densities of its principle nest-site competitor – the House Wren. The core breeding ranges of the two species demonstrate little overlap.

Loss/degradation of breeding habitat

The decline of Prothonotary Warbler populations in the U.S. is attributable to loss and degradation of its wetland habitat (Petit 1999). A similar pattern of habitat loss has occurred in the species' breeding range in Canada, where nearly all deciduous swamp forests have been drained to varying degrees and/or have been cut-over (see Habitat Trends above). Drainage of swamp forests, whether through ditching, agricultural tiling, municipal drains or irrigation, depletes the water table and removes standing water. Degradation of breeding habitat in this way poses one of the most significant, widespread and ongoing threats facing the species in Canada.

Adverse effects of both flooding and drought have been reported. In riparian habitats, short-term floods can be a major cause of Prothonotary Warbler nest failures (Walkinshaw 1953; Flaspohler 1996; Knutson and Klaas 1997). At the same time, however, Knutson and Klaas (1997) suggest that periodic major flooding can benefit Prothonotary Warblers by maintaining suitable floodplain habitat in the face of competition with House Wrens for nest sites. Meanwhile, long-term high water events in swamp forest can result in massive dieback of trees, rendering habitat unsuitable (Page 1996). Likewise, the species does not persist very long at sites where successive droughts dry up swamp forest habitat (McCracken *et al.* 2006).

The Prothonotary Warbler will likely be sensitive to climate change, especially at the northern periphery of its range. Periodic high water levels on the Great Lakes appear to benefit the species (McCracken *et al*. 2006; Wormington 2006). Most climate change scenarios in the Great Lakes basin predict lessening amounts of precipitation, increased evaporation of surface water, and reduced ground water supplies (e.g. Smith *et al*. 1998; Environment Canada 2001). Because the species is so highly dependent on the availability of water, it seems likely that the negative effects stemming from lower water supplies would offset any northward range expansion that might otherwise be expected to occur as a result of warming temperatures (see Matthews *et al.* 2004).

Development activities can also contribute to the loss of habitat. One regularly occupied nesting site (Turkey Point) was destroyed when it was developed into a marina in the late 1970s (McCracken 1984). Because some jurisdictions in southern Ontario still do not have tree-cutting bylaws, some forms of development are also likely to involve removal of large swaths of forest and drainage of swamps. For example, a proposal to develop a large swamp forest, which was believed to support one or more

Prothonotary Warblers, into a golf course was eventually stopped, but not before the site had been severely fragmented by ditching and the clearing of fairway lanes (McCracken and Mackenzie 2003). In addition, residential/estate development adjacent to swamp forests is apt to artificially increase local populations of nest predators (e.g. raccoons) and/or competitors (e.g. House Wrens).

Likewise, logging disturbances that take place in occupied habitat create forest openings and edge habitat that can result in increases in numbers of nest competitors, nest predators, and nest parasites. Overharvest by logging also reduces the amount of open water cover in swamp forests through heightened evaporation. The increased light penetration can also result in rapid encroachment of invasive plants (e.g. *Phragmites*). In addition, removal of standing dead timber results in loss of nesting cavities.

Loss of wintering habitat

Coastal mangrove forest in Latin America is highly threatened by deforestation for building supplies, charcoal production and resort development (Terborgh 1989; Petit *et al.* 1995; and reviewed by McCracken 1998a). Mangrove habitat is also under increasingly intense pressure from commercial shrimp farmers (e.g. Arendt 1992). Loss and degradation of wintering habitat is believed to have a strong effect on wintering Prothonotary Warblers (Lefebvre *et al.* 1994; Warkentin and Hernández 1996; McCracken 1998a), and is likely contributing to the species' decline continentally. A relatively high level of site fidelity on the wintering grounds is believed to increase the species' sensitivity to habitat loss and disturbance (e.g. Holmes and Sherry 1992; Warkentin and Hernández 1996).

Invasive forest insects

Forest insect infestations have the potential to kill large numbers of trees. While this could benefit Prothonotary Warblers in the short term through the creation of more dead stubs, the long-term impact is expected to be severe if the affected trees make up a large proportion of the canopy. Anything that significantly opens the tree canopy is apt to result in significant degradation in habitat quality, whether it is through encroachment of invasive plants or increased numbers of wrens and cowbirds.

The emerald ash borer (*Agrilus planipennis)* is of increasing concern in southern Ontario, since ash is a frequent subdominant tree in swamp forests here (McCracken *et al*. 2006). The Asian long-horn beetle (*Anoplophora glabripennis)* presents another important emerging concern, depending upon its ability to spread beyond its present area of containment in the Toronto region and its affinity for silver and red maple, which are typically dominant trees in Prothonotary Warbler swamp habitats.

Invasive plants

Two invasive species of plants – *Phragmites* and European black alder (*Alnus glutinosa*) – can significantly degrade Prothonotary Warbler breeding habitats, particularly when water levels are low and/or when canopy cover is reduced.

Within the last decade at Rondeau Provincial Park, *Phragmites* has expanded dramatically through many of the slough forests, especially in the larger and more open sloughs and in areas where canopy closure has been reduced due to catastrophic tree windthrow (see below; McCracken *et al.* 2006). Because the Prothonotary Warbler requires expanses of open water, this invasive emergent effectively fills in the open pools of water, rendering nesting habitat unsuitable. European black alder is a highly invasive shrub that can also significantly degrade Prothonotary Warbler nesting habitat in open swamp forest conditions, in much the same way as *Phragmites*. It is becoming increasingly abundant in one important nesting area (McCracken *et al*. 2006).

Catastrophic weather events

The intensity and frequency of storms (including hurricanes) on both the wintering and breeding grounds is anticipated to increase as a result of climate change. Owing to the Prothonotary Warbler's clumped and restricted distribution in Canada, catastrophic weather events along the north shore of Lake Erie pose a serious threat to the species. Such an event occurred at Rondeau Provincial Park in July 1998, resulting in a dramatic change in forest structure (Larson and Waldron 2000). The number of Prothonotary Warblers nesting at Rondeau has declined markedly since then, likely because the more open canopy has favoured House Wren populations (Dobbyn and McCracken 2005; McCracken *et al*. 2006). A similar severe weather event at Point Pelee in the late 1970s resulted in significant windfall and may have reduced habitat suitability for Prothonotary Warblers there (D.A. Sutherland *fide* V. McKay and A. Wormington).

SPECIAL SIGNIFICANCE OF THE SPECIES

The Prothonotary Warbler is one of only two species of Wood Warbler that nest in tree cavities. Owing to its extreme habitat specificity, the Prothonotary Warbler may be a useful indicator of the quality of forested wetlands. Its attraction to bird watchers also gives it local socio-economic importance.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The Prothonotary Warbler is presently regulated as an Endangered species under Canada's *Species at Risk Act* and by Ontario's *Endangered Species Act*. General protection is also afforded through the *Migratory Birds Convention Act*. In addition, regulations and policies, which promote protection of its breeding habitat in Ontario, benefit the species. For example, the Natural Heritage component of Ontario's

Provincial Policy Statement supports conservation measures for Significant Wetlands, Significant Woodlands, Significant Wildlife Habitat, and Significant Areas of Natural and Scientific Interest – all areas where Prothonotary Warblers are liable to occur – and provides protection for significant habitat of Threatened or Endangered species. In addition, the Ontario Ministry of Natural Resources has produced silvicultural guidelines for managing forests in southern Ontario that are relevant to protection of Prothonotary Warbler habitat (OMNR 2000). Finally, the majority of the breeding population now remaining in Ontario occurs on public, protected lands (see Habitat Protection/Ownership above).

Within the Partners In Flight (PIF) North American Landbird Conservation Plan (Rich *et al.* 2003), the Prothonotary Warbler is regarded as one of 100 species on the continental "Watch List" (the list of species of greatest continental conservation concern), primarily because of its high degree of habitat specificity at all times of the year and its continental downward trend. Although it is still common and widespread in the southeastern U.S. and is currently ranked as G5 by NatureServe (2005), there is concern about its status in the northern portion of its range (Table 2).

Table 2. NatureServe (2005) ranks and status designations for Prothonotary Warbler in Ontario and the adjacent Great Lakes states.

Jurisdiction	Rank	Designation
Illinois	S5	Not listed
Indiana	S4	Not listed
Michigan	S3	Special Concern
Minnesota	SNR	Not Listed
New York	S2	Not Listed
Ohio	S3	Special Concern
Ontario	S1S2	Endangered
Pennsylvania	S2S3	Special Concern
Wisconsin	S3	Special Concern

TECHNICAL SUMMARY

Protonotaria citrea
Prothonotary Warbler — Paruline orangée
Range of occurrence in Canada: Ontario

Extent and Area Information	
• Extent of occurrence *(EO) (*km^2*)* • Based on the range envelope of known/probable breeding occurrences provided in Figure 2	ca 15,000 km²
• *Specify trend in EO*	Stable
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (*km^2*)* • Based on current estimated population of no more than 20 pairs, each occupying territories of 2 ha	0.4 km²
• *Specify trend in AO*	Declining
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations from Figure 2*	10
• *Specify trend in # (since last COSEWIC assessment)*	Stable
• *Are there extreme fluctuations in number of locations?*	No
• *Specify trend in area, extent or quality of habitat*	Stable or declining depending on location
Population Information	
• *Generation time (average age of parents in the population)*	2-4 years
• *Number of mature individuals* • Based on most recent population surveys conducted in 2005, includes counts of unmated males	28-34 individuals
• *Total population trend:*	Decline
• *% decline over the last/next 10 years or 3 generations* Based on estimated minimum population of 40 pairs in 1995 (Page 1996), versus 8 pairs in 2005	80%
• *Are there extreme fluctuations in number of mature individuals?*	No
• *Is the total population severely fragmented?*	No
• *Specify trend in number of populations*	Stable
• *Are there extreme fluctuations in number of populations?*	N/A
• *List populations with number of mature individuals in each:*	
Threats (actual or imminent threats to populations or habitats)	
• Loss/degradation of breeding habitat • Loss of Wintering Habitat • Invasive plants and insects	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* **USA:** Generally secure across most of its US range, although Breeding Bird Survey results show a long-term continent-wide decline of –1.3%/year between 1966 and 2005.	
• *Is immigration known or possible?*	Yes
• *Would immigrants be adapted to survive in Canada?*	Yes
• *Is there sufficient habitat for immigrants in Canada?*	Yes, but it is highly fragmented
• *Is rescue from outside populations likely?*	Maybe, but the closest source populations are small, scattered and likely in decline

Quantitative Analysis	PVA model predicts >90% chance of extinction within 100 yrs, when no immigration, and 0% when there is immigration of 1 female per year
Current Status: COSEWIC: Endangered (1996,2000,2007); Ontario: Endangered	

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code**: A2b, C2a(i), D1

Reasons for Designation:

In Canada, this species breeds only in deciduous swamp forests in southwestern Ontario. It has shown an 80% decrease in abundance over the last 10 years and its current population is between 28 and 34 mature individuals, only. Threats include loss and degradation of breeding habitat, loss of coastal mangrove forests in Central and South America where the species winters, and habitat disturbances that result in increased nest site competition with House Wrens and increased nest parasitism by Brown-headed Cowbirds.

Applicability of Criteria

Criterion A: (Declining Total Population): Endangered A2b; population has declined by 80% over the last three generations

Criterion B: (Small Distribution and Decline or Fluctuation): Does not meet criterion

Criterion C: (Small Total Population Size and Decline): Endangered C2a(i); population contains 28-34 mature individuals, the population has been steadily declining over the last 20 years and this may continue as habitat is further degraded and no population contains > 250 mature individuals

Criterion D: (Very Small Population or Restricted Distribution): Endangered D1; population contains 28-34 mature individuals

Criterion E: (Quantitative Analysis):

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Jon McCracken is presently the Ontario Program Manager for Bird Studies Canada (BSC) – a non-profit institution dedicated to the research, monitoring, and conservation of Canada's birds. He graduated from the University of Western Ontario with an Honours Bachelor of Science in zoology in 1977. As a contract biologist and environmental consultant for government and non-government agencies, he subsequently worked on a large variety of projects, with a particular focus on site and regional assessments of breeding birds. Since joining BSC in 1989, he has been heavily involved in developing, implementing and overseeing a variety of volunteer-based, bird monitoring programs, including the Canadian Migration Monitoring Network, the Marsh Monitoring Program, and the Ontario Breeding Bird Atlas. He has also been extensively involved in a large variety of species at risk assessments and species recovery programs in Ontario, and is presently the co-chair for the Prothonotary Warbler recovery team.

COLLECTIONS EXAMINED

Examination of zoological collections was not warranted in the preparation of this assessment.

Appendix A. List of Important Areas Recently Known to Support Prothonotary Warblers in Ontario (1991-2005).

Region	Site name	UTM 10x10 km square (NAD83)	Maximum population in time period[1]	History of occupancy	Ownership
Essex	Amherstburg	17LG25	3 pairs	Likely occupied annually since at least 2001	private
Essex	Holiday Beach	17LG35	4 pairs	Likely occupied annually since at least 1997	Essex Region CA; private
Essex	Hillman Marsh	17LG75	1 pair	Occupied ephemerally	Essex Region CA; private
Chatham-Kent	Rondeau Provincial Park	17MG27; 17MG28; 17MG38	15 pairs	Occupied annually at least since the 1930s	Ontario Parks
Norfolk	Hahn Woods (base of Long Point)	17NH31	5 pairs	Occupied more or less annually since the 1930s	CWS and private
Norfolk	Long Point (remote)	17NH71	1 pair	Occupied somewhat ephemerally in several scattered locations since at least the early 1980s.	CWS and private
Norfolk	Backus Woods	17NH42	5 pairs	Occupied in most years since the early 1980s	Long Point Region CA and private
Norfolk	Lower Big Creek	17NH41	3 pairs	Occupied regularly but somewhat ephemerally in several scattered locations since at least the 1930s	CWS and private
Hamilton-Wentworth	Dundas Marsh	17NH89	2 pairs	Occupied fairly regularly since the 1950s	Royal Botanical Gardens

[1]Together, these sites have the capacity to support over 40 pairs of Prothonotary Warblers.